**Declaration in accordance with Schedule 2, Part 3 of the Environmental Planning and Assessment Regulation 2000**

Submission of Environmental Impact Statement prepared under Part 5.1 of the (NSW) Environmental Planning and Assessment Act 1979

Environmental Impact Statement prepared by:

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<tr>
<th>Name</th>
<th>Qualifications</th>
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In respect of Parramatta Light Rail Project Environmental Impact Statement

Applicant name: Transport for NSW

Applicant Address: Level 10, 130 George Street, Parramatta NSW 2150

Proposed development: The project would comprise an approximate 12-kilometre alignment from Westmead to Carlingford and Camellia and would consist of a mix of both on-street and dedicated corridor alignment. Between Westmead and Camellia, the project would generally be located along existing streets within Westmead, the Parramatta CBD and the suburbs of Rosehill and Camellia. Between Camellia and Carlingford, the project would be located within the existing T6 Carlingford Line rail corridor. Full details of the proposed development are included in Chapters 5 and 6 of the Environmental Impact Statement.

Land to be developed: Generally along existing roadways and the existing T6 Carlingford Line rail corridor. Requires some acquisition of private land in adjacent areas. Please refer section 5.14 of the Environmental Impact Statement for details.

Environmental Impact Statement: An Environmental Impact Statement is attached that assesses all matters specified in the Secretary’s Environmental Assessment Requirements dated 19 April 2017, in accordance with Part 5.1 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 19 April 2017, and that, to the best of my knowledge the information contained in the Environmental Impact Statement is not false or misleading.

Signatures: [Mark Hather's signature] [Alex McDonald's signature]

Name: Mark Hather Alex McDonald
Date: 22 August 2017 22 August 2017
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<td>Oliver Edgson</td>
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<td>Laura Lynch</td>
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<td>Mark Hather</td>
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Appendix B: Secretary’s environmental assessment requirements checklist
Appendix C: Planning and statutory requirements
Appendix D: Community consultation framework
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<td>ABS</td>
<td>Australian Bureau of Statistics</td>
</tr>
<tr>
<td>ACM</td>
<td>asbestos-containing material</td>
</tr>
<tr>
<td>Active transport</td>
<td>Active transport includes non-motorised forms of transport involving physical activity, such as walking and cycling</td>
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<tr>
<td>AEC</td>
<td>areas of environmental concern</td>
</tr>
<tr>
<td>AEI</td>
<td>areas of environmental interest</td>
</tr>
<tr>
<td>AEP</td>
<td>annual exceedance probability</td>
</tr>
<tr>
<td>agglomeration benefits</td>
<td>agglomeration benefits refer to the productivity benefits firms derive from being located in close proximity to each other, enabling increased interaction between firms with resulting improved productivity through knowledge sharing and collaboration</td>
</tr>
<tr>
<td>AHD</td>
<td>Australian height datum</td>
</tr>
<tr>
<td>AHIMS</td>
<td>Aboriginal Heritage Information Management System</td>
</tr>
<tr>
<td>AMUs</td>
<td>Archaeological Management Units</td>
</tr>
<tr>
<td>ANZEC</td>
<td>Australian and New Zealand Environment and Conservation Council</td>
</tr>
<tr>
<td>AQI</td>
<td>air quality index</td>
</tr>
<tr>
<td>ARI</td>
<td>the average recurrence interval refers to the average or expected value of the periods between exceedances of a given rainfall total accumulated over a given duration</td>
</tr>
<tr>
<td>ARPANSA</td>
<td>Australian Radiation Protection and Nuclear Safety Agency</td>
</tr>
<tr>
<td>AS</td>
<td>Australian Standard</td>
</tr>
<tr>
<td>ASS</td>
<td>acid sulfate soils</td>
</tr>
<tr>
<td>BRT</td>
<td>bus rapid transit</td>
</tr>
<tr>
<td>BTEX</td>
<td>benzene, toluene, ethylbenzene and xylene</td>
</tr>
<tr>
<td>BTS</td>
<td>Bureau of Transport Statistics</td>
</tr>
<tr>
<td>CBD</td>
<td>central business district</td>
</tr>
<tr>
<td>CCLMP</td>
<td>Construction Contaminated Land Management Plan</td>
</tr>
<tr>
<td>CCTV</td>
<td>closed-circuit television</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
</tr>
<tr>
<td>CEMP</td>
<td>construction environmental management plan</td>
</tr>
<tr>
<td>CPTED</td>
<td>crime prevention through environmental design</td>
</tr>
<tr>
<td>CHL</td>
<td>Commonwealth Heritage List</td>
</tr>
<tr>
<td>CLM Act</td>
<td>Contaminated Land Management Act 1997</td>
</tr>
<tr>
<td>CMP</td>
<td>conservation management plan</td>
</tr>
<tr>
<td>CO</td>
<td>carbon monoxide</td>
</tr>
<tr>
<td>CoPC</td>
<td>contaminants or chemicals of potential concern</td>
</tr>
<tr>
<td>CSEP</td>
<td>Community and Stakeholder Engagement Plan</td>
</tr>
<tr>
<td>CSTR</td>
<td>combined services route</td>
</tr>
<tr>
<td>DBH</td>
<td>diameter at breast height</td>
</tr>
<tr>
<td>DBYD</td>
<td>dial before you dig</td>
</tr>
<tr>
<td>DDA</td>
<td>Disability Discrimination Act 1992</td>
</tr>
<tr>
<td>DEC</td>
<td>the former NSW Department of Environment and Conservation; now the NSW Office of Environment and Heritage</td>
</tr>
<tr>
<td>DECC</td>
<td>the former NSW Department of Environment and Climate Change; now the NSW Office of Environment and Heritage</td>
</tr>
<tr>
<td>DECCW</td>
<td>the former NSW Department of Environment, Climate Change and Water; now the NSW Office of Environment and Heritage</td>
</tr>
<tr>
<td>DISPLAN</td>
<td>(Parramatta Local) Disaster Plan</td>
</tr>
<tr>
<td>DP&amp;E</td>
<td>(NSW) Department of Planning and Environment</td>
</tr>
<tr>
<td>DPI</td>
<td>(NSW) Department of Primary Industries</td>
</tr>
<tr>
<td>DSAPT</td>
<td>Disability Standards for Accessible Public Transport 2002</td>
</tr>
<tr>
<td>DSI</td>
<td>Detailed Site Investigation</td>
</tr>
<tr>
<td>dwell time</td>
<td>the length of time that a train is stopped at a station or stop</td>
</tr>
<tr>
<td>EMC</td>
<td>electromagnetic compatibility</td>
</tr>
<tr>
<td>EMF</td>
<td>electromagnetic fields</td>
</tr>
<tr>
<td>EMI</td>
<td>electromagnetic interference</td>
</tr>
<tr>
<td>EPA</td>
<td>NSW Environment Protection Authority</td>
</tr>
<tr>
<td>EP&amp;A Act</td>
<td>NSW Environmental Planning and Assessment Act 1979</td>
</tr>
</tbody>
</table>
### Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>EP&amp;A Regulation</td>
<td>NSW Environmental Planning and Assessment Regulation 2000</td>
</tr>
<tr>
<td>EPBC Act</td>
<td>Commonwealth Environment Protection and Biodiversity Conservation Act 1999</td>
</tr>
<tr>
<td>EPL</td>
<td>environment protection licence</td>
</tr>
<tr>
<td>ESD</td>
<td>ecologically sustainable development</td>
</tr>
<tr>
<td>FBA</td>
<td>(NSW) Framework for Biodiversity Assessment</td>
</tr>
<tr>
<td>GDE</td>
<td>ground dependant ecosystem</td>
</tr>
<tr>
<td>GPAP</td>
<td>Greater Parramatta Access Plan</td>
</tr>
<tr>
<td>GPOP</td>
<td>Greater Parramatta to the Olympic Peninsula</td>
</tr>
<tr>
<td>GREP</td>
<td>government resource efficiency policy</td>
</tr>
<tr>
<td>GIS</td>
<td>geographic information system</td>
</tr>
<tr>
<td>HAMU</td>
<td>heritage archaeological management unit</td>
</tr>
<tr>
<td>HNA</td>
<td>highly noise affected</td>
</tr>
<tr>
<td>ICNG</td>
<td>Interim Construction Noise Guideline</td>
</tr>
<tr>
<td>ISCA</td>
<td>Infrastructure Sustainability Council of Australia</td>
</tr>
<tr>
<td>INP</td>
<td>Industrial Noise Policy</td>
</tr>
<tr>
<td>ISEPP</td>
<td>State Environmental Planning Policy (Infrastructure)</td>
</tr>
<tr>
<td>LEP</td>
<td>local environmental plan</td>
</tr>
<tr>
<td>LGA</td>
<td>local government area</td>
</tr>
<tr>
<td>LNG</td>
<td>liquefied nitrogen gas</td>
</tr>
<tr>
<td>LPG</td>
<td>liquefied petroleum gas</td>
</tr>
<tr>
<td>LRV</td>
<td>light rail vehicle</td>
</tr>
<tr>
<td>μg / m³</td>
<td>micrograms per cubic metre</td>
</tr>
<tr>
<td>mg / m³</td>
<td>milligrams per cubic metre</td>
</tr>
<tr>
<td>matter of NES</td>
<td>matter of national environmental significance (as defined under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999)</td>
</tr>
<tr>
<td>MCA</td>
<td>multi-criteria analysis</td>
</tr>
<tr>
<td>MRI</td>
<td>magnetic resonance imaging</td>
</tr>
<tr>
<td>NBN</td>
<td>national broadband network</td>
</tr>
<tr>
<td>Abbreviations</td>
<td>Definition</td>
</tr>
<tr>
<td>--------------</td>
<td>------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>NCA</td>
<td>noise catchment area</td>
</tr>
<tr>
<td>NHL</td>
<td>National Heritage List</td>
</tr>
<tr>
<td>NML</td>
<td>noise management level</td>
</tr>
<tr>
<td>NO₂</td>
<td>nitrogen dioxide</td>
</tr>
<tr>
<td>NOₓ</td>
<td>oxides of nitrogen</td>
</tr>
<tr>
<td>NPI</td>
<td>the Commonwealth Department of the Environment’s National Pollutant Inventory</td>
</tr>
<tr>
<td>NPW Act</td>
<td>NSW National Parks and Wildlife Act 1979</td>
</tr>
<tr>
<td>NSW</td>
<td>New South Wales</td>
</tr>
<tr>
<td>NSW 2021</td>
<td>NSW 2021: A Plan to Make NSW Number One (NSW Department of Premier and Cabinet, 2011)</td>
</tr>
<tr>
<td></td>
<td>is the NSW Government’s 10 year strategic business plan to rebuild the NSW economy, provide</td>
</tr>
<tr>
<td></td>
<td>quality services, renovate infrastructure, restore government accountability, and strengthen</td>
</tr>
<tr>
<td></td>
<td>local environment and communities</td>
</tr>
<tr>
<td>NSW Long Term Transport Master Plan</td>
<td>the NSW Long Term Transport Master Plan (Transport for NSW, 2012c) is the NSW Government’s 20 year plan to improve the NSW transport system by delivering an integrated, modern transport system that puts the customer first</td>
</tr>
<tr>
<td>O₃</td>
<td>ozone</td>
</tr>
<tr>
<td>OCP</td>
<td>organochlorine pesticides</td>
</tr>
<tr>
<td>OEH</td>
<td>NSW Office of Environment and Heritage</td>
</tr>
<tr>
<td>OEMP</td>
<td>operational environmental management plan</td>
</tr>
<tr>
<td>OHW</td>
<td>overhead wiring</td>
</tr>
<tr>
<td>OOHW</td>
<td>out of hours works</td>
</tr>
<tr>
<td>OPP</td>
<td>organophosphorus pesticides</td>
</tr>
<tr>
<td>PAD</td>
<td>potential archaeological deposit</td>
</tr>
<tr>
<td>PAH</td>
<td>Polycyclic aromatic hydrocarbon</td>
</tr>
<tr>
<td>PCB</td>
<td>polychlorinated biphenyl</td>
</tr>
<tr>
<td>PM₂.₅</td>
<td>particulate matter with an aerodynamic diameter less than 2.5 microns</td>
</tr>
<tr>
<td>PM₁₀</td>
<td>particulate matter with an aerodynamic diameter less than 10 microns</td>
</tr>
<tr>
<td>PMF</td>
<td>probable maximum flood</td>
</tr>
</tbody>
</table>
The project refers to the Parramatta Light Rail project – Stage 1 (the subject of this Environmental Impact Statement).

Rebuilding NSW: State Infrastructure Strategy 2014 (NSW Government, 2014b) outlines the NSW Government’s plan to invest $20 billion in new productive infrastructure to sustain productivity growth in NSW’s major centres and regional communities, as well as to support forecasted population growth of almost six million people in Sydney and more than nine million people in NSW.

Sydney’s Rail Future: Modernising Sydney’s Trains (Transport for NSW, 2012b) is the NSW Government’s long-term plan to increase the capacity of Sydney’s rail network through investment in new services and upgrading of existing infrastructure. Sydney’s Rail Future is being delivered in five stages. The project comprises Stage 4 of Sydney’s Rail Future, which would provide the largest increase in capacity to the Sydney rail network for 80 years.
Western Sydney Light Rail Feasibility Study – Study released by City of Parramatta Council, which identified a number of strategy transport corridors around Parramatta, and recommended the first stage of the Western Sydney Light Rail.
Executive summary

Parramatta Light Rail is one of the NSW Government’s latest major infrastructure projects being delivered to serve a growing Sydney. Parramatta Light Rail Stage 1 (the project) is expected to open in 2023 and will connect Westmead to Carlingford via Parramatta central business district (CBD) and Camellia with a two-way track spanning 12 kilometres. The alignment will link Parramatta’s CBD and Parramatta Station to the Westmead Health precinct, Parramatta North Urban Transformation Program, the new Western Sydney Stadium, the new Powerhouse and Riverside Theatres Cultural Hub, the private and social housing redevelopment at Telopea, Rosehill Gardens Racecourse and three Western Sydney University campuses.

Introduction

By 2036, more than half of all Sydneysiders will call Western Sydney home, a population shift that is pulling the heart of metropolitan Sydney to the west and elevating Parramatta’s status as Australia’s next great city. In the next 20 years, the population of the Parramatta local government area (LGA) will undergo extraordinary growth from 240,000 residents in 2016 to more than 415,000 by 2036. Employment opportunities in Greater Parramatta would also grow, increasing from around 96,000 jobs to around 160,000 jobs by 2036 (Greater Sydney Commission, 2016c).

The majority of this growth will be seen in the Greater Parramatta to the Olympic Peninsula (GPOP) priority growth area, and primarily within several precincts including Westmead, Parramatta North, Parramatta CBD, Camellia, Telopea and Rydalmere. The rate of growth in population and jobs is expected to be far greater than that experienced in the previous 20 years and an effective integrated transport network is now required to support and accommodate this growth.

A key element of the future transport network announced by the NSW Government is the development of the Parramatta Light Rail network. This would deliver a new light rail system for Western Sydney, with Stage 1 of this network being between Westmead and Carlingford via the Parramatta CBD and Camellia.

By providing connections to precincts and with transport hubs along the corridor, Parramatta Light Rail would improve accessibility within the GPOP priority growth area as a key component of an integrated transport network supporting growth. It would provide a new public transport service for precincts undergoing renewal in the GPOP priority growth area and provide connections to major attractions in the Parramatta CBD including the new Western Sydney Stadium and the new Powerhouse Museum.

On 17 February 2017, the NSW Government announced the preferred alignment for the first stage of Parramatta Light Rail (the project), connecting Westmead to Carlingford via the Parramatta CBD and Camellia.

Key features of the project

Key project elements

The project would extend from Westmead to Carlingford via Parramatta CBD and Camellia. The key project elements would include:

» A new light rail network of around 12 kilometres in length (including approximately seven kilometres within the existing road corridor separated from general traffic and approximately five kilometres utilising the existing heavy rail T6 Carlingford Line and Sandown Line for use as light rail corridors and replacing current heavy rail services).
A total of 16 stops (subject to further design development). The stops would form a combination of side and island platforms depending on the final design of the project and existing constraints at each stop location. Platforms would be approximately 45 metres long.

Interchanges with existing rail and/or bus facilities at Westmead, Parramatta CBD and Carlingford.

Light rail vehicle (LRV) driver amenities at the light rail termini at Westmead and Carlingford and at the stabling and maintenance facility at Camellia.

Alterations to road network to accommodate the project.

Active transport infrastructure (e.g. shared paths) and urban design features would be provided along sections of the project alignment.

An integrated stabling and maintenance facility located in Camellia.

An overview of the key project elements is shown on Figure ES.1.

Constructing the project

Construction of the project is expected to commence in mid-2018 (subject to planning approval) and is anticipated to take up to five years.

The main construction activities would include:

- Property acquisition and adjustment including boundary fencing and temporary hoardings (as required).
- Demolishing buildings and structures along the project alignment.
- Relocation of services and utilities.
- Modifications to the surrounding road network.
- Construction of tracks, overhead wiring (OHW) and associated infrastructure (track infrastructure).
- Construction of light rail stops.
- Construction of new and modification of existing bridges and culverts.
- Construction of the stabling and maintenance facility in Camellia.
- Construction of substations and associated electrical works.
- Establishment of construction compounds along the construction alignment for stockpiling and storage of materials.
- Demobilisation, rehabilitation and landscaping of impacted areas prior to the commissioning phase.

A number of activities would be carried out before the start of the substantial construction works. These ‘enabling works’ would be required to make ready the key construction sites and include establishment of construction compounds, relocation of services and utilities, and road modification and reconfiguration.
Executive summary

Parramatta Light Rail | Stage 1 – Westmead to Carlingford via Camellia

Environmental Impact Statement

Figure ES.1 Key project elements

**Project operation**

When operational, the light rail would have the capacity to carry up to 250-300 passengers (equivalent to about six buses). Services would operate on a ‘turn-up-and-go’ basis, operating from 5 am to 1 am, seven days a week with additional services during major events.

The ticketing system for the project would integrate with the Opal electronic ticketing system. Opal top-up machines would be provided at selected stops.
Passenger information systems would be located at each stop and on the LRV providing up-to-date service information.

**Project objectives**

The vision for the whole Parramatta Light Rail is to deliver integrated light rail services that support the NSW Government’s vision for the GPOP priority growth area.

A key consideration for defining the vision has been balancing the specific scope of the Parramatta Light Rail, having light rail services at the core, integrated with other transport services, and supporting the significant land use outcomes envisaged for the study area.

Five project objectives that apply specifically to the project have been identified across four category areas of city shaping, connectivity, place and choice. These are shown in Figure ES.2.

### Figure ES.2 Project objectives

<table>
<thead>
<tr>
<th>Category</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>City Shaping</td>
<td>• Support the vision for Parramatta as a 21st century city – attracting new investment and economic development</td>
</tr>
<tr>
<td></td>
<td>• A catalyst for shaping new growth – activating underutilised lands and providing the transport capacity needed to support sustainable population and employment growth in the area</td>
</tr>
<tr>
<td>Connectivity</td>
<td>• Connecting people and places – supporting the diverse mix of customer journeys that links employment, cultural, educational, health and sporting precincts with existing and new communities</td>
</tr>
<tr>
<td>Place</td>
<td>• Contribute to the creation of local hubs – supporting the creation of attractive and memorable public spaces that are better utilised by communities</td>
</tr>
<tr>
<td>Choice</td>
<td>• Providing attractive transport choices for customers – ‘turn up and go’, safe, reliable, all day light rail service that is integrated with roads, buses, trains and active transport</td>
</tr>
</tbody>
</table>

**Project need and benefits**

The project would provide a catalyst for urban renewal along its corridor, providing connections to areas that will be transformed through significant NSW Government and private investment. By providing a reliable, frequent and convenient new public transport product with connections to existing interchanges, the project would offer an attractive alternative to private vehicles, assisting in minimising car dependence for intermediate trips in the GPOP priority growth area.

The project would complement the existing transport network and other proposed network improvements to support growth and respond to the growing travel demands within and beyond the GPOP priority growth area.
Existing and other transport network improvements include:

» Transformational projects such as WestConnex (under construction), Sydney Metro West (under development) and rapid bus routes along strategic corridors (under development).

» New walking and cycling networks, travel demand management, parking management solutions and road network changes to address regional car and freight movements that currently occur in and around the Parramatta CBD.

Other key strategic benefits of the project would include:

» City shaping benefits – including reduced urban sprawl, improved housing affordability and reduced socio-economic disadvantage.

» Place making benefits – such as improved amenity for customers and residents, improved cycling and pedestrian environments, and health benefits from increased active transport.

» Productivity benefits – this includes reduced transport and logistics costs for businesses, assisting in a transition to a knowledge economy and increased agglomeration benefits from knowledge transfer.

» Transport benefits – including travel-time savings, reduced crowding, reliability improvements and reduced future road congestion.

The new light rail service would have an estimated travel time of 38 minutes between the Carlingford and Westmead light rail stops (refer to Figure ES.3). This includes:

» Eighteen minutes between Carlingford and the Parramatta CBD stops, which is six minutes faster than bus and the equivalent of heavy rail excluding wait time when transferring.

» Six minutes between Cumberland Hospital and Westmead Hospital stops, which is 15 minutes faster than bus.

Figure ES.3 Estimated travel times

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 (EP&A Act). In particular, it addresses the requirements of the Secretary of the Department of Planning and Environment. It also includes consideration of the issues raised by the community and stakeholders during the development of the project.
It is expected that a project of this scale, located in a heavily urbanised environment would have some adverse impacts, particularly during construction. These impacts need to be considered within the context of the overall objectives of the project and the significant transportation and other benefits it would provide over the medium to longer term, and particularly for future generations.

Key biophysical, economic and social considerations 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. This has resulted in a number of design changes and refinements that have mitigated many of the potential significant impacts.

Where impacts cannot be avoided through design modifications, appropriate, well established and proven mitigation measures have been developed. These mitigation measures are consolidated in Chapter 17 – Outcomes, environmental management and mitigation.

Despite these efforts, a number of adverse residual impacts would remain. These impacts would be largely temporary and confined to the construction period. A summary of the key issues as identified in the Environmental Impact Statement are provided in Table ES.1.

**Table ES.1 Summary of key issues**

<table>
<thead>
<tr>
<th>KEY AREAS</th>
<th>IMPACTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic, transport and access (construction)</td>
<td>In some areas of the project (particularly Westmead and the Parramatta CBD), construction work would be carried out adjacent to areas with high volumes of traffic and pedestrians. This would result in some temporary impacts to traffic performance on the surrounding road network due to construction vehicles, temporary road closures, loss of parking spaces and loading zones, bus route diversion, relocation of bus stops, and temporary closure or diversions of pedestrian and cyclist access. With respect to traffic, truck volumes would be low and roads and intersections potentially affected by the project would continue to operate through the construction period generally at a level of service comparable to existing conditions. In areas of high pedestrian activity, construction staging would minimise impact on footpath widths and crossing facilities to maintain existing pedestrian capacity, amenity and safety. Existing pedestrian movements would be maintained along footpaths and crossings, facilitated by traffic controllers where required. There would be consideration of all pedestrians, including vulnerable users, with designs in accordance with legislative requirements (for example, kerb ramps at crossings, maintaining minimum footpath widths). The project would require closure of the T6 Carlingford Line. Replacement bus services would be provided and would operate every 10 minutes in the peak and inter-peak periods on weekdays, and hourly every 30 minutes in the off-peak and evenings. An additional journey time increase of 1-7 minutes (depending on origin station) would be likely during construction for the AM peak. Additional buses would be provided as required to meet peak loads. The buses used would be low-floor and wheelchair accessible, but would not be able to accept motorised scooters as do trains. Where cycle routes and cycleways are impacted by construction worksites, alternate routes would be identified and implemented through appropriate signage and in consultation with Bicycle User Groups and the relevant Road Authority. The project would result in the progressive loss of parking spaces. Around 863 spaces would be potentially affected during construction with around 168 potentially relocated. All accessible parking spaces and loading zones would be (where practicable) be relocated to the adjacent side streets. A detailed process...</td>
</tr>
</tbody>
</table>
for managing impacts on car parking along the corridor has been developed for the project.

Transport for NSW has and would continue to work closely with Roads and Maritime and the City of Parramatta Council to optimise the local and regional road network during construction. Given the progressive nature of construction this would require an iterative and dynamic approach – managed most appropriately through progressive submission and updating of detailed construction management plans.

### Traffic, transport and access (operation)

When operational, the project would provide significant improvements to the public transport network capacity and efficiency including new public transport interchange facilities at and around Westmead and Parramatta Railway stations. For the existing Carlingford line, it would provide customers with a door-to-door saving of up to 21 minutes between Carlingford and the Parramatta CBD.

The project is forecast to attract up to 15,000 per day (2041). This would reduce crowding for remaining heavy rail passengers and improve passenger comfort. It is also expected to provide wider road network benefits by encouraging greater use of public transport - forecast to attract 25,000 cars off the road by 2041, resulting in 188,000 fewer car kilometres each day. This is expected to benefit road users as a result of increased speeds and reduced vehicle operating costs. The community would also benefit as a result of improved safety and reduced pollution, greenhouse gas emissions, noise and barriers to active transport.

### Non-Aboriginal heritage

The project has considered the potential impacts on World Heritage listed Parramatta Park and Old Government House and Domain such that the alignment is located away from the World Heritage buffer zone and therefore minimises any direct impacts on the landscape values. Some minor road works (line marking) would be required within the heritage buffer zone and the alignment may have a minor impact on some of the identified view lines to and from Parramatta Park.

Around 17 State listed items are located in the study area. The project would have direct, visual and/or indirect impacts on the Cumberland District Hospital Group (direct/visual – moderate, indirect – minor, with minor positive impacts from the reinstated views), Lennox Bridge (visual – major, direct – moderate, indirect – minor), the Ancient Aboriginal and Early Colonial Landscape (Robin Thomas Reserve) (visual/direct – moderate, indirect – minor), the Rydalmere Hospital Precinct (former) (direct/visual/indirect – minor) and the Dundas Railway Station Group (direct/visual – moderate, indirect – low). Opportunities to minimise these impacts would be considered during detailed design. Other impacts on State listed items ranged from neutral to minor and would not significantly alter their respective heritage values.

Among the 85 locally-significant heritage items in the study area, the project would result in a major impact on three items – the Royal Oak Hotel and stables and two individually-listed bridges (Camellia Bridge and Carlingford Bridge). These items are proposed to be removed to enable the functioning of the project including road construction in proximity of the rail alignment and installation of the required double tracks. Moderate direct impacts and moderate visual impacts would also occur to two local heritage items – Alfred Square and the former courthouse wall and sandstone cellblock due to the project corridor alignment being located within the curtilages of these items. The remainder of the local heritage items within the study area would have neutral to minor direct, visual and potential heritage impacts and would not be significantly impacted.

Excavation works would have the potential to impact on State and locally significant archaeology, with the exception of areas of known previous extensive ground disturbance.
## KEY AREAS

### IMPACTS

<table>
<thead>
<tr>
<th>Key Areas</th>
<th>Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aboriginal heritage</strong></td>
<td>The project area contains extensive documented and potential Aboriginal archaeological resources associated with the historic inhabitancy of the region by the Burramattagal people. The presence of the Parramatta Sand Body (a geological formation associated with significant Aboriginal archaeology) was also identified within the project area. Containment of the project to existing road and rail transport infrastructure corridors has limited the extent of impact on the area; however, given the linear nature of the project and surrounding spatial constraints including topography/landscape and existing development, alignment selection was not able to avoid all impacts on Aboriginal archaeological sites. A total of 10 Aboriginal archaeological sites/potential archaeological deposit (PADs) were identified within the study area. Archaeological test excavations identified intact sands containing artefacts below modern and historical disturbance in five locations along the project alignment which would be at least partially impacted by the project. Salvage excavations would be carried out for four of the five archaeological sites exhibiting at least a moderate significance prior to the commencement of construction.</td>
</tr>
<tr>
<td><strong>Noise and vibration</strong></td>
<td>Relatively high noise levels are predicted from the construction works in most catchments along the alignment. Noise levels are typically higher for receivers which have a direct line of sight to the works and where construction works are situated in close proximity to receivers. The highest noise levels and greatest impacts are associated with activities that have noise intensive plant items, including rock breakers and concrete saws. Due to the close vicinity of receivers to the works, the assessment has identified that worst-case construction activities are likely to result in high noise levels during noise intensive activities which would be adjacent to receivers. These activities are typically associated with bridge construction works (piling), excavation/earthworks (with rock breakers), pavement works and ballast track works. It is expected; however, that the construction noise levels would frequently be lower than the worst-case levels predicted for significant periods of time. This is because construction works are linear. Less noisy activities would occur at different construction stages and/or would move around the site with increasing distance to the closest receivers. As such, the duration of the noisiest activities would be relatively short at most locations. Construction works would be required to be carried out outside standard construction hours due to the need to minimise impacts on the road network. During the night time, airborne noise levels are expected to exceed the criteria during noise intensive activities. Works outside of standard daytime construction hours would be required in all precincts, given the high volumes of pedestrians and traffic that use these precincts each day. This limits the hours upon which construction works can take place safely. Cumberland Hospital has areas that are likely to be particularly sensitive to noise impacts. Feasible and reasonable mitigation would be considered further during detailed construction planning and in consultation with the NSW Health.</td>
</tr>
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</table>
KEY AREAS | IMPACTS
---|---
**Based on the forecast redistribution of traffic during construction, noticeable increases in road traffic noise are also predicted to occur on less busy routes, particularly local roads linking the construction areas to the main arterial routes.**

The project would apply all feasible and reasonable work practices to meet the Environment Protection Authority’s (EPA) Interim Construction Noise Guideline’s noise management level (NML). This would typically include use of localised hoarding around noise generating plant items and limiting use of noise intensive plant items to daytime or evening periods. All potentially impacted residents would be informed of the nature of works to be carried out, the expected noise levels, duration of noise generating construction works, and contact details during construction. A Construction Environmental Management Plan (CEMP) would also be prepared to provide the framework and mechanisms for the management and mitigation of potential noise and vibration impacts from the project.

Noise and vibration (operation) | The majority of residential and other noise sensitive receivers are predicted to comply with the noise trigger levels as specified in Rail Infrastructure Noise Guideline (RING) (NSW EPA, 2013). Exceedances are however, predicted in most noise catchment areas (NCAs) at receivers which are adjacent to the alignment. This is typically apparent in locations between stops where LRVs speeds are higher, near sections of highly resilient track (being track that can vibrate over a longer length, potentially generating more noise), or near tight radius curves. In total, 41 residential and 46 other sensitive receivers are predicted to be above the noise trigger levels in the 2033 design year. In locations within the CBD; however, existing noise levels are in most cases already above the noise levels predicted from the LRVs.

Reasonable and feasible mitigation would be investigated further during detailed design, including potential property treatments to address residual impacts. The final form of the proposed mitigation measures would be determined during detailed design.

Through Westmead, Parramatta North, Parramatta CBD, and Rosehill and Camellia, the light rail alignment would be on or adjacent to the existing road traffic network. Noise from traffic, along with the airborne noise of the LRVs, may mask ground-borne noise impacts on some receivers. Some buildings within the CBD; however, may experience increases of ground-borne noise.

Receivers in the Carlingford Precinct that are adjacent to the existing T6 Carlingford Line are not anticipated to experience a significant increase in ground-borne noise levels as a result of the project, except in areas where the track alignment is moved substantially closer.

More detailed investigations would be conducted including measurement of existing internal and external noise and vibration levels at particular locations, including ground-borne noise and vibration levels due to the existing road and rail traffic. These investigations would inform the required trackform design in these locations and confirm the appropriateness of the ground-borne noise design goals.

Consultation with the impacted receivers would also be carried out during the detailed design phase to confirm the sensitivity of these locations to ground-borne noise. Investigations would establish the internal noise level achieved by these buildings at present, the location of sensitive spaces within each building and the level to which any sensitive spaces are isolated from airborne noise.
### Executive summary

#### KEY AREAS

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<th>IMPACTS</th>
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#### Business

Business impacts would vary across the local business precincts and would be dependent on the type of business activity. The project is expected to end a number of commercial leases and full acquisition of some commercial properties. Additional commercial properties are also likely to require a partial acquisition (such as strip acquisition). All acquisitions would be managed in accordance with the Land Acquisition (Just Terms Compensation) Act 1991 and in accordance with the improvements and reforms as announced by the NSW Government in October 2016.

Main adverse impacts during construction would include: property acquisitions and lease cessations, decrease in passing trade and potential sales, reduced business visibility, reduction in parking, changes in loading zones locations and reduced amenity due to noise, dust, vibrations and traffic congestion. This would particularly be the case on ‘Eat Street’ in Parramatta CBD where the existing alfresco dining areas would no longer be accommodated during construction. Measures would be implemented to minimise temporary impacts on businesses.

When operational, main positive impacts would include: stimulation of urban renewal and development opportunities, enhanced business connectivity, improved business revenue and viability, increase in passing trade and potential sales and greater connectivity to other employment centres. Main adverse impacts would include: reduction in on-street parking, changes in load zone locations and reduction in passing trade to some businesses due to altered pedestrian network. Space for alfresco dining would be reinstated along Eat Street, where possible.

#### Social

During construction, the project would result in temporary impacts on local amenity for some residents and users of community facilities including patients within Cumberland Hospital due to increased noise, dust and construction traffic. These impacts would be managed through the implementation of mitigation measures and through early consultation with affected parties.

The project would also result in the temporary displacement of homeless people due to construction activities at Prince Alfred Square and within the Parramatta CBD. The presence of construction activities and increased noise from construction works may impact on amenity and perceptions of safety for people in this group, and may require some people to find alternative places to stay. A strategy for managing displacement of homeless people would be prepared in collaboration with the City of Parramatta Council and other agencies in accordance with the NSW Government’s Protocol for Homeless People in Public Places: Guidelines for Implementation (May 2013).

Temporary changes to traffic and access, including for pedestrians, cyclists and motorists would occur near to construction works. This may result in delays and disruptions for motorists and temporary changes to accessibility for pedestrians and cyclists, resulting in some people having to travel further to reach their destination.

#### Local property and land use

The project would require around 41 total property acquisitions and around 102 partial property acquisitions (many of which would only require a small area of land). All acquisitions would be managed in accordance with the Land Acquisition (Just Terms Compensation) Act 1991 and in accordance with the improvements and reforms as announced by the NSW Government in October 2016.

During construction, there would also be a temporary or permanent loss of open space areas associated with works within Prince Alfred Square, Robin Thomas Reserve and Vineyard Creek Reserve. Following completion of construction activities (other than that acquired for the project), these sites would be restored to at least their former condition (unless otherwise agreed with landowners).
### Executive summary

**Parramatta Light Rail | Stage 1** – Westmead to Carlingford via Camellia

**Environmental Impact Statement**

<table>
<thead>
<tr>
<th>KEY AREAS</th>
<th>IMPACTS</th>
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<tr>
<td><strong>When operational, the project would have no major direct impacts on land use, though it would offer substantial future development opportunities. Transport for NSW would address development opportunities and resultant impacts in an integrated manner in direct collaboration with key planning agencies, including the Department of Planning and Environment, UrbanGrowth NSW, the Greater Sydney Commission and City of Parramatta Council. This may include separate development assessment and approval processes which would include further opportunity for community and stakeholder input.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Visual landscape character</strong></td>
<td>In general, the construction of the project would result in minor to high adverse landscape impacts, and minor to high adverse visual impacts. Adverse impacts are anticipated during construction due to the partial road or footpath closures, the presence of construction activity, removal of street trees, building demolition and a general reduction in amenity. High adverse impacts would occur where the project is located within or adjacent to areas of landscape or visual sensitivity (such as heritage or natural landscapes including the Cumberland Hospital heritage precinct), open spaces (such as Prince Alfred Park and Robin Thomas Reserve) or key urban landscapes (such as Church Street). Urban design responses would minimise the permanent impacts on landscape and visual setting; however, some adverse impacts residual impacts would remain.</td>
</tr>
<tr>
<td><strong>Trees</strong></td>
<td>Despite the early design effort, construction of the project would impact a large number of trees including those of moderate and high retention value. Further opportunities to minimise impacts on trees through detailed design or construction methods would be further explored. Where loss of trees is unavoidable, trees removed would be offset in accordance with the Transport for NSW’s Vegetation Offset Guide (2016). Offset of trees would be at a ratio of between 2:1 and 8:1 depending on the size of the tree removed. This would be detailed in a project specific tree offset strategy.</td>
</tr>
<tr>
<td><strong>Hydrology</strong></td>
<td>During construction, potential mainstream flooding impacts would be generally minor in nature and readily mitigated by managing specific detailed design aspects and site planning. Based on the current modelling results, the project can be operated along its entire length up to a 0.2 EY (exceedances per year) flood event. This equates to around a 1 in 5 year flood event. The project would require road regrading in combination with drainage upgrades. This would result in both improvement (reduction) in flood levels or changes to flood levels in locations where overland flows currently affect urban areas along the project corridor. Other potential flooding impacts of the project would include changes to the peak water levels during flood events, increased velocity and scouring of existing waterways, changes to the hydraulic categorisation and flood hazard, impacts on existing emergency management procedures and sensitivity of predicted impacts to climate change. Comprehensive mitigation measures have been identified to manage flooding up to a one percent Annual Exceedance Probability flood event. Predicted increases in flood levels would be resolved during the subsequent design stages of the project.</td>
</tr>
</tbody>
</table>
**KEY AREAS** | **IMPACTS**
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Utilities and services | A substantial number of utilities are anticipated to be affected during construction works, requiring adjustment and/or protection works to avoid interaction with the light rail alignment. Adjustments and/or protection works would be carried out with the involvement of the asset owner. Impacts would be managed through well established and proven established mitigation and management measures.
Sustainability | Sustainability principles have been incorporated throughout the design development process. A project specific environment and sustainability policy has also been developed. Transport for NSW is committed to achieving a minimum Infrastructure Council of Australia (ISCA) score of 65 (an ‘Excellent’ rating) for the project as a whole and for the full lifecycle of the project. This would require the implementation of sustainability initiatives throughout the governance, design, construction and operation of the project.
Cumulative impacts | The cumulative impacts during construction have been a particularly important consideration given the potential overlap with a considerable number of projects in the Parramatta North and Parramatta CBD precincts. Cumulative impacts would be highly dynamic and time/activity specific so are difficult to precisely define in any detail at this stage of the assessment process. Cumulative impacts would be managed and minimised through a comprehensive coordination and consultation process involving a range of State and local government agencies, including the Sydney Coordination Office within Transport for NSW.
Other environmental issues | A number of other issues were assessed in the Environmental Impact Statement such as biodiversity, groundwater, air quality, water quality, contamination, greenhouse gases, hazards and risks. No issues of major risk or consequence were identified. Notwithstanding, management and mitigation measures have been identified to minimise any potential impacts.

**Community consultation**

The stakeholder and community consultation process for the project has played an integral role in informing and scoping investigations for this Environmental Impact Statement and will continue to do so through construction.

Key stakeholders for the project have included:

- State government agencies including agencies that form part of the Transport for NSW cluster, Department of Planning and Environment, UrbanGrowth NSW, Land and Housing Corporation, Property NSW, emergency services, NSW EPA, NSW Office of Environment and Heritage (OEH), Health Infrastructure, NSW Health, Sydney Water and NSW Department of Education.
- Commonwealth Department of the Environment and Energy.
- City of Parramatta Council.
- Public utilities, business and industry groups.
- Directly impacted communities.
- The broader community and interested community groups.
Transport for NSW has been and continues to be interested in community and stakeholder feedback on the project. The Parramatta Light Rail communications objectives include to:

» Communicate the rationale for the project and the transport, community, economic and broader benefits it will deliver, including how it fits into the NSW Government’s plans to increase Sydney’s light rail capacity.

» Identify all relevant stakeholders and their issues and ensure these are addressed as early as possible during the Environmental Impact Statement process for each phase.

» Inform stakeholders about the key features, related issues and benefits of the project.

» Build community and key stakeholder relationships and maintain goodwill.

» Provide information about the planning approvals process and encourage community participation.

» Clearly communicate the timing and proposed staging of the project, including property acquisition processes.

Project justification and conclusions

The project is justified in terms of its strategic transport need and its anticipated benefits, taking into account the objectives of the EP&A Act and matters of ecologically sustainable development. The project is considered to best meet the objectives when compared to all other alternatives considered in terms of:

» City shaping – The project would provide the best catalyst for urban renewal and development of the GPOP priority growth area by providing a new transport mode, signalling a long-term commitment to the area and creating a sense of place with the unique branding of light rail vehicles and stops. It would enable changes to current planning controls and increase the attractiveness of the GPOP priority growth area to households.

» Improve public transport accessibility – It would provide a new turn-up-and-go light rail service between Carlingford and Westmead, with direct links to key assets and planned investments, including Westmead and Cumberland health areas, Western Sydney Stadium, Parramatta CBD, Western Sydney University campuses and the new Powerhouse and Riverside Theatres Cultural Hub.

» Reduced traffic congestion – The project would attract 45,000 passengers per day by 2041, of which 54 per cent would be new public transport customers. This would result in 25,000 fewer cars on the road each day by 2041, improving residential amenity as a result of improved safety and reduced pollution, noise and barriers to pedestrian movements. This would also result in 15,000 fewer heavy rail passengers each day by 2041, reducing crowding.

The consequences of not proceeding with the project would be that the GPOP priority growth area would be a less attractive opportunity and may not achieve the investment required to meet its vision. In addition, continued expansion of the existing road and bus network would increasingly result in higher levels of congestion with the predicted growth in jobs and dwellings over the next 20 years.

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, and where possible, avoided or appropriate mitigation measures developed. This has resulted in a number of design changes that have 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. It is therefore in the public interest that the project proceeds.
Next steps

Transport for NSW is seeking approval from the Minister for Planning for the construction and operation of Parramatta Light Rail (Stage 1). Subsequent steps in the process are as follows:

» Exhibition of the Environmental Impact Statement for a minimum of 30 days and invitation for the community and stakeholders to make submissions.

» Consideration of submissions. Submissions received by the Secretary would be provided to Transport for NSW and any relevant public authorities. Transport for NSW may then be required to prepare and submit:
  • A submissions report, responding to issues raised in the submissions.
  • A preferred infrastructure report, outlining any proposed changes to the project to minimise its environmental impacts or to deal with any other issues raised.

» Determination of the Environmental Impact Statement. The Secretary of the Department of Planning and Environment would then make a decision on the project and, if approved, set 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 Parramatta Light Rail project via www.majorprojects.planning.nsw.gov.au/page/on-exhibition.

Your submission must reach the Department of Planning and Environment by close of business on 23 October 2017. 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 & 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 and Environment to delete your personal information before publication, please make this clear at the top of your letter. You need to include:

1. Your name and address (at the top of the letter only).
2. The name of the application and the application number (SSI 8285).
3. A statement on whether you support or object to the proposal.
4. The reasons why you support or object to the proposal.
5. 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 www.planning.nsw.gov.au/donations or phone 1300 305 695 for a copy.

Address:
Department of Planning and Environment
GPO Box 39, Sydney, NSW 2001.

Your submission should be marked Attention: Director, Transport Assessments.
Part A:
Introduction and need
Introduction

This document comprises the Environment Impact Statement for the project, which has been prepared in accordance with the requirements of Part 5.1 of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act). The Environment Impact Statement document has been prepared to address the Secretary’s Environmental Assessment Requirements (SEARs) which have been issued for the project. This document provides a description of the project and its justification, identifies the existing environment, assesses the likely environmental impacts and outlines the proposed mitigation measures to minimise the likely impacts of the project.

1.1 Background to the Parramatta Light Rail

By 2036, more than half of all Sydneysiders will call Western Sydney home; a population shift that is pulling the heart of metropolitan Sydney to the west and elevating Parramatta’s status as Australia’s next great city. In the next 20 years, the population of the Parramatta local government area (LGA) is expected to undergo extraordinary growth from 240,000 residents in 2016, to more than 415,000 by 2036. Employment opportunities in Greater Parramatta would also grow, increasing from around 96,000 jobs to around 160,000 jobs by 2036 (Greater Sydney Commission, 2016a).

The majority of this growth will be seen in the Greater Parramatta to the Olympic Peninsula (GPOP) priority growth area, and primarily within several precincts including Westmead, Parramatta North, Parramatta central business district (CBD), Camellia, Telopea and Rydalmere.

The potential uplift in population and jobs is far greater than the growth experienced in the previous 20 years and an effective integrated transport network is required to support and accommodate this growth. To support the realisation of the Greater Sydney Commission’s vision for the GPOP priority growth area, there will be the need for an integrated transport network solution that:

» Manages an increase in travel demand.

» Reinforces current strategic planning to strengthen Greater Parramatta as Sydney’s Central City.

» Supports areas of urban renewal and redevelopment, and drives the successful growth of these precincts.

» Improves the liveability in communities across the priority growth area.

» Directly connects new growth precincts with the Parramatta CBD.

To realise the potential of the GPOP priority growth area, an integrated transport plan is currently being developed by the NSW Government. This plan includes consideration of a range of different transport options, which would assist in meeting the transport needs of the future GPOP priority growth area. A key element of the future transport network announced by the NSW Government is the development of the Parramatta Light Rail network, which would deliver a new light rail system for Western Sydney, with Stage 1 of this network being between Westmead and Carlingford via the Parramatta CBD and Camellia.

This work responds to actions identified in the NSW Long Term Transport Master Plan (NSW Government, 2012a) and Sydney’s Light Rail Future – Expanding public transport, revitalising our city (NSW Government, 2012b), and Unlocking Western Sydney’s Potential with Light Rail: Western Sydney Light Rail Feasibility Study (City of Parramatta Council, 2013). Parramatta Light Rail would also support the NSW Government’s vision for Parramatta as the Central City for Greater Sydney. This vision is supported by the Greater Parramatta and the Olympic Peninsula Strategy as outlined in Towards our Greater Sydney 2056 – a draft amendment to update A Plan for Growing Sydney (Greater Sydney Commission, 2016a), the draft West Central District Plan (Greater Sydney Commission, 2016a).
Commission, 2016b) and the draft Greater Parramatta and the Olympic Peninsula vision (Greater Sydney Commission, 2016c).

By providing connections to precincts and with transport hubs along the corridor, Parramatta Light Rail would improve accessibility within the GPOP priority growth area as a key component of an integrated transport network supporting growth. It would provide a new public transport service for precincts undergoing renewal in the GPOP, and would provide connections to major attractions in the Parramatta CBD including the new Western Sydney Stadium and the Museum of Applied Arts and Sciences (previously the Powerhouse Museum).

1.2 Project development

In 2014, the NSW Government shortlisted four corridors where light rail could play a key role in improving transport connections and cater for future growth. This built upon a feasibility study carried out by City of Parramatta Council. These corridors were:

6 Parramatta to Macquarie Park via Carlingford.
7 Parramatta to Castle Hill.
8 Parramatta to Bankstown.
9 Parramatta to Sydney Olympic Park and Strathfield/Burwood.

All four shortlisted corridors included a core spine between Westmead and Camellia.

The NSW Government carried out a strategic assessment of the four shortlisted corridors and the core spine to determine a preferred light rail network (refer to section 3.4). This included an analysis of potential employment and urban renewal opportunities, transport benefits as well as engineering and environmental challenges. Further discussion regarding the options development process carried out for the project is provided in Chapter 3 (Project development and alternatives).

This assessment work showed that the Macquarie Park and Sydney Olympic Park/Strathfield corridors would deliver strong urban renewal and transport benefits. As such, both corridors and the CBD spine were selected as the basis of the preferred network. The preferred network included the Camellia to Carlingford section of the Macquarie Park corridor, which would offer a more frequent and reliable transport service to users of the existing T6 Carlingford Line. Transport for NSW is currently carrying out further studies of benefits and costs associated with a future extension from Carlingford to Epping (part of the Macquarie Park corridor).

In December 2015, the NSW Government announced a preferred network for Parramatta Light Rail to link areas that are being transformed by government and private investment, including Westmead, Parramatta North, Camellia, Telopea, Rydalmere, Sydney Olympic Park and Strathfield. The project would also serve major attractions in the Parramatta CBD including the new Western Sydney Stadium and the proposed Museum of Applied Arts and Sciences.

Since the announcement of the preferred network in 2015, further investigations into possible route options within the preferred network were carried out in consultation with key stakeholders. This confirmed the preferred alignment that would be best placed to achieve the project objectives. Further detail regarding this process is provided in Chapter 3 (Project development and alternatives).

On 17 February 2017, the NSW Government announced Stage 1 of the Parramatta Light Rail (the project), a 12 kilometre light rail corridor which would link the following areas:

» Westmead
» North Parramatta
» Parramatta CBD
» Rosehill
Introduction

» Camellia
» Rydalmere
» Dundas
» Telopea
» Carlingford.

The Parramatta Light Rail network would be delivered in stages to ensure the infrastructure needed to support the current growth of Greater Parramatta is in place and that the light rail is operating as soon as possible. Planning work continues for Stage 2 of the network with consideration of other strategic transport projects (such as Sydney Metro West). This planning work is expected to be completed by the end of 2017.

1.3 Project overview

The project would comprise an approximate 12 kilometre alignment from Westmead to Carlingford and Camellia and would consist of a mix of both on-street and dedicated corridor alignment. Between Westmead and Camellia, the project would generally be located along existing streets within Westmead, the Parramatta CBD and the suburbs of Rosehill and Camellia. Between Camellia and Carlingford, the project would be located within the existing T6 Carlingford Line rail corridor.

1.3.1 Key features of the project

The project would extend from Westmead to Carlingford via Parramatta CBD and Camellia. The key features of the project would include the following:

» A new light rail network of around 12 kilometres in length (including approximately seven kilometres within the existing road corridor separated from general traffic and approximately five kilometres utilising the existing T6 Carlingford Line and former Sandown freight line for use as light rail corridors and replacing current heavy rail services).

» A total of 16 stops (subject to further design development). The stops would form a combination of side and island platforms depending on the final design of the proposed action and existing constraints at each stop location. Platforms would be approximately 45 metres long.

» Interchanges with existing rail, bus and/or ferry facilities at Westmead, Parramatta CBD and Carlingford.

» Creation of two light rail and pedestrian zones (no general through vehicle access) within the Parramatta CBD along Church Street (generally between Market Street and Macquarie Street) and Macquarie Street (generally between Howwood Place and Smith Street).

» Light rail vehicle (LRV) driver amenities at light rail termini at Westmead and Carlingford and at the stabling and maintenance facility at Camellia.

» An integrated stabling and maintenance facility located in Camellia. The facility would consist of a number of elements including:
  • Stabling area for storage of LRVs.
  • A stabling and maintenance building including a workshop containing servicing tracks to carry out LRV inspections and administration facilities for managing the administration, operation and maintenance of the project systems.
  • An automatic train wash plant and sanding plant for replenishing LRV sand boxes and for testing sanding equipment.
» Provision of a number of new bridge structures along the alignment including over James Ruse Drive and Clay Cliff Creek, Parramatta River (near the Cumberland Hospital), Kissing Point Road and Vineyard Creek, Rydalmere.

» Modification of Lennox Bridge (Church Street) and a number of existing bridge structures along the T6 Carlingford Line (including Parramatta River, Adderton Road and Pennant Hills Road) to accommodate the light rail alignment and active transport links.

» Alterations to the existing road network to accommodate the project, including line marking, additional traffic lanes and turning lanes, new traffic signals, and changes to traffic flows (e.g. creation of left-in, left-out arrangements etc.).

» Ancillary infrastructure including up to eight electricity substations and overhead lines and poles to allow for LRV operations.

» Active transport corridors and additional urban design features along sections of the alignment and at stop locations.

» Replacement of existing rail infrastructure along the former Sandown Line corridor, between the junction at Camellia Station and the stabling and maintenance facility, and removal of the remaining rail infrastructure, east of the stabling and maintenance facility.

» Closure of the existing T6 Carlingford Line north of Parramatta Road including replacement of existing rail infrastructure between Camellia and Carlingford, and removal of existing rail assets at the Parramatta Road level crossing (such as signalling and boom gates).

An overview of the key features of the project is shown on Figure 1.1. Further details regarding the key components of the project are provided in Chapter 5 (Project description – Infrastructure and operations) of this Environment Impact Statement.
1.4 Proponent and method of delivery

Transport for NSW is the proponent for the project and will deliver the planning and concept design phases of the project, and the early works (such as demolition of existing structures, utility works, implementation of road configurations etc. - refer to section 6.5 for details). The detailed design, construction, maintenance and operation of the project would be delivered by the private sector under contracts with Transport for NSW.
1.5 Planning and statutory requirements

A detailed description of the planning and statutory requirements and the planning approvals process for the project is provided in Appendix C (Planning and statutory requirements) to this Environmental Impact Statement. The following section provides a summary of the assessment.

1.5.1 Planning approvals process

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

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

Clause 79 of State Environmental Planning Policy (Infrastructure) 2007 (Infrastructure SEPP) permits development for the purpose of a railway or rail infrastructure facilities to be carried out by or on behalf of a public authority without consent, provided that the project is not carried out on land reserved under the NSW National Parks and Wildlife Act 1974 (NPW Act).

As the project would be for a light rail and would be carried out by or on behalf of Transport for NSW on land that is not reserved under the NPW Act, the project could, subject to identification of significant impacts, be assessed under Part 5 of the EP&A Act. Development consent (under Part 4 of the EP&A Act) from the relevant local council is not required. Transport for NSW, as proponent and determining authority, has however, formed the view that the project would have the potential to significantly affect the environment. As such, the project is proposed to be assessed under Part 5.1 of the EP&A Act.

Following determination that the project would be assessed under Part 5.1 of the EP&A Act, a State significant infrastructure (SSI) application and supporting document was submitted to the Secretary of the NSW Department of Planning and Environment on 24 February 2017. The Secretary issued the Secretary environmental assessment requirements (SEARs) for the project on 19 April 2017, with revised SEARs issued on 21 July 2017 (refer to Appendix A). This Environmental Impact Statement has been prepared to address the SEARs and the requirements of Schedule 2, Part 3 of the Environmental Planning and Assessment Regulation 2000 which sets out the general requirements and of this Environmental Impact Statement. A checklist reflecting where each of the SEARs is addressed in this Environmental Impact Statement is provided at Appendix B.

Approval from the NSW Minister for Planning is required following public consultation before Transport for NSW can proceed with the project.

1.5.1.2 Declaration as critical State significant infrastructure

Section 115V of the EP&A Act provides for the declaration of State significant infrastructure and critical State significant infrastructure, while Part 5.1 of the EP&A Act establishes the assessment and approval regime for State significant infrastructure and critical State significant infrastructure.

Transport for NSW is seeking for the project to be declared by the Minister for Planning as critical State significant infrastructure under sections 115U(4) and 115V of the EP&A Act. As part of the declaration, it is anticipated that an amendment to Schedule 5 of State Environmental Planning Policy (State and Regional Development) 2011 would be made. The project remains subject to assessment under Part 5.1 of the EP&A Act and requires the approval of the Minister for Planning.

A summary of the applicable planning approvals process for the project is summarised in Figure 1.2.
1.5.2 Additional approvals

1.5.2.1 NSW legislation

As detailed in Appendix C, Sections 115ZG and 115ZH of the EP&A Act provides that a number of additional approvals, permits and licences that would otherwise be triggered for development under NSW legislation are either not required for SSI projects and/or critical SSI, or cannot be refused and must be substantially consistent with the Part 5.1 approval (refer section C.1.4).

However, some additional approvals may still be required for the project under other relevant NSW legislation which are listed in Table 1.1.
### Table 1.1 Other approvals potentially required for the project

<table>
<thead>
<tr>
<th>LEGISLATION</th>
<th>RELEVANT PROVISIONS</th>
<th>APPROVAL/ACTION REQUIRED</th>
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<tr>
<td>Roads Act 1993 (Roads Act)</td>
<td>Section 138 of the Roads Act requires consent from the relevant roads authority for the erection of a structure, or the carrying out of work in, on or over a public road, or the digging up or disturbance of the surface of a road. The project would require full and partial road closures for construction and operation. However, under clause 5(1) in Schedule 2 of the Roads Act, public authorities do not require consent for works on unclassified roads.</td>
<td>Consent required from the relevant roads authority for works impacting classified roads, such as James Ruse Drive.</td>
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<tr>
<td>Transport Administration Act 1998 (TA Act)</td>
<td>Section 104N(2) of the TA Act allows for the Minister for Transport to declare the route of a light rail system. Declaration of the project as a light rail system would allow for various exemptions from various approvals, duties, rates and taxes, pursuant to Division 2A, Part 9 of the TA Act. Part 9, Division 2A provides a number of special provisions for light rail systems.</td>
<td>It is intended that the project be declared as a light rail system. Following that dedication, the project would become a ‘light rail system’ within the meaning of Part 9, Division 2A and the other provisions of this Division of the TA Act would apply. This includes section 104P which makes Transport for NSW the proponent/determining authority for the development of light rail systems, including anything that is incidental to the carrying out of such a development.</td>
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<td>Section 99A of the TA Act deals with ‘Closure and disposal of railway lines’. Specifically, this section identifies that the rail infrastructure owner cannot close any railway line or part of a railway line within the Greater Metropolitan Area unless authorised by an Act of Parliament or an order by the Minister for Transport. An order can only be made if the Minister is satisfied that the closure is required for the purposes of, or in connection with, SSI. The order, if made, does not take effect until the carrying out of SSI is approved.</td>
<td>It is intended that an order will be made in accordance with Section 99A of this Act with respect to the section of the existing T6 Carlingford Line (between Parramatta Road and Carlingford Station) and the Sandown Line (a branch freight line).</td>
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</table>

#### 1.5.2.2 Commonwealth legislation

The project is not considered to trigger the need for approval under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). Although the permanent alignment for the project would be located within the vicinity of the World Heritage and National Heritage site of Old Government House and Domain (located within about 150 to 300 metres at the closest locations in Westmead), the project is not expected to impact on the curtilage or identified buffer zone of the site. The alignment may, however, have a minor impact on some of the identified view lines to and from Parramatta Park. This issue is discussed further in Chapter 12 (Local impacts: Westmead Precinct) and Technical Paper 10 – Built Heritage Impact.
Assessment. Beyond Old Government House and Domain, there are no other likely impacts on matters of national environmental significance under the EPBC Act.

Notwithstanding the above, a referral was made to the Commonwealth under the EPBC Act on 15 June 2017 identifying the project as a non-controlled action due to the low potential for impacts on identified matters of National Environmental Significance (NES). Based on the outcome of this referral, the Department of the Environment and Energy (DoEE) advised on 19 July 2017 that the project is considered to be a non-controlled action.

1.6 Purpose and structure of this Environmental Impact Statement

1.6.1 Purpose of the Environmental Impact Statement

The purpose of this Environmental Impact Statement is to obtain approval for the project, as per the requirements under section 115Y of the EP&A Act.

The Environmental Impact Statement has been prepared in accordance with the SEARs which have been issued by the Department of Planning and Environment for the project (refer Appendix A). A checklist of the SEARs is provided in Appendix B.

The Environment Impact Statement documents the range of engagement activities that Transport for NSW has used to inform the community and stakeholders about the project during (and prior to) preparation of this Environmental Impact Statement. This process, and the consideration of public submissions received as part of the Environment Impact Statement public exhibition, provides the basis for stakeholders to convey their views on the project to the NSW Government.

1.6.2 Environmental Impact Statement approach and structure

1.6.2.1 Environmental Impact Statement approach

This Environmental Impact Statement takes a regional and local (precinct-based) approach to assessment of potential environmental impacts. This approach was taken because:

» The alignment for the project passes through a series of diverse local areas (each of which have been identified as having distinctive characteristics).

» Presenting all the potential local environmental impacts for a precinct in one chapter in this Environmental Impact Statement makes it clearer and easier for each of the local communities along the alignment to determine how they might be affected by the project.

» Due to its nature and size, the project also has the potential for regional level impacts on the environment, including regional planning and land use, traffic, transport and cumulative impacts. There are also other environmental impacts (such as biodiversity, contamination and air quality impacts) that are best described on a regional or whole-of-project basis, rather than specific to individual precincts.

» The identification of the proposed precincts along the project alignment was developed, taking into account a series of factors including:
  • Consideration of existing land uses along the project alignment, with the aim of grouping similar land uses, such as residential, education, health/medical or industrial developments.
  • Identification of previous precincts identified in regional and metropolitan strategies including:
    • Greater Sydney Commission – as part of their vision for the GPOP priority growth area
    • Department of Planning and Environment – as part of the GPOP urban renewal area.
Consideration of physical barriers, such as major landscape features (e.g. Parramatta River) or major transport routes (e.g. Victoria Road).

The extent of the five local precincts identified and assessed for the purposes of this Environmental Impact Statement (Part D – Chapters 11 to 15) are described below and shown in Figure 1.3:

- **Westmead** – between the Westmead terminus and the Parramatta River crossing west of the Cumberland Hospital site.
- **North Parramatta** – between the Parramatta River crossing west of the Cumberland Hospital site and Victoria Road (north of Prince Alfred Square).
- **Parramatta CBD** – between Victoria Road and Purchase Street, Parramatta (inclusive of Robin Thomas Reserve).
- **Rosehill and Camellia** – between Purchase Street, Parramatta and the stabling and maintenance facility, Camellia and Parramatta River, Camellia. This precinct also includes the existing T6 Carlingford Line, south of the Camellia junction to Parramatta Road.
- **Carlingford** – consisting of the existing heavy rail line, north of Parramatta River, Rydalmere.
1.6.2.2 Environmental Impact Statement structure

This Environmental Impact Statement is presented across a series of volumes. Volumes 1A to 1C contain the main Environmental Impact Statement (this report) and the appendices. Volumes 2 to 7 provide the technical papers that form the technical basis of the main Environmental Impact Statement. The structure and content of the main Environmental Impact Statement is outlined in Table 1.2.
### Table 1.2 Structure and content of the main Environmental Impact Statement report

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>DESCRIPTION</th>
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<tr>
<td><strong>Part A</strong></td>
<td><strong>Introduction and need</strong></td>
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<tr>
<td>Chapter 1</td>
<td><strong>Introduction</strong></td>
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<tr>
<td></td>
<td>Provides a background to the project and an overview of the key features of the project. The chapter also outlines the overall structure and content of the Environmental Impact Statement.</td>
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<tr>
<td>Chapter 2</td>
<td><strong>Strategic context and need</strong></td>
</tr>
<tr>
<td></td>
<td>Provides the strategic context, explains the need for and objectives of the project.</td>
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<tr>
<td><strong>Part B</strong></td>
<td><strong>Parramatta Light Rail and its development</strong></td>
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<td>Chapter 3</td>
<td><strong>Project development and alternatives</strong></td>
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<td></td>
<td>Describes how the Parramatta Light Rail network was developed and reviews the strategic alternatives and options that were considered.</td>
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<td>Chapter 4</td>
<td><strong>Community and stakeholder consultation</strong></td>
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<td></td>
<td>Provides an overview of the community consultation and stakeholder engagement processes that have been carried out for the project network (including the project) to date. Identifies a summary of the key issues raised during the consultation and how these have been addressed within the Environmental Impact Statement.</td>
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<tr>
<td>Chapter 5</td>
<td><strong>Project description - Infrastructure and operation</strong></td>
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<td></td>
<td>Identifies the physical infrastructure and built form of the project. Describes the functionality of the light rail stops and the proposed operation of the project.</td>
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<td>Chapter 6</td>
<td><strong>Project description - Construction</strong></td>
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<td>Outlines how the project is likely to be constructed and identifies the location and function of the main construction sites which would be required to construct the project.</td>
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<tr>
<td>Chapter 7</td>
<td><strong>Assessment approach and environmental risk analysis</strong></td>
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<td></td>
<td>Outlines the overall assessment approach to assess the environmental impacts associated with the project.</td>
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<tr>
<td><strong>Part C</strong></td>
<td><strong>Regional environmental impacts</strong></td>
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<tr>
<td>Chapter 8</td>
<td><strong>Regional planning, transport and socio-economic impacts</strong></td>
</tr>
<tr>
<td></td>
<td>Assesses the key potential regional impacts associated with the project including broader land use planning and urban development, regional transport and traffic impacts and potential socio-economic benefits and impacts.</td>
</tr>
<tr>
<td>Chapter 9</td>
<td><strong>Regional cumulative impacts</strong></td>
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<td>Assesses the potential for cumulative impacts with other projects within the GPOP priority growth area which may interact with the construction and/or operation of the project.</td>
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<td>CHAPTER</td>
<td>DESCRIPTION</td>
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| Chapter 10 | **Other environmental impacts**  
Identifies environmental impacts which have been assessed at a broader regional level, including biodiversity; Aboriginal heritage; hydrology, drainage and surface water quality; groundwater; contamination; air quality; utilities and services; greenhouse gas and climate change; waste; hazards and risks; and privacy. |
| **Part D** | **Local environmental impacts** |
| Chapter 11 | **Local impacts: Westmead precinct**  
Identifies potential environmental impacts which may impact on the Westmead precinct at a local level, including local traffic and access, heritage, visual, noise, and vibration and land use impacts. |
| Chapter 12 | **Local impacts: Parramatta North precinct**  
Identifies potential environmental impacts which may impact on the Parramatta North precinct at a local level, including local traffic and access, heritage, visual, noise, and vibration and land use impacts. |
| Chapter 13 | **Local impacts: Parramatta CBD precinct**  
Identifies potential environmental impacts which may impact on the Parramatta CBD precinct at a local level, including local traffic and access, heritage, visual, noise, and vibration and land use impacts. |
| Chapter 14 | **Local impacts: Rosehill and Camellia precinct**  
Identifies potential environmental impacts which may impact on the Rosehill and Camellia precinct at a local level, including local traffic and access, heritage, visual, noise, and vibration and land use impacts. |
| Chapter 15 | **Local impacts: Carlingford precinct**  
Identifies potential environmental impacts which may impact on the Carlingford precinct at a local level, including local traffic and access, heritage, visual, noise, and vibration and land use impacts. |
| **Part E** | **Environmental management and conclusions** |
| Chapter 16 | **Project sustainability**  
Describes the overall approach to sustainability and how specific objectives and initiatives are being incorporated into the design, construction and operation of the project. |
| Chapter 17 | **Environmental management and mitigation**  
Describes the environmental management, monitoring and compliance systems that would be implemented during construction of the project, in addition to providing a consolidated list of all proposed mitigation measures identified in Chapters 10 to 16. |
| Chapter 18 | **Environmental risk analysis**  
Provides an overview of the environmental risk analysis carried out for the project, highlighting both pre- and post-mitigation risk outcomes. |
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<th>CHAPTER</th>
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| Chapter 19 | **Justification and conclusions**  
Confirms the justification for the project, considering the project objectives, consistency with the principles of ecologically sustainable development and the objects of the EP&A Act. |
| Chapter 20 | **References**  
Provides a list of references used to inform the Environmental Impact Statement. |
| **Appendices** | |
| Appendix A | Secretary’s Environmental Assessment requirements |
| Appendix B | Secretary’s Environmental Assessment requirements checklist |
| Appendix C | Planning and statutory requirements |
| Appendix D | Community Consultation Framework |
| **Technical papers** | |
| Volume 2 | » Technical Paper 1 – Traffic and Transport Existing Conditions  
» Technical Paper 2 – Construction Traffic and Transport Impact Assessment  
» Technical Paper 3 – Operational Traffic and Transport Impact Assessment |
| Volume 3 | » Technical Paper 4 – Biodiversity Assessment Report  
» Technical Paper 5 – Aboriginal Cultural Heritage Assessment |
| Volume 4 | » Technical Paper 6 – Water Quality Impact Assessment  
» Technical Paper 7 – Flooding Impact Assessment  
» Technical Paper 8 – Contaminated Land Assessment  
» Technical Paper 9 – Air Quality Impact Assessment |
| Volume 5 | » Technical Paper 10 – Built Heritage Impact Assessment  
» Technical Paper 11 – Non-Aboriginal Archaeological Assessment |
| Volume 6 | » Technical Paper 12 – Landscape and Visual Impact Assessment  
» Technical Paper 13 – Noise and Vibration Impact Assessment |
| Volume 7 | » Technical Paper 14 – Business Impact Assessment  
» Technical Paper 15 – Social Impact Assessment |
2 Strategic context and need

This chapter discusses the strategic need and benefits of the project taking into account key NSW government transport and planning strategies and policies as well as the overall project objectives.

2.1 The opportunity and challenges

2.1.1 NSW Government’s vision in defining Greater Sydney

As Sydney’s population grows from 4.7 million people in 2016 to 8 million people in 2056, a metropolis focused on a single eastern Sydney CBD will not meet the changing demographic needs of Greater Sydney (Greater Sydney Commission, 2016a).

To address and support this growing population, the NSW Government’s vision includes defining Greater Sydney as a metropolis of three cities, with Western Sydney Airport as the anchor for the Western City, the Sydney central business district (CBD) for the Eastern City, and Greater Parramatta for the Central City. At the heart of the Central City is the Greater Parramatta and Olympic Peninsula (GPOP) priority growth area — a region spanning 13 kilometres east to west from Strathfield to Westmead, and extending seven kilometres north to south from Carlingford to Granville.

The relationship of GPOP to the three-cities vision for Greater Sydney is shown on Figure 2.1.

![Figure 2.1 GPOP as part of the metropolis of three cities in Greater Sydney](image)
Within the GPOP priority growth area, a number of precincts have been identified by the NSW Government based on the potential for urban development. The key GPOP precincts relevant to the project include Westmead Health Precinct; Parramatta North Urban Transformation area; Parramatta CBD; Camellia Town Centre; Rydalmere Precinct; and Telopea Priority Precinct.

2.1.2 Greater Parramatta to the Olympic Peninsula priority growth area

The GPOP priority growth area possesses strategic attributes that make it attractive to be developed as Sydney’s Central City. Substantial public and private investment in the GPOP priority growth area is planned over the next five to 10 years. The size of these investments provides a unique opportunity to realise the vision for the area and transform it. These investments include:

» Westmead Health Precinct – This area is undergoing a major transformation with the potential for 30,000 to 50,000 additional jobs.
» Western Sydney University (Westmead campus) – Currently constructing a commercial tower to serve as a new campus for 10,000 additional students.
» The new Western Sydney Stadium and the new Powerhouse Museum and Riverside Theatres Cultural Hub.
» Parramatta North Urban Transformation area providing an additional 4,500 new dwellings.
» Telopea Priority Precinct.
» Development within Parramatta CBD such as Parramatta Square.

Substantial growth in jobs, dwellings and population within the GPOP priority growth area is expected to occur over the next 20 years. The population of the Parramatta local government area (LGA) will undergo extraordinary growth from 240,000 residents in 2016 to more than 415,000 by 2036. Employment opportunities in Greater Parramatta would also grow, increasing from around 96,000 jobs to around 160,000 jobs by 2036 (Greater Sydney Commission, 2016c).

The GPOP priority growth area already contains a blend of well-established social infrastructure, providing the foundations for it to further evolve into a vibrant, modern and attractive area. This includes a health and education precinct (Westmead), parks and recreation (such as Parramatta Park and Bicentennial Park), arts and culture (such as the Riverside Theatres), tertiary education campuses (Western Sydney University), and sports and recreation facilities (Western Sydney Stadium and Sydney Olympic Park).

The centrality of the GPOP priority growth area within Greater Sydney provides the opportunity for it to be an attractor to people from all parts of Sydney – to visit, work, live and play. This will support Parramatta becoming a 30-minute city, consistent with the Australian Government’s Smart Cities Plan and its vision for cities where residents can easily access employment, schools, shopping, services and recreational facilities, all within a 30-minute journey.

2.1.3 The challenges to realising the GPOP vision

The potential for growth within the GPOP priority growth area is currently constrained by a lack of transport connectivity and accessibility, which in turn affects further densification and opportunities for rezoning within the precinct. Planned growth and urban renewal in the GPOP priority growth area will not be achieved by just maintaining the current transport network and planning controls. The core challenges to achieving the GPOP vision are discussed below.

2.1.3.1 Accessibility

The GPOP priority growth area precincts are separated by geographical and human-made features such as the Parramatta River, Parramatta Road, M4 Motorway, large green spaces, heavy
Strategic context and need

rail lines and the major arterial roads of James Ruse Drive, Victoria Road and Silverwater Road. These act as barriers to effectively connect and integrate the various precincts.

Current public transport services are infrequent, inaccessible or indirect to destinations within the GPOP priority growth area. Heavy rail services on the T6 Carlingford Line are limited due to single line running and the transfer required at Clyde to the T1 Western Line, with only two services per hour in each direction in the morning peak. The T1 Western Line is crowded during peak times and is predominately used for commuting to the Sydney CBD. Nearly 60 per cent of the GPOP priority growth area precincts do not have a direct bus connection between precincts and are not directly connected to important social infrastructure.

The limited public transport accessibility and the availability of relatively cheap parking in the GPOP priority growth area results in relatively high levels of car use. In 2016, cars accounted for nearly 73 per cent of trips to and from GPOP priority growth area precincts in the two-hour morning peak (7 am to 9 am). The number of car trips is expected to increase by 52 per cent by 2041. This will result in an additional 30,000 cars in the area in the two-hour morning peak, of which 9,000 will be commuting to the Parramatta CBD.

2.1.3.2 Congestion

In 2016, more than 20 per cent of roads in the GPOP priority growth area were already experiencing congestion in the two-hour morning peak. Accommodating planned growth in the GPOP priority growth area is forecast to generate significant additional traffic volumes, which will further increase congestion. By 2026, it is forecast that nearly 30 per cent of roads in the GPOP priority growth area will be congested, increasing to nearly 40 per cent by 2041.

Congestion, particularly at key intersections, will be higher by 2041. For example, Hawkesbury Road will be at 153 per cent of capacity and Church Street at 152 per cent of capacity, and the intersection of James Ruse Drive and Kissing Point Road will be at 180 per cent of its capacity in 2041.

2.1.3.3 City-shaping impacts

The lack of transport accessibility and increased congestion will constrain growth, hamper productivity improvements and lead to sub-optimal urban renewal outcomes. Changes to planning controls are limited by current transport accessibility and capacity limits to accommodate planned growth. For example:

» Westmead Redevelopment – Currently 76 per cent of trips to Westmead Hospital are made by car. Considering the predicted growth of the precinct, and the limited proposed increase in staff and public car parking, significant mode shift from private vehicles will be needed.

» Parramatta North – Currently serviced by buses running to the Parramatta CBD, but with no direct bus service between Cumberland Hospital and Westmead Hospital. The Parramatta North Urban Transformation area was partially rezoned in mid-2015. There is the potential for further rezoning (potential 1,500 dwellings) and it is expected that transport improvements would be required to support planned growth.

» Parramatta CBD – Planned uplift in floor space ratios would be constrained given known transport capacity issues.

» Camellia – Grand Avenue via James Ruse Drive is the only road access point, and there is insufficient capacity to accommodate the additional traffic movements that would be created by planned growth in this suburb.

» Telopea – NSW Land and Housing Corporation has indicated that additional public transport capacity would be necessary to accommodate planned growth in Telopea.

» Rydalmere – For increased land use development from low density to medium density, additional public transport capacity is required.
The opportunity for significant co-location of businesses and customers will be limited and congestion will increase the cost of doing business, making the GPOP priority growth area less attractive for business investments. This will lead to fewer jobs created and reduced knowledge transfer between businesses.

2.1.3.4 Place making

GPOP priority growth area precincts are geographically and functionally separated with some only activated at certain times of the day (such as during business hours), reducing foot traffic for businesses outside of peak hours – resulting in lower levels of passive security and safety. A poor pedestrian and cycling environment, with high levels of motor vehicle congestion, reduces the number of destinations accessible using active transport, and therefore reduces the associated amenity and health benefits.

Without a public transport system that connects social infrastructure within the GPOP priority growth area, the 30-minute vision will not be fully realised and the area will be less attractive to visit, work, live and play.

2.1.3.5 Urgency

A number of city-shaping and urban renewal activities have commenced within the GPOP priority growth area with significant private sector investment either planned or already occurring. Construction of the Westmead redevelopment has already commenced with a target completion date of 2021. A staged development approval process for the Parramatta North Urban Transformation area is underway to enable the first stages of residential development to be completed in 2023. Such zoning change and planning approvals will see dwellings and population increase by more than two-thirds and jobs increase by more than half over current levels in the next ten years to 2026.

There is a significant risk that without additional public transport investment, this development will occur in an ad hoc manner and ‘crowd out’ future public transport corridors. This would contribute to increased complexity of planning and costs associated with property acquisition because it is easier for future developments to integrate with stops and stations, rather than retro-fit a transport solution after significant development has occurred. It would also increase disruption to households and businesses during construction.

Without the project to support urban renewal activities, developments along the corridor (especially in the areas of Parramatta North, Camellia, and Telopea, where public transport accessibility is currently limited) will not realise the NSW Government’s vision and plan to support the growth of the GPOP priority growth area.

2.2 Why Parramatta Light Rail?

The project would provide a catalyst for urban renewal along its corridor by providing connections to areas that will be transformed through significant NSW Government and private investment. By providing a reliable, frequent and convenient new public transport product with connections to existing interchanges, the project would offer an attractive alternative to private vehicles, assisting in minimising car dependence for intermediate trips (those being five to 10 kilometres in length). The project would improve public transport accessibility, attracting people away from the use of cars and reduce congestion. This would lead to improved amenity and make the area a more attractive place to live.

The project would complement the existing transport network and other proposed network improvements to support growth and respond to the growing travel demands within and beyond the GPOP priority growth area. These include:

- Transformational projects such as WestConnex (under construction), Sydney Metro West (under development) and rapid bus routes along strategic corridors (under development).
2.3 Key benefits of the project

The project would support the Greater Sydney Commission’s vision for the GPOP priority growth area which envisions significant growth in population and jobs over the next 25 years. Overall, the project would result in the following key strategic benefits to the broader community and to the economy:

- **City-shaping benefits** – reduced urban sprawl, improved housing affordability and reduced socio-economic disadvantage.
- **Place making benefits** – improved amenity for customers and residents, improved cycling and pedestrian environments, and health benefits from increased active transport.
- **Productivity benefits** – reduced transport and logistics costs for businesses, assisting in a transition to a knowledge economy, and increased agglomeration benefits from knowledge transfer.
- **Transport benefits** – travel-time savings, reduced crowding, reliability improvements, and reduced future road congestion.

2.3.1 City-shaping benefits

The project would support the vision for the GPOP priority growth area to attract additional people and jobs to the area. The project would enable changes to current planning controls and increase the attractiveness of the GPOP priority growth area to households and businesses by improving public transport accessibility and by attracting people away from cars to reduce congestion.

The project would support greater urban densification at stops and along the corridor, reflected in more residential and commercial land being rezoned to allow for higher permissible floor space ratios. Residential and commercial uses are valued significantly higher than the former industrial uses optimising the best land use outcomes.

The project would also improve housing affordability by improving accessibility to new housing developments in attractive areas, in particular, urban renewal precincts in Parramatta North, Camellia, Telopea and Rydalmere, which are being delivered by NSW Government in the next five years.

The project would provide the infrastructure to ensure that these areas are well connected to future employment opportunities in the Parramatta CBD and Westmead. The project would increase opportunities for disadvantaged groups by improving access to jobs, educational facilities, community activities, social support, events, recreational activities and services through improved travel times and service frequency. This would provide increased employability to those groups. It would also provide opportunities for improved housing affordability within reasonable proximity to economic centres and reduce the need for car ownership.

2.3.2 Place-making benefits

The project would catalyse urban renewal by focusing new housing and employment around safe, connected and diverse urban precincts. Frequent light rail services throughout the day and off-peak periods would enhance liveability, promote activity, increase safety through passive surveillance, and attract a range of retail opportunities within stop precincts.

The project would also provide a catalyst for more active travel by providing additional active transport infrastructure and by increasing the number of walking trips to access light rail stops. More than half of the population of the GPOP priority growth area would be within walking distance of a stop by 2026. The project would reduce the reliance on cars for localised travel, and the need for car spaces in the city and in new developments. Reduced car use and improved urban amenity...
Strategic context and need

would increase walking and cycling to access shops, services and jobs in the local area, and the Carlingford shared path would link to existing active transport links and encourage cycling trips to commute to the Parramatta CBD or access the Western Sydney University campus in Rydalmere.

During operation, the project would also improve amenity, such as noise, congestion and environmental pollution, for residents by reducing the number of cars on the streets of the GPOP priority growth area. The project is forecast to take 25,000 cars off the road each day by 2041, resulting in 188,000 fewer car kilometres per day.

Figure 2.2 provides a graphical summary of the place-making benefits provided by the project.

2.3.3 Productivity benefits

The project would reduce transport costs and increase productivity by reducing the time spent travelling for work and business, reducing congestion. This includes:

» Reduced transport and logistics costs for businesses by providing a new light rail connection with frequent services throughout commercial centres within the GPOP. The project could also result in a reduction of up to 25,000 cars off the road each day, increasing capacity for remaining vehicles. By 2041, the project is forecast to save approximately two million hours of business travel per year.

» Supporting a transition to knowledge industries, an important component of Sydney’s current and future economy. The project includes dedicated light rail stops supporting the Westmead health precinct and Cumberland Hospital, as well as Western Sydney University campuses at Rydalmere and Westmead.
Increased productivity associated with the agglomeration of firms being located in close proximity to each other, enabling knowledge transfer and collaboration. The project would bring businesses closer together by reducing travel times, contributing to more effective business interaction and connectivity, and attracting more businesses to locate within the Parramatta CBD.

Reduced transport and logistics costs as a result of the project would increase the ability for businesses to compete with each other and put downward pressure on prices, benefiting households through reduced cost of living.

The project would increase the number of people within 30 minutes of the Parramatta CBD with access to public transport. This would increase the labour pool that would be accessible to employers by connecting employment and residential centres, reducing public transport commuting times, reducing congestion, unlocking affordable housing supply and attracting households to move closer to businesses.

In addition to attracting new jobs to the area, the project would create up to 1,000 direct jobs per year associated with the construction of the project (Transport for NSW, 2017). The project would also create indirect jobs as more expenditure occurs in the local area.

Figure 2.3 provides a summary of the productivity benefits of the project.

Figure 2.3  Summary of productivity benefits

2.3.4 Transport benefits

The project would provide an attractive public transport option to serve future residents and jobs in the GPOP priority growth area as it provides a high-frequency, turn-up-and-go light rail service that is direct, fast and reliable. Stops would be located close to where people work and live in the future, providing quick and direct access to public transport.

The project would provide travel time savings and reliability improvements to existing public transport customers that switch from heavy rail and buses to light rail, and provide a cheaper option than car travel (when parking costs are included). It is estimated that 54 per cent of light rail demand would be new public transport customers as a result of the attractiveness of the new light rail service.

The project would also benefit the remaining heavy rail customers through reduced crowding and non-users would value having an additional transport option; for example, if their car breaks down or there are delays on other public transport modes.

The key benefits to public transport customers are discussed in the following sections.
2.3.4.1 Reduced travel times and improved reliability

The project is an attractive public transport option to serve future residents and jobs in the GPOP priority growth area and would provide a high-frequency, turn-up-and-go service. The project would provide significant travel time savings.

Light rail would operate every 7.5 minutes in each direction during the day, between 7:00 am and 7:00 pm. This means that people can simply turn up at a stop without consulting a timetable. There would be six more services per hour than the current T6 Carlingford Line during peak periods, reducing average wait time by 11 minutes. Outside this period, light rail would provide a service every 10 minutes between 5 am and 7 am and 7 pm to 11 pm, and every 15 minutes between 11 pm to 1 am.

The project would provide a direct link between Carlingford and the Parramatta CBD, and between the Westmead and Cumberland health areas. Light rail passengers travelling between Carlingford and Parramatta would avoid a transfer at Clyde that currently adds an additional five minutes of wait time to their journey if travelling by heavy rail. Passengers travelling from Carlingford to Sydney CBD experience an increase in travel time; however, they would have access to express trains running between Parramatta and Sydney CBD.

The new light rail service would have an estimated travel time of 38 minutes between the Carlingford and Westmead light rail stops (refer to Figure 2.4). This includes:

» Eighteen minutes between Carlingford and the Parramatta CBD stops, which is six minutes faster than bus and the equivalent of heavy rail excluding wait time when transferring.

» Six minutes between Cumberland Hospital and Westmead Hospital stops, which is 15 minutes faster than bus.

Figure 2.4 Light rail operating times (includes simulated intersection delays)

The light rail service would operate in a designated corridor and light rail vehicles would generally not share lanes with cars. The light rail alignment includes priority (or traffic signal pre-emption) at intersections that have capacity to accommodate this outcome. When the light rail arrives at an intersection, traffic signal phases would prioritise a light rail vehicle to travel through the intersection. Light rail would also avoid the major intersection at James Ruse Drive as a result of a new grade separated crossing of this arterial road.

The project includes 11 new light rail stops (and would replace five existing train stations with light rail stops), which would reduce walk times from home to the stop and from the stop to the final destination with an average distance of 800 metres between light rail stops, compared to the existing average distance of 1.5 kilometres between stations on the T1 Western Line.
Buses are currently impacted by congestion, have four fewer services per hour than light rail and have two fewer stops in the Parramatta CBD. Heavy rail services are less frequent, require a transfer and only have a single station in the Parramatta CBD resulting in a longer walk to final destinations. Overall, the project would provide significant travel-time savings relative to bus and heavy rail alternatives.

2.3.4.2 Amenity, comfort and convenience of light rail stops and vehicles
There are a number of features of light rail vehicles and stops that would improve transport amenity for light rail customers by making them feel more informed, comfortable and safe, such as:

» Digital passenger information displays at stops displaying real time information on the next arriving services (including multiple modes at major interchanges).

» Customer service officers would be rostered to visit stops and travel on light rail vehicles to proactively identify and respond to customers that may require assistance (including mobility impaired customers and new customers requiring information) and carry out spot cleaning.

» High-quality lighting, CCTV and emergency help points would be included at each light rail stop, with direct access to a controller in the control centre to provide a safe waiting environment.

» Ticket machines on platforms would provide a single point of service for customers, who would be able to top up Opal cards, purchase single tickets and view customer information posters on the outside of the machine.

» Step height to vehicles at platforms is designed to accommodate people with wheelchairs and strollers boarding and alighting.

» All light rail stops would include high-quality shelters and wayfinding signage.

» All light rail vehicles would be air conditioned.

2.3.4.3 Transport mode shift reducing crowding and congestion
The project is expected to result in a potential mode shift of up to 15,000 passengers from heavy rail to light rail by 2041. This would improve passenger comfort by reduced crowding at rail stations during peak periods.

The project is forecast to remove around 25,000 cars off the road by 2041, resulting in up to 188,000 fewer car kilometres each day. This is expected to benefit road users by:

» Car user travel time savings and improved reliability due to mode shift from car to light rail, resulting in up to 11,000 fewer car hours each day by 2041. This reduction in traffic would more than offset the impacts associated with assigning additional road space and prioritisation of light rail.

» A reduction in car operating costs as a result of increased speeds, which would reduce fuel consumption and vehicle wear and tear, and reduce average trip lengths.

» Improving the environment by reducing air pollution, greenhouse gas emissions, noise pollution and water pollution. It is estimated that reduced car use would result in a reduction of greenhouse gas emissions by around 2.4 million tonnes per year by 2041.

2.3.4.4 Transport network operations
The project is well integrated with the existing heavy rail and bus networks, including heavy rail interchanges at Parramatta and Westmead and a bus interchange at Carlingford. It also provides the opportunity to interchange with potential future metro stations. A study is currently underway to assess the feasibility of extending the Parramatta Light Rail to Epping to provide a northern link to Sydney Metro Northwest.
The project would repurpose the T6 Carlingford Line, resulting in a number of cost savings as planned upgrade projects along the alignment will no longer be required. The repurposing of the T6 Carlingford Line would also reduce maintenance costs which would no longer be required.

It would also provide additional capacity to improve resilience to delays elsewhere on the transport network, particularly between Westmead and Parramatta, and would support special events.

2.4 Consistency with NSW strategic planning policies

2.4.1 State and Premier priorities

In September 2015, the NSW Premier released 30 ‘State priorities’, including 12 ‘Premier priorities’ and 18 State priorities to grow the economy, deliver infrastructure, and improve health, education and other services across NSW. Key priorities relevant to the project include ‘building infrastructure’ and ‘creating jobs’.

Over the next 15 years, NSW will require infrastructure to support 40 per cent more train trips, 30 per cent more car trips and 31 per cent more households (NSW Government, 2015). The project forms part of the NSW government’s infrastructure investment program to support forecast population growth in the Greater Parramatta region.

The NSW government is committed to the creation of 150,000 new jobs by 2019. Through investment in infrastructure such as the project, new jobs and apprenticeships are being created for the construction sector.

The project would contribute to economic growth by providing direct benefits to customers in terms of reduced travel time and better reliability. It would also deliver wider economic benefits by facilitating increased connectivity and support investment in urban renewal projects, further supporting job growth in the construction sector.

2.4.2 NSW 2021: A Plan to Make NSW Number One

NSW 2021: A Plan to make NSW Number One (NSW 2021; NSW Department of Premier and Cabinet, 2011) is the NSW Government’s 10 year strategic business plan to rebuild the NSW economy, provide quality services, renovate infrastructure, restore government accountability, and strengthen local environment and communities. The plan sets long-term goals, targets and priority actions to guide NSW Government policy and budget decision-making. The Parramatta Light Rail’s expected contribution to achieving these long-term goals is outlined in Table 2.1.

<table>
<thead>
<tr>
<th>NSW 2021 Target</th>
<th>Project’s Contribution to Achieving the NSW 2021 Targets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal 1: Improve the performance of the NSW economy</td>
<td>The project would contribute to economic growth by providing direct benefits to customers and businesses in terms of increasing accessibility, improving travel time and reducing congestion resulting in improved productivity. Investment in the project would also contribute to the economy as it would support investment in urban renewal initiatives within the GPOP priority growth area.</td>
</tr>
<tr>
<td>Goal 7: Reduce travel times</td>
<td>The project would minimise waiting times for customers using this mode by providing easy and reliable ‘turn-up-and-go’ service, and increased frequency for customers along the T6 Carlingford Line.</td>
</tr>
</tbody>
</table>
Strategic context and need

<table>
<thead>
<tr>
<th>NSW 2021 TARGET</th>
<th>PROJECT’S CONTRIBUTION TO ACHIEVING THE NSW 2021 TARGETS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal 8:</td>
<td>Grow patronage on public transport by making it a more attractive choice</td>
</tr>
<tr>
<td>Increase the share of commuter trips made by public transport</td>
<td>The project would provide an alternative reliable public transport service and would improve connections across the GPOP priority growth area.</td>
</tr>
<tr>
<td>Goal 9:</td>
<td>Improve customer experience with transport services</td>
</tr>
<tr>
<td>Improve customer satisfaction with transport services</td>
<td>The project would provide a new public transport service and would respond to public transport customer satisfaction by ensuring customer needs are met through the provision of a safe, high quality, integrated and affordable transport service.</td>
</tr>
<tr>
<td>Increase real-time travel information to customers</td>
<td>Users of the project would have access to clear, accurate and timely information through mobile and web-based applications and at interchanges, stops and on light rail vehicles throughout the network.</td>
</tr>
</tbody>
</table>

2.4.3 A Plan for Growing Sydney

A Plan for Growing Sydney (NSW Government, 2014a), Towards our greater Sydney 2056 – a draft amendment to update A Plan for Growing Sydney (Greater Sydney Commission, 2016a) and the draft West Central District Plan (Greater Sydney Commission, 2016b) sets out the NSW Government’s strategy for accommodating Sydney’s future population growth over the next 20 to 40 years. The plan consists of goals, directions and actions that provide a framework for strengthening the global competitiveness of Sydney and delivering strong investment and jobs growth in Western Sydney. The draft amendment to A Plan for Growing Sydney sets out the new focus on the Sydney metropolis of three cities.

A Plan for Growing Sydney sets out four goals, including:

» A competitive economy with world-class services and transport
» A city of housing choice with homes that meet our needs and lifestyles
» A great place to live with communities that are strong, healthy and well connected
» A sustainable and resilient city that protects the natural environment.

The project aligns with these goals by providing well connected communities and increasing housing choices around urban centres through its support of urban renewal initiatives along the project corridor within the GPOP priority growth area.

The project aligns with A Plan for Growing Sydney through the following actions:

» Grow Greater Parramatta as Sydney’s second CBD by connecting and integrating Westmead, Parramatta North, Parramatta CBD, Camellia and Rydalmere (Action 1.2.1).
» Identify and deliver enabling infrastructure to support growth and urban renewal (Action 1.3.2).

2.4.4 The Greater Parramatta and the Olympic Peninsula

The GPOP was identified as a new priority growth corridor in the most recent metropolitan strategy A Plan for Growing Sydney (NSW Government, 2014a). In 2016, the Greater Sydney Commission collaborated with key government agencies, City of Parramatta Council, institutions and businesses to develop the Greater Parramatta and Olympic Peninsula Vision (Greater Sydney Commission, 2016c). The document outlines a vision for the GPOP priority growth area to become the geographic and demographic centre of Greater Sydney (Greater Sydney Commission, 2016c).
Within the GPOP priority growth area (refer to Figure 2.1), a number of growth precincts along the
alignment are earmarked for future development (refer to section 2.1.1). Activities within the
precincts have commenced and there is a need to improve connectivity to support the realisation
of the Greater Parramatta and Olympic Peninsula Vision. The project would provide a new public
transport option within the GPOP priority growth area and would address intermediate trip
demands within and between these precincts, enhancing connectivity along the project
alignment to employment, residential, education, service and entertainment destinations. This
would be particularly critical for precincts along the project alignment that currently have limited
access to public transport, such as Parramatta North, and/or low frequency of services, such as
precincts along the T6 Carlingford Line.

2.5 Consistency with NSW transport policies and strategies

2.5.1 Rebuilding NSW: State Infrastructure Strategy Update 2014

The Rebuilding NSW: State Infrastructure Strategy Update 2014 (NSW Government, 2014b) outlines
the NSW Government’s plan to invest $20 billion in new infrastructure to sustain productivity growth
in NSW’s major centres and regional communities, as well as to support the forecasted population
growth within Sydney and NSW. Projects identified in Rebuilding NSW: State Infrastructure Strategy
Update 2014 are based on investment recommendations made by Infrastructure NSW.

The Rebuilding NSW: State Infrastructure Strategy Update 2014 recognises that improving
connectivity within Parramatta is a key challenge. The Strategy supports an approach that treats all
modes of travel equally and considers light rail solutions within the approach to planning
Parramatta’s transport needs.

2.5.2 NSW Long Term Transport Master Plan

The NSW Long Term Transport Master Plan identifies a ‘three-tiered network’ approach to expand
the capacity of Sydney’s transport system, comprising a mass transit network linking regional cities
and major centres, an intermediate transit network linking town centres and a local transit network
linking local villages. Parramatta Light Rail is a key long-term action of the NSW Long Term Transport
Master Plan, which would provide a new intermediate transit network that would improve access,
connectivity and public transport capacity through the GPOP.

The key transport challenges for Parramatta identified in the NSW Long Term Transport Master Plan
include:

» Peak period congestion around Parramatta’s CBD affects bus services and amenity.

» Local barriers to movement include Parramatta River, Parramatta Park, major arterial roads and
rail lines.

» Stronger transport connections to other parts of Greater Sydney are required.

2.5.3 Sydney’s Light Rail Future

Sydney’s Light Rail Future - Expanding public transport, revitalising our city (NSW Government,
2012b) is the NSW Government’s plan to address road congestion by offering an effective public
transport option that builds on the current transport network and will grow public transport
capacity, enhance commuter experiences and reduce congestion, leaving more space for vital
commercial traffic as well as pedestrians.

While Sydney’s Light Rail Future is focused on expanding light rail services for the CBD and inner
Sydney, it recognised the importance of light rail for Western Sydney and is committed to working
with City of Parramatta Council on a light rail feasibility study which would focus on Parramatta’s
CBD. The development of the preferred Parramatta Light Rail network is discussed in Chapter 3 (Project development and alternatives).

2.5.4 Sydney’s Walking Future and Sydney’s Cycling Future

Sydney’s Walking Future (NSW Government, 2013a) and Sydney’s Cycling Future (NSW Government, 2013b) are the NSW Government’s plan to promote active transport as a more convenient, better connected and safer mode of transport by investing in new walking and cycling links that connect people to places and public transport. A number of specific issues have been identified with existing pedestrian and cycling environments in the GPOP priority growth area, that inhibit uptake of active transport and make pedestrians and cyclists feel unsafe. Parramatta Light Rail includes initiatives to encourage the uptake of active transport and crime prevention through environmental design (CPTED) principles have been incorporated in the project development (refer to Chapter 5 – Project description – Infrastructure and operation).

2.5.5 Parramatta Strategic Framework

The Parramatta Strategic Framework (Greater Sydney Commission, 2016d) was developed to facilitate integrated decision-making for investment in Parramatta; in particular, major infrastructure and urban renewal development in the Parramatta CBD.

The framework connects the metropolitan direction for Parramatta contained in A Plan for Growing Sydney to an urban analysis for the Parramatta CBD, as well as NSW Government and the City of Parramatta Council major projects. Parramatta Light Rail is consistent with the Parramatta Strategic Framework. In particular, Parramatta Light Rail would improve the connectivity between Westmead and Parramatta CBD, which is identified as an enabler for optimising Parramatta’s status as a dual CBD.

2.5.6 Draft Greater Parramatta Access Plan

The Greater Parramatta Access Plan (GPAP) is currently being prepared by Transport for NSW and will outline the functions of a fully integrated transport network in Parramatta’s CBD, with the aim of putting the customer first and meeting the growing transport demands of the Parramatta CBD. The plan will seek to ensure the right modes of transport are prioritised in different parts of the CBD, to optimise capacity and improve journey reliability.

The GPAP will consider the transport changes necessary to support the growth of the Parramatta CBD over the next 10 years, and consider efficient, reliable and safe journeys to, from and within the Parramatta CBD.

A multi-agency steering committee will oversee the development of the GPAP, and the plan will be developed in collaboration between relevant State and local government agencies and key stakeholders.

Initiatives identified as part of the GPAP are likely to include:

- Travel demand management measures, to support and modify transport customer behaviour.
- Changes to the bus network, including the provision of bus related infrastructure.
- Initiatives to relieve traffic pinch points in the CBD and surrounding road network.
- Active transport network integration, including provision for cyclists and pedestrians.
- Wayfinding improvements, to increase legibility for all transport users.
- Road safety initiatives to improve safety in the Greater Parramatta area.
- ‘Future Transport’ led technologies, to enable evolving transport technologies and initiatives.
- Provision for the effective movement of freight and goods in the Parramatta CBD.
- Changes to kerbside use allocations.
Transport facilities to support developing transport projects, such as Metro West.

The GPAP will provide a high level framework, outlining the initiatives for changes to the integrated transport network, to accommodate growth in the Greater Parramatta area. The plan will provide a description of the range of specific actions that are required to support each of the initiatives, including implementation timeframes and identification of action owners.

### 2.6 Summary of strategic need

The project has been assessed against key relevant State government policies. This includes:

- The NSW Premier’s 30 ‘State priorities’, including 12 ‘Premier priorities’ to grow the economy, deliver infrastructure, and improve health, education and other services across NSW.
- NSW 2021: A Plan to Make NSW Number One.
- A Plan for Growing Sydney.
- Towards our greater Sydney, 2056 – a draft amendment to update A Plan for Growing Sydney.
- Draft West Central District Plan.
- Greater Parramatta to the Olympic Peninsula Vision.
- NSW Long Term Transport Master Plan.
- Sydney’s Light Rail Future.
- Sydney’s Walking Future.
- Sydney’s Cycling Future.
- Parramatta Strategic Framework.
- Draft Greater Parramatta Access Plan.

The project would support the Greater Sydney Commission’s vision for the GPOP priority growth area by facilitating population growth and attracting new jobs to the area. The project would enable changes to current planning controls and increase the attractiveness of the GPOP priority growth area to households by:

- Improving public transport accessibility - A new turn-up-and-go light rail service between Carlingford and Westmead. This directly links key assets and planned investments, including Westmead and Cumberland health areas, Western Sydney Stadium, Parramatta CBD, Western Sydney University campuses and the new Powerhouse Museum and Riverside Theatres Cultural Hub.
- Reducing congestion - The project is forecast to attract 45,000 passengers per day by 2041, of which 54 percent would be new public transport customers. This would result in 25,000 fewer cars on the road each day by 2041, improving residential amenity as a result of improved safety and reduced pollution, noise and barriers to pedestrian movements. This would also result in 15,000 fewer heavy rail passengers each day by 2041, reducing crowding.

The key benefits of the project would include:

- City-shaping benefits - including reduced urban sprawl, improved housing affordability and reduced socio-economic disadvantage.
- Place making benefits - such as improved amenity for customers and residents, improved cycling and pedestrian environments, and health benefits from increased active transport.
- Productivity benefits - this includes reduced transport and logistics costs for businesses, assisting in a transition to a knowledge economy, and increased agglomeration benefits from knowledge transfer.
Transport benefits - including travel-time savings, reduced crowding, reliability improvements, and reduced future road congestion.

2.7 Project objectives

A set of objectives have been developed for the project to achieve the overall project goals that will deliver NSW Government's vision for the GPOP priority growth area. The objectives for the project are shown in Table 2.2.

<table>
<thead>
<tr>
<th>VISION</th>
<th>Goals</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vision</td>
<td>Vision</td>
<td>To deliver integrated light rail services that support the NSW Government’s vision for the Greater Parramatta to the Olympic Peninsula priority growth area</td>
</tr>
<tr>
<td>City shaping</td>
<td>Support the vision for Parramatta as a 21st century city - attracting new investment and economic development.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A catalyst for shaping new growth - activating underutilised lands and providing the transport capacity needed to support sustainable population and employment growth in the area.</td>
<td></td>
</tr>
<tr>
<td>Connectivity</td>
<td>Connecting people and places - supporting the diverse mix of customer journeys that link employment, cultural, educational, health and sporting precincts with existing and new communities.</td>
<td></td>
</tr>
<tr>
<td>Place</td>
<td>Contribute to the creation of local hubs - supporting the creation of attractive and memorable public spaces that are better utilised by communities.</td>
<td></td>
</tr>
<tr>
<td>Choice</td>
<td>Providing attractive transport choices for customers - Turn-up-and-go, safe, reliable, all-day light rail service that is integrated with roads, buses, trains and active transport.</td>
<td></td>
</tr>
</tbody>
</table>
Part B:
The Project and its development
3  Project development and alternatives

This chapter describes the alternatives and options evaluation process carried out to determine the preferred option. It outlines the various transport modes, corridor and alignment options considered to address the need and objectives as identified in Chapter 2.

This chapter also identifies the consequences of not proceeding with the project.

3.1  Overview

A number of studies have identified potential transport solutions to cater for land use changes in the Greater Parramatta to the Olympic Peninsula (GPOP) priority growth area, as well as current and future demand on the transport network in the Central City. These include:

» The NSW Long Term Transport Master Plan (NSW Government, 2012a).
» Towards Our Greater Sydney 2056 (Greater Sydney Commission, 2016a).
» Greater Parramatta and Olympic Peninsula Vision (Greater Sydney Commission, 2016c).
» Draft West Central District Plan (Greater Sydney Commission, 2016b).

The Parramatta Light Rail project was developed as part of a comprehensive options identification and assessment process, which assessed the feasibility of alternative options to deliver the necessary transport system capacity within the GPOP priority growth area.

As illustrated in Figure 3.1 and explained in the following sections in more detail, the assessment consisted of three key stages:

1  Strategic planning
2  Corridor options
3  Alignment options identification.
3.2 Strategic planning analysis

Following the identification of the need for a new public transport option for the GPOP priority growth area (refer to Chapter 2), a strategic approach was adopted to define an integrated transport network solution that responds to different transport demands within the GPOP priority growth area. The following section provides a summary of the option identification and evaluation process used to develop the range of transport mode options considered for the project.

3.2.1 Mode selection

Light rail has been identified as the preferred solution to support growth in the GPOP priority growth area to meet the project’s city shaping and place making objectives, based on a multi-criteria analysis (MCA) of a range of transport options.

The NSW Government is also separately investigating and/or delivering a number of transport projects across the GPOP priority growth area. These include WestConnex, Sydney Metro West, and bus priority and rapid bus transit projects. Preliminary demand modelling on the possible impact of
Sydney Metro West on light rail demand found that the introduction of a metro service would complement the project, increase patronage for both light rail and metro services, and achieve greater uplift in population and jobs. A range of road, suburban/metro rail and bus projects such as these would be required to support the realisation of the Greater Sydney Commission’s Greater Parramatta and Olympic Peninsula Vision.

3.2.1.1 Methodology
The assessment of the most appropriate transport mode was carried out in two main phases:

» The first phase provided an initial assessment of the viability of a number of modes to meet the transport requirement to connect the GPOP priority growth area precincts, given current constraints. The assessment produced a number of viable alternatives that were taken to the next stage of the assessment.

» The second phase provided a more detailed analysis of the short listed transport modes. For the assessment, a comparative transport mode was defined for the GPOP priority growth area and a strategic assessment performed of the short listed mode options to arrive at the preferred mode.

3.2.1.2 Options identification
To meet the city shaping, place making and transport needs across the GPOP priority growth area, a range of options were considered that would reduce the dependency on private vehicles, increase the use of public and active transport, better manage increasing travel demand within the GPOP priority growth area and initiate and promote urban development. The range of transport modes considered ranged from pedestrian or bicyclist options, cars, different lengths of buses and light rail vehicles, suburban and metro trains, and ferries to alternative technologies, such as cable cars, personal rapid transit and monorail systems.

Table 3.1 outlines the range of strategic options that were considered, whether they were shortlisted and the rationale for their inclusion or exclusion from further consideration.

<table>
<thead>
<tr>
<th>TRANSPORT MODE</th>
<th>SHORT-LISTED</th>
<th>DESCRIPTION/ RATIONALE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cars (including ride share and taxis)</td>
<td>No</td>
<td>Significantly more road space would be required to transport the same number of passengers as alternative public transport modes. For example, it is estimated that one light rail vehicle could transport the same number of passengers (200 people) as 170 cars or three buses. This highlights the clear disadvantages of cars as an inefficient transport mode. For this reason and the purposes of the mode assessment, cars were therefore ruled out as a viable transport mode and deemed unnecessary for further consideration.</td>
</tr>
<tr>
<td>Walking</td>
<td>No</td>
<td>Not suitable for longer travel distances or accepted by all customers as an accessible public transport mode.</td>
</tr>
<tr>
<td>Cycling</td>
<td>No</td>
<td>Not suitable for longer travel distances or accepted by all customers as an accessible public transport mode.</td>
</tr>
<tr>
<td>Bus in shared streets</td>
<td>Yes</td>
<td>Consistent with existing arrangement. Conventional bus technology already in operation in Parramatta.</td>
</tr>
<tr>
<td>Buses in bus lanes</td>
<td>Yes</td>
<td>Similar to the existing bus lanes in Argyle Street, Wilde Avenue, Smith Street and Church Street in Parramatta.</td>
</tr>
</tbody>
</table>
## Short-listed options

Based on the consideration of the range of strategic options, three transport scenarios were considered to be the most feasible for further consideration as the preferred transport option. These scenarios were:

1. Buses in shared streets or bus lanes.
2. Buses in a dedicated busway (bus rapid transit).
3. Light rail operated in shared, separated and segregated operations.

Each of the transport scenarios would differ in the degree of priority and segregation that would be afforded to public transport services. Consideration of each of the shortlisted transport-based scenarios is provided below.

### Buses in shared streets or bus lanes

Increasing bus service frequencies or providing new routes in shared streets or bus lanes could improve public transport accessibility in the GPOP priority growth area, potentially contributing to the city shaping objectives of the project by enabling changes to existing planning controls.
However, buses would continue to share road space with general traffic along the project corridor, which is expected to become increasingly congested over time. Increasing congestion would also result in noise and pollution for adjacent communities, and reduced safety and visual amenity for pedestrians and cyclists. This would make it less attractive for people to work and live in the GPOP priority growth area, contrary to the project’s city shaping objectives. As such, this option was not considered to be a viable option for further assessment.

**Dedicated busway (bus rapid transit) option**

Unlike conventional bus services, bus rapid transit systems typically operate on dedicated lanes and corridors, separated from other forms of road traffic. The separation of services from general traffic allows for higher travel speeds, improved service reliability and increased frequencies relative to conventional bus services.

Bus rapid transit systems can serve more destinations than light rail, as they are not required to operate on fixed tracks. Buses tend to have lower costs per vehicle-kilometre, but light rail often has lower costs per passenger-kilometre due to higher load factors.

The Institute of Transport and Logistics Studies at the University of Sydney examined the impact of the Liverpool-Parramatta T-way on housing prices. This was Sydney’s first bus rapid transit system and was implemented in south-west Sydney in 2003. The study examined repeat-sales data from before and after the opening of the T-way, and identified little difference between properties close to bus rapid transit stops and outside the catchment. As such, bus rapid transit would not support the city shaping and place making objectives of the project.

**Light rail option**

Light rail typically has a lower capacity and speed than conventional heavy rail and metro rail services but higher capacity and speed compared to traditional street-running tram services as well as conventional bus services. The main benefit of a light rail system would be that it provides a higher level of amenity, travel speed, reliability and capacity compared to existing bus services.

Light rail creates certainty with investment and land use planning. Light rail is relatively permanent, as a result of fixed infrastructure such as tracks and catenaries. This would send a signal to investors that there is a relatively long-term commitment from the NSW Government in the area. There is also documented market research indicating that customers prefer light rail over buses and that light rail has higher support from businesses to drive economic growth.

There is evidence from Sydney Light Rail (Dulwich Hill Extension) that land values increase by nine per cent within 400 metres of a light rail stop and four per cent within an 800-metre catchment. This reflects that households would be willing to pay more at these locations as a result of improved transport amenity (e.g. noise, pollution and safety), choices and connectivity (refer to section 8.4 for further details). As such, light rail would support the city shaping and place making objectives of the project.

Light rail would also have an additional funding source relative to bus rapid transit. The Special Infrastructure Contribution scheme in December 2015 is based on light rail labelled as priority infrastructure, to be funded by development contributions.

### 3.2.1.4 Options assessment

To assess the two remaining feasible transport mode options, an assessment compared a light rail mode option against an alternative bus rapid transit option. The assessment included the selection of a range of criteria to differentiate between the two mode options. The assessment included the adoption of 16 criteria. These criteria, in addition to the outcome of the assessment against these criteria are presented in Table 3.2.

Note, the options assessment presented in Table 3.2 present a comparison between the light rail bus rapid transit options only.
<table>
<thead>
<tr>
<th>CRITERIA</th>
<th>ALIGNMENT WITH PROJECT OBJECTIVES</th>
<th>ALIGNMENT WITH CRITERIA</th>
<th>LIGHT RAIL OPTION</th>
<th>BUS RAPID TRANSIT OPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 A Plan for Growing Sydney and GPOP Vision</td>
<td>City shaping</td>
<td>Very good compared to bus rapid transport as Parramatta Light Rail is specifically referenced in A Plan for Growing Sydney and Greater Sydney Commission’s GPOP Vision. Would provide improved amenity as a more attractive transport system supporting the vision for Parramatta as a modern 21st century city.</td>
<td>Neutral compared to light rail with no reference to bus rapid transit in A Plan for Growing Sydney or the GPOP Vision.</td>
<td></td>
</tr>
<tr>
<td>2 City shaping</td>
<td>City shaping</td>
<td>Very good compared to bus rapid transport with a strong incentive for developers and local council to invest in Parramatta if the project is light rail. The relative permanency of light rail (as a result of tracks and overhead wiring (OHW)) sends a signal to investors that there is a relatively long-term commitment from the NSW Government in the area.</td>
<td>Good compared to light rail with a dedicated busway having relatively permanent infrastructure but not to the same extent as light rail (which also includes tracks and OHW).</td>
<td></td>
</tr>
<tr>
<td>3 Supporting existing development precincts and opening new catchments</td>
<td>Place</td>
<td>Very good compared to bus rapid transport with strong support for existing and new developments and light rail included in a number of land planning initiatives (such as the Parramatta North Urban Transformation). There is evidence from Sydney Light Rail (Dulwich Hill Extension) that land values increased by nine per cent within 400 metres of a light rail stop and four per cent within an 800-metre catchment because light rail is attractive to households and businesses.</td>
<td>Neutral, as there no projects specifically planned around bus stops in the GPOP priority growth area. There is evidence from Sydney (Liverpool T-Way) that there is little difference between properties close to bus rapid transit stops and outside the catchment because bus rapid transit is not as attractive to households and businesses. There has been limited uplift around T-way stops in the GPOP priority growth area.</td>
<td></td>
</tr>
</tbody>
</table>
### Place making and urban renewal opportunities

<table>
<thead>
<tr>
<th>CRITERIA</th>
<th>ALIGNMENT WITH PROJECT OBJECTIVES</th>
<th>ALIGNMENT WITH CRITERIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Place</td>
<td>Very good compared to bus rapid transport with the City of Parramatta Council and developers ready to invest in improved amenity and streetscaping in Parramatta, such as Parramatta Square and Westmead health precinct on Hawkesbury Road. Allows for options in the design for centre islands, kerbside or side platforms; while bus rapid transit systems that operate in streets typically must have kerbside or side platforms only.</td>
</tr>
</tbody>
</table>

### Stakeholder support

<table>
<thead>
<tr>
<th>CRITERIA</th>
<th>ALIGNMENT WITH PROJECT OBJECTIVES</th>
<th>ALIGNMENT WITH CRITERIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Choice</td>
<td>Very good compared to bus rapid transport with strong stakeholder support from City of Parramatta Council and the wider community.</td>
</tr>
</tbody>
</table>

### Public transport customers

<table>
<thead>
<tr>
<th>CRITERIA</th>
<th>ALIGNMENT WITH PROJECT OBJECTIVES</th>
<th>ALIGNMENT WITH CRITERIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Choice</td>
<td>Very good compared to bus rapid transport with benefits for public transport customers with the new technology, stop amenity and vehicle ride comfort.</td>
</tr>
</tbody>
</table>

### Travel times and reliability

<table>
<thead>
<tr>
<th>CRITERIA</th>
<th>ALIGNMENT WITH PROJECT OBJECTIVES</th>
<th>ALIGNMENT WITH CRITERIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Connectivity</td>
<td>Neutral compared to bus rapid transport with similar speeds to bus rapid transit, but the potential for light rail vehicle to bunch and no opportunity for vehicles on tracks to bypass others.</td>
</tr>
<tr>
<td>CRITERIA</td>
<td>ALIGNMENT WITH PROJECT OBJECTIVES</td>
<td>ALIGNMENT WITH CRITERIA</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-----------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>8 Integration with rail and other modes</strong></td>
<td>Connectivity</td>
<td>Poor compared to bus rapid transport as light rail requires transfers to continue journeys at the light rail termini, such as at Westmead and Carlingford; light rail integration with trains at Parramatta is from Macquarie Street, whereas buses would be in the bus interchange. Good compared to light rail because buses can continue beyond the bus rapid transit corridor to other destinations, as with the T-way routes; buses would connect with trains at Paramatta interchange.</td>
</tr>
<tr>
<td><strong>9 Road network impacts</strong></td>
<td>Additional criteria</td>
<td>Poor compared to bus rapid transport as light rail can reduce road capacity where a segregated light rail corridor replaces traffic lanes. Neutral compared to light rail with kerbside bus lanes having a lesser impact on traffic than light rail with separated running.</td>
</tr>
<tr>
<td><strong>10 Scope and constructability</strong></td>
<td>Additional criteria</td>
<td>Very poor compared to bus rapid transport with high scope and project complexity as a result of track work, overhead power and a light rail depot. Poor compared to light rail with complex bus priority and busway infrastructure, but not as complex as light rail which requires track work, overhead power and a light rail depot.</td>
</tr>
<tr>
<td><strong>11 Transport network impacts during construction</strong></td>
<td>Additional criteria</td>
<td>Very poor compared to bus rapid transport with high impacts on traffic and existing public transport customers during construction. Poor compared to light rail with impacts on traffic during construction, but lesser impacts on the existing bus customers.</td>
</tr>
<tr>
<td><strong>12 Environmental and planning impacts</strong></td>
<td>Choice</td>
<td>Good compared to bus rapid transport with cleaner light rail vehicles than conventional bus technologies. Poor compared to light rail with diesel buses likely in the short to medium term and noise and emissions from buses. However, in the long term, cleaner fuel buses and electric buses are likely.</td>
</tr>
</tbody>
</table>

Project development and alternatives

Paramatta Light Rail | Stage 1 - Westmead to Carlingford via Camellia Environmental Impact Statement
## Project Development and Alternatives

<table>
<thead>
<tr>
<th>CRITERIA</th>
<th>ALIGNMENT WITH PROJECT OBJECTIVES</th>
<th>ALIGNMENT WITH CRITERIA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>13</strong> Capital expenditure</td>
<td>Additional criteria (value for money)</td>
<td>Very poor compared to bus rapid transport with high capital costs for light rail as a result of high scope and project complexity and the requirement for track work, overhead power and a light rail depot.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Poor compared to light rail with high capital costs for bus rapid transit, but not as costly as light rail.</td>
</tr>
<tr>
<td><strong>14</strong> Property acquisition costs</td>
<td>Additional criteria (value for money)</td>
<td>Very poor compared to bus rapid transport with the need to purchase property at the light rail stabling and maintenance facility and both on and off the project corridor.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Poor compared to light rail with potential property acquisition along alignment, but not as significant as for light rail as bus lanes are not as wide as separated light rail running and no requirement for a depot.</td>
</tr>
<tr>
<td><strong>15</strong> Operating and maintenance costs</td>
<td>Additional criteria (value for money)</td>
<td>Poor compared to bus rapid transport with high operating costs for light rail with fewer vehicles and drivers to move the same number of passengers; less costly than bus rapid transit.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Very poor compared to light rail due to higher costs for bus rapid transit with multiple drivers and vehicle costs</td>
</tr>
</tbody>
</table>

**Legend**

- **Strong positive/very good**
- **Weak positive/good**
- **Neutral**
- **Weak negative/poor**
- **Strong negative/very poor**
3.2.1.5 Preferred option

Based on the comparative assessment, light rail scored high in criteria relating to city shaping, place making and the customer experience. As such, light rail most directly addresses the project objectives. Light rail scored lower on capital costs and construction impacts and complexity; however, these are additional criteria related to risk and value for money. Even so, experience from other projects such as the CBD and South East Light Rail has identified that the whole of life costs between bus rapid transit and light rail were very similar, taking into account both capital and operating costs.

Overall, the provision of a new light rail network in the GPOP priority growth area would provide the best support for the city shaping and place making objectives of the project, because light rail would:

» Create certainty with investment and land use planning. The relative permanency of light rail infrastructure sends a signal to investors that there is a relatively long-term commitment from the NSW Government in the area.

» Provide sufficient carrying capacity. Based on vehicle capacity and feasible service frequencies, light rail can serve up to 5,000 passengers per hour, per direction by 2041.

» Align with customer preferences, with customers expressing preference for light rail services in comparison to buses due to reliability, ride comfort and legibility. Light rail changes the image of Parramatta and the way that residents, commuters, students, businesses and tourists consider Parramatta, by providing an iconic transport infrastructure. Light rail would brand the city as a progressive, modern urban place that has higher liveability and attractiveness. Light rail also has higher support from businesses to drive economic growth.

» Have lower environmental and amenity costs. Light rail emissions are related to electricity generation, meaning that there are no on-site emissions (that is, no costs are borne by the local area in the vicinity of light rail). Light rail environmental and amenity costs are significantly lower per passenger than additional buses or a bus rapid transit alternative.

» Deliver superior city shaping and place making outcomes. Light rail would provide a higher land value uplift when compared to a bus solution as it would improve transport amenity (for example, lower congestion, pollution and noise) and connectivity, increasing the attractiveness of the GPOP priority growth area.

» Catalyse investment for integrated street outcomes with wider footpaths and infrastructure and the removal of bus stops and parking to provide more pleasant and attractive urban spaces and streetscapes, especially in the CBD and/or high-activity pedestrian precincts.

» Provide a more legible method of transport, including the ability to find the stops and know where it is going, and provide a stronger perception of reliability and certainty of operations.

» Provide better amenity for the waiting customers at the light rail stops.

Light rail was therefore considered to be the preferred mode of public transport for the GPOP priority growth area.
3.3 Corridor options analysis

Following determination of the preferred mode of transport, a series of strategic light rail corridor options were considered which would best meet the needs of the GPOP priority growth area. An overview of the strategic corridor assessment processes that were carried out is presented below.

3.3.1 Strategic development of light rail

3.3.1.1 Western Sydney Light Rail feasibility study (Parramatta City Council, 2013)

In 2013, the City of Parramatta Council (formerly Parramatta City Council) completed a two-part feasibility study into a potential Western Sydney light rail network. Part 1 of the study identified 15 possible corridors in a 15 kilometre radius from Parramatta for light rail routes against five criteria (transport, environment, economy, social health and land use).

Part 2 of the study recommended that the first stage of the Western Sydney Light Rail should be provided, consisting of two lines, the first of which connected the Westmead Health Precinct, Parramatta CBD, Western Sydney University (Parramatta campus) at Rydalmere, Eastwood town centre and Macquarie Park, and the second line connecting Parramatta to Castle Hill. The subsequent phases of this proposed network included a connection between Parramatta, Camellia and Rhodes via Sydney Olympic Park and a line to Bankstown via Chester Hill (Parramatta City Council, 2013). This feasibility study acted as an advocacy document for Parramatta City Council to make the case for better public transport services for Greater Parramatta and was a catalyst for the NSW Government to establish the Parramatta Transport Corridor Strategy.

3.3.1.2 Identifying corridors

In 2014, Transport for NSW commenced preparation of the Parramatta Transport Corridor Strategy (Transport for NSW, 2014). The Parramatta Transport Corridor Strategy explored the feasibility of rapid transit – including light rail – along 13 transport routes across nine priority transport corridors, all of which connected to Parramatta. These corridor options were selected on the basis of their potential to support existing and projected population growth, and to relieve associated levels of road congestion.

The selection of these corridors was informed by:

» NSW Long Term Transport Master Plan (NSW Government, 2012a).


» Western Sydney Light Rail Feasibility Study – Environmental Study (Parramatta City Council, 2013).

The 13 initial corridors assessed are identified in Figure 3.2.
Figure 3.2 Parramatta Transport Corridor Strategy - Strategic corridors

- Parramatta to Rouse Hill via T-way
- Parramatta to Castle Hill via Windsor Road and Old Northern Road
- Parramatta to Castle Hill via Windsor Road and Shепerground Road
- Parramatta to Macquarie Park via Kissing Point Road, Eastwood and County Road Reserve
- Parramatta to Macquarie Park via Carlingford and Epping
- Parramatta to Ryde via Victoria Road
- Parramatta to Burwood via Camellia/Silverwater
- Parramatta to Burwood/Strathfield via Parramatta Road
- Burwood/Strathfield to Sydney CBD via Parramatta Road
- Parramatta to Bankstown via Clyde, Lidcombe and Regents Park
- Parramatta to Bankstown via Clyde Street and Chester Hill
- Parramatta to Liverpool via Cumberland Highway
- Parramatta to Mount Druitt via Great Western Highway
3.3.1.3 Assessing the corridors and routes

The 13 routes identified were assessed using a MCA process. For the MCA, a set of criteria was adopted for scoring the corridors and routes. These criteria were developed from the objectives identified for the Parramatta Transport Corridor Strategy, with the addition of a feasibility criterion to address potential constraints. The six criteria are summarised in Table 3.3 below. Each potential route was then assessed against these criteria.

Table 3.3 Criteria used to evaluate corridors

<table>
<thead>
<tr>
<th>CRITERIA</th>
<th>Standard</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improve public transport accessibility to, from and within Parramatta CBD</td>
<td>Service areas with low resident accessibility to jobs</td>
<td>Travel time saving (in-vehicle time and wait time) offered by rapid transit over existing bus travel over the length of the corridor.</td>
</tr>
<tr>
<td></td>
<td>Serve areas with high social disadvantage</td>
<td>The degree of social disadvantage along proposed route, as defined by the Australian Bureau of Statistics’ Socio-Economic Indexes for Areas.</td>
</tr>
<tr>
<td>Configure the public transport network in Western Sydney to improve services</td>
<td>Improve public transport service quality</td>
<td>The ratio of existing peak public transport journey times to off-peak public transport journey times.</td>
</tr>
<tr>
<td></td>
<td>Serve corridors of high existing public transport demand</td>
<td>Morning peak public transport trips per kilometre of route length.</td>
</tr>
<tr>
<td>Support planned land use and provide opportunities for urban renewal</td>
<td>Potential to support planned increase in housing in the route catchment</td>
<td>Forecast population growth between 2011 and 2036 for travel zones within 400 metres of the route.</td>
</tr>
<tr>
<td></td>
<td>Potential to support planned increase in employment in the route catchment</td>
<td>Forecast employment growth between 2011 and 2036 for travel zones within 400 metres of the route.</td>
</tr>
<tr>
<td></td>
<td>Potential to support new urban renewal opportunities</td>
<td>Access to major proposed residential developments and employment areas.</td>
</tr>
<tr>
<td>Support planned land use and provide opportunities for urban renewal</td>
<td>Minimise impact on the strategic road network</td>
<td>The proportion of the route that overlaps with the strategic road network.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The proportion of the route where the available road corridor is less than 20 metres in width.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alternate routes available to mitigate the impact the proposal would have on network capacity.</td>
</tr>
</tbody>
</table>
3.3.1.4 Preferred corridors

Following the MCA investigation process, the NSW Government announced on 27 October 2014 four corridor options for further analysis. These corridors were:

1. Parramatta to Castle Hill via Old Northern Road.
2. Parramatta to Macquarie Park via Carlingford and Epping.
4. Parramatta to Bankstown along Clyde Street.

Common to all four corridors was a route through Greater Parramatta from Westmead through the Parramatta CBD linking the Westmead Health Precinct, Parramatta North Urban Transformation area, Parramatta CBD and Camellia Town Centre. The alignments for the shortlisted routes are shown in Figure 3.3.

An overview of the rationale for shortlisting each of these four corridors is provided in Table 3.4.

### Table 3.4 Shortlisted corridor options

<table>
<thead>
<tr>
<th>CORRIDOR</th>
<th>RATIONALE FOR SHORTLISTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parramatta to Castle Hill via Old Northern Road</td>
<td>This corridor was assessed as having:</td>
</tr>
<tr>
<td></td>
<td>» High potential for improving public transport journey times and increasing the frequency of services.</td>
</tr>
<tr>
<td></td>
<td>» Low level of engineering risk and land acquisition requirements.</td>
</tr>
<tr>
<td></td>
<td>» Greater opportunity for reducing the dependence on private car journeys by providing a competitive public transport option.</td>
</tr>
<tr>
<td></td>
<td>Overall, the options assessment determined that replacing some existing bus services with light rail had the potential to improve journey times, increase capacity and offer a greater level of reliability between Parramatta and the Hills area. This improved transport link would not only serve a significant proportion of Parramatta’s current workforce but also support future growth along the corridor.</td>
</tr>
</tbody>
</table>
### CORRIDOR | RATIONALE FOR SHORTLISTING
---|---
**Parramatta to Macquarie Park via Carlingford and Epping** | The proposed corridor between Parramatta and Macquarie Park via Epping was shown to have both significant strengths and weaknesses. The major strength was that it would support Greater Parramatta as Sydney’s Central City and would align well with Western Sydney’s future strategic public transport network by directly linking the Global Economic Corridor to Parramatta. This route would also support planned land use change and provide opportunities for urban renewal in the GPOP priority growth area. In addition, this route would provide the opportunity to integrate with and utilise existing transport infrastructure such as the T6 Carlingford Line.

**Parramatta to Strathfield/ Burwood via Camellia and Sydney Olympic Park** | This corridor route was assessed as providing significant potential to support the future population and employment growth in and around Sydney Olympic Park and strengthen Greater Parramatta as part of the ‘three cities’ vision for Greater Sydney, through improved business accessibility. This route further differentiates itself from the Parramatta Road alternative in that it had lower engineering and environmental constraints and minimised the need for property acquisition. This option also avoided interference with other strategic objectives for transport in the GPOP priority growth area.

**Parramatta to Bankstown along Clyde Street** | Both Bankstown alignments demonstrated that they were able to:

- Service areas of high social disadvantage.
- Service areas with high existing public transport demand.
- Maxmise potential for reduced car use.

The Parramatta to Bankstown route along Clyde Street differentiated itself from the non-shortlisted Parramatta to Bankstown route via the existing rail corridor due to a higher level of engineering feasibility and lower environmental and planning risks.
The remaining nine options were not shortlisted as they did not perform as well as the shortlisted options for public transport demand, urban renewal potential and alignment with NSW Government policies (Elton Consulting, 2016). However, a number of these options are considered...
to be important in providing an integrated public transport network serving the region, and are being considered for other transport modes (e.g. rapid bus routes).

A summary of the rationale for not pursuing the remaining corridors is provided in Table 3.5.

<table>
<thead>
<tr>
<th>CORRIDOR</th>
<th>RATIONALE FOR NOT SHORTLISTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parramatta to Rouse Hill</td>
<td>This option offered limited opportunity to improve travel times over the existing bus services that operate through this corridor via the North West T-way. Additionally, this option presented significant constraints with respect to existing gradients.</td>
</tr>
<tr>
<td>Parramatta to Castle Hill via Windsor Road</td>
<td>This route was assessed as the weaker of the two route options to Castle Hill. Compared to the shortlisted Parramatta to Castle Hill via Old Northern Road route, this route presented a lower level of public transport demand, and a less direct and slower route to Parramatta. This route was also determined to have relatively higher engineering constraints.</td>
</tr>
<tr>
<td>Parramatta to Macquarie Park via Eastwood</td>
<td>This route was assessed as the weaker of the two route options identified between Parramatta and Macquarie Park. Compared to the shortlisted Macquarie Park via Carlingford and Epping route, this route presented a lower level of public transport demand, offered fewer opportunities for urban renewal and was observed to have a number of environmental and planning risks, including potentially higher requirements for property acquisition.</td>
</tr>
<tr>
<td>Parramatta to Ryde</td>
<td>This option presented significant challenges due to the constrained conditions along Victoria Road, resulting in limited capacity to accommodate light rail. The implementation of light rail would potentially have a high impact on the existing bus network, particularly on Victoria Road, where it would interrupt longer existing services journeying to the Parramatta CBD. In addition, this option presented fewer opportunities for urban renewal.</td>
</tr>
<tr>
<td>Parramatta to Strathfield/Burwood via Sydney Olympic Park (Parramatta Road alternative)</td>
<td>While having some benefits, this route differentiated itself from the shortlisted option in that it had higher engineering and environmental constraints and would result in additional property acquisition. This route option also resulted in increased interference with strategic objectives for transport in the GPOP priority growth area.</td>
</tr>
<tr>
<td>Burwood/Strathfield to the Sydney CBD (Parramatta Road)</td>
<td>While also offering some potential for renewal, the link did not directly support the key objective of the study to support the growth of Parramatta CBD. It is important to note that transport services will continue to be investigated for this corridor through UrbanGrowth NSW’s Parramatta Road Urban Transformation Strategy.</td>
</tr>
<tr>
<td>Parramatta to Bankstown, via Clyde, Lidcombe and Regents Park</td>
<td>Although this route presented a number of strengths, this route was assessed as the weaker of the two Bankstown options. Compared to the Parramatta to Bankstown route along Clyde Street option, this option presented a lower level of engineering feasibility and higher environmental and planning risks.</td>
</tr>
<tr>
<td>Parramatta to Liverpool via the Cumberland Highway</td>
<td>This option was not shortlisted due to the potential conflicts with existing road freight transport. Additionally, compared with the other options assessed, this route presented a lower level of public transport demand and offered limited potential for urban renewal.</td>
</tr>
</tbody>
</table>
Following the identification of the four shortlisted corridors, the feasibility, costs and benefits of these corridors was investigated through a Strategic Business Case. This investigation is summarised in the following sections.

3.3.2 Assessment of shortlisted options

The Strategic Business Case assessed the feasibility of the four light rail transport corridors as announced by the NSW Government in June 2014 (refer to section 3.3.1). The Strategic Business Case considered a range of factors for each of the shortlisted corridors as outlined in Table 3.6.

<table>
<thead>
<tr>
<th>FACTOR</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design and operation principles</td>
<td>Options were assessed using a standard design and operating principles including: service frequency; vehicle size and capacity; priority; and stop location and design.</td>
</tr>
<tr>
<td>Customer outcomes</td>
<td>A number of drivers of customer satisfaction were assessed including: timeliness; personal safety and security; ticketing; convenience; accessibility; comfort; cleanliness; and information.</td>
</tr>
<tr>
<td>Availability of a stabling and maintenance facility</td>
<td>Locations for a stabling and maintenance facility site were identified and assessed to meet a range of design criteria including minimum site area, fleet size, ability to accommodate maintenance requirements etc.</td>
</tr>
<tr>
<td>Transport demand</td>
<td>Transport demand forecasting for each of the corridors was conducted using the Public Transport Project Model developed and run by the Bureau of Transport Statistics (BTS). Patronage modelling also took into account predicted changes in land use, employment and travel patterns in the study area.</td>
</tr>
<tr>
<td>Construction and engineering feasibility</td>
<td>Potential construction issues and engineering challenges were assessed for each of the four corridor options, including traffic management, disruptions to public transport services, road widening, interfaces with existing roads and the design and construction of new bridges and structures.</td>
</tr>
<tr>
<td>Traffic network assessment</td>
<td>Surface transport network impacts of the proposed corridors were assessed using a mesoscopic simulation traffic model. This was also used to identify potential impacts on the road network that would be caused by the operation of light rail within existing road corridors.</td>
</tr>
<tr>
<td>Environmental impacts</td>
<td>A desktop review of potential environmental impacts from constructing light rail in each of the four corridors including: impacts on flora and fauna; potential flooding issues; impacts on heritage items; presence of contamination and acid sulphate soils; potential noise impacts on surrounding areas; and impacts on public land.</td>
</tr>
<tr>
<td>Stimulate jobs and housing growth</td>
<td>The potential for light rail to stimulate urban renewal and jobs growth in each of the four corridors was assessed using current projections by the BTS.</td>
</tr>
</tbody>
</table>
Project development and alternatives

<table>
<thead>
<tr>
<th>FACTOR</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constructing light rail in stages</td>
<td>A high level consideration of potential staging of the shortlisted options.</td>
</tr>
<tr>
<td>Improving bus services to act as a feeder to light rail</td>
<td>A high level consideration of improving bus services to act as a feeder to light rail and opportunities for locating interchanges was considered for the shortlisted options.</td>
</tr>
<tr>
<td>Benefit cost analysis</td>
<td>A benefit cost analysis to assess the economic merits of the four corridors was also conducted including consideration of transport, land use and wider economic benefits in addition to estimated direct and indirect costs for each corridor.</td>
</tr>
</tbody>
</table>

The assessment also identified that a staged implementation may be beneficial as it would defer upfront capital expenditure (making light rail more affordable from the day of opening), reduce construction and traffic impacts in the short term, and would enable subsequent future stages of a light rail implementation to benefit from the lessons learnt in earlier stages of the proposed light rail network.

A summary of the Strategic Business Case assessment for each of the four shortlisted routes is provided in Table 3.7.

Table 3.7 Shortlisted corridor options

<table>
<thead>
<tr>
<th>CORRIDOR</th>
<th>ASSESSMENT OF CORRIDOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parramatta to Castle Hill via Old Northern Road</td>
<td>The assessment found that the key challenge for constructing light rail to Castle Hill was the limited capacity for accommodating light rail on the existing road network. The investigations showed that light rail to Castle Hill would result in major disruptions to roads both during construction and once in operation. In addition, compared to the Strathfield via Sydney Olympic Park and Macquarie Park corridors, this corridor presented lower transport demand and less potential for urban renewal.</td>
</tr>
<tr>
<td>Parramatta to Macquarie Park via Carlingford and Epping</td>
<td>The assessment identified that light rail would help to meet strong and growing transport demand in the Parramatta to Macquarie Park corridor and could link key residential, education and commercial precincts, including the Western Sydney University’s Parramatta campus at Rydalmere, the Rydalmere Industrial Precinct, Camellia and Telopea. The majority of these benefits were found to be between Parramatta and Epping due to Sydney Metro Northwest providing a new fast transport connection between Epping and Macquarie Park.</td>
</tr>
<tr>
<td>Parramatta to Strathfield/Burwood via Camellia and Sydney Olympic Park</td>
<td>The Parramatta to Olympic Park via Strathfield corridor presented a good opportunity to support planned land use changes and future growth. Light rail would also provide a new east-west transport link through the GPOP priority growth area integrated with the wider transport network at the key hubs at Parramatta and Strathfield. This would provide greater connectivity to those travelling to, through and beyond the corridor.</td>
</tr>
</tbody>
</table>
Investigations showed that light rail would not offer the same level of transport benefits to customers in the Bankstown corridor compared to those in other corridors. The existing heavy rail line via Lidcombe will still provide a faster journey to Parramatta than light rail and the Sydney Metro City & Southwest will provide a fast connection to Sydney CBD. Transport for NSW therefore found the Bankstown corridor is best served in the short term by improved bus services that could be developed into rapid bus or light rail as demand grows. While investigations showed light rail to Bankstown could act as a catalyst for future housing growth, this potential would only be realised over the longer term and will not be matched by a similar uplift in employment opportunities.

### The preferred network corridor

On the basis of the Strategic Business Case assessment, the NSW Government announced on 8 December 2015, the preferred light rail network between Parramatta and Strathfield via Camellia and Sydney Olympic Park with a branch line between Camellia and Carlingford.

The preferred network was chosen on its potential to encourage urban growth and contribute to the region’s transport network. The preferred network was identified as including:

- A core spine linking precincts within Greater Parramatta including Westmead health precinct, Parramatta CBD and Camellia.

- The replacement of the existing heavy rail service between Camellia and Carlingford with a more frequent light rail service, directly linking the existing T6 Carlingford Line to the Parramatta CBD.

- A light rail service through Camellia renewal area, Sydney Olympic Park also connecting to Strathfield.

Key factors considered in the selection of the preferred network corridor when compared to other options were:

- Combines the two strongest performing corridors as assessed in the Strategic Business Case and would support strategic precincts with the highest growth and forecast demand of future population and employment.

- Provides a good opportunity for staged delivery by initially converting the existing T6 Carlingford Line with light rail. It would improve connectivity to Parramatta and the wider public transport network for growing communities along the T6 Carlingford Line.

- Creates an integrated transport network by providing customers with connections to two major transport interchanges at Parramatta and Strathfield, improving connections to and from businesses, homes and major events.

### Alignment options identification process

Following identification of the preferred network, a detailed options analysis was carried out to ensure that the final alignment was based on a comprehensive, objective and quantitative assessment of options, taking into account stakeholder and community feedback.

An options analysis framework was developed reflecting the need to define a route that met the objectives of the project (refer to section 2.7) and the opportunities presented in the GPOP priority growth area.
The framework consisted of the following three phases (refer to Figure 3.4):

» **Phase 1 Needs assessment** – Carried out with a range of stakeholders including Health Infrastructure, Sydney Olympic Park Authority, the City of Parramatta Council, Land and Housing Corporation, the Department of Education and Planning, Venues NSW, UrbanGrowth NSW and Western Sydney University. The assessment identified stakeholder ‘requirements’ in relation to possible route options. In addition, stakeholders were also consulted to provide input into the draft framework. Following finalisation of the framework, alternative route options to the ‘baseline’ route (the route identified as part of the preferred network) were identified. In addition to options generated by the project team, consultation with stakeholders identified a number of further options for consideration creating a long list of potential route options.

» **Phase 2 Option evaluation** – Involved a two-step assessment process. The first step involved a strategic merit test (SMT), applied to the long list of potential route options. Qualitative in nature, the purpose of the SMT was to eliminate options that were not technically feasible or would present other critical issues. This resulted in a shorter list of options that were carried forward for further consideration. The second step, a multi-criteria analysis, involved quantitative assessment of the shortlisted route options and included an economic appraisal for each option.

» **Phase 3 Preferred route selection** – Once the qualitative and quantitative assessment was completed, a preferred network was selected for each section of the final preferred alignment.

**Figure 3.4 Route options evaluation framework**

Further details regarding the assessment of each of the above phases is provided in the following sections.
3.4.1 Phase 1 - Options developed

Since the announcement of the preferred Parramatta Light Rail network in December 2015, Transport for NSW identified and assessed a range of potential light rail alignment options along the preferred network corridor. This assessment consisted of two types of evaluation, which are typically used to differentiate between different options in the early phases of transport projects:

» A SMT, which is a qualitative analysis

» A MCA which enables both quantitative and qualitative aspects of an option to be assessed.

In July 2016, a SMT was carried out as a preliminary assessment tool to further refine the alignment along the preferred network corridor between Westmead and Strathfield (as identified in section 3.4.3). The options considered for the SMT (relevant to the project) included alignment options for the following sections:

» Westmead to the Parramatta CBD

» Parramatta CBD to Camellia

» Along the Carlingford Line between Camellia and Carlingford.

3.4.2 Phase 2 - Option evaluation

As an outcome of the SMT analysis, nine potential route alignment options (the shortlisted options) were carried forward for further assessment using a MCA approach where more rigorous quantitative assessment was carried out with further stakeholder inputs taken into consideration.

The MCA considered seven key evaluation criteria, including a high level economic appraisal for each option. The evaluation criteria for the MCA comprised:

1 Alignment with Government priorities - This criterion assessed how each option aligned with key Government strategic priorities which are relevant to the project. These include the Premier’s Priorities, State Priorities, A Plan for Growing Sydney, and the Long Term Transport Master Plan.

2 City building and place making outcomes - This criterion was designed to measure each option’s success in driving city building and place making outcomes, including supporting existing development precincts, future place making and urban renewal opportunities, and alignment with the Parramatta Strategic Framework.

3 Transport outcomes - This criterion allowed the assessment of transport outcomes of each option. Some of the sub-criteria include travel time savings, transport user benefits, impact on road network, and interface with other transport modes.

4 Deliverability and risk - This criterion related to how the project could be delivered, assessing the scope, constructability, impact on properties, environmental and planning, and risks for each option.

5 Affordability - This criterion compared the costs, revenue and potential funding avenues for each option. Some of the sub-criteria included capital expenditure, revenue and potential level of funding.

6 Stakeholder and community support - This criterion allowed stakeholder and community support to be factored into the SMT.

7 Economic appraisal - This criterion considered the economic implications of each option alignment, including public transport uses, road users, and productivity considerations.

As part of the evaluation process, the MCA recognised that the project was required to support immediate to medium-term growth in land uplift, especially in the western section of the GPOP priority growth area. However the analysis also identified that land use planning in the eastern half of the preferred alignment (to the east of the proposed stabling and maintenance facility at Camellia), including finalisation of the Camellia Masterplan, Sydney Olympic Park Masterplan and
Sydney Markets land use strategy required further investigation to better integrate land use planning with the project. Additionally, after the MCA was performed, the new Sydney Metro West project was announced by the NSW Government, with further implications for the project’s eastern alignment.

Based on the uncertainties associated with the eastern end of the preferred alignment, it was recommended that the assessment focus on Stage 1 of the project (refer to section 3.5), west of Camellia. Seven shortlisted options were therefore considered for Stage 1 of the Parramatta Light Rail network using the MCA process for three sections of the network:

» Westmead to the Parramatta CBD
» Parramatta CBD to Camellia
» Through Camellia to Carlingford.

An assessment of the primary project alignment options considered as part of the MCA process relevant to the identification of the preferred alignment for Stage 1 of the Parramatta Light Rail network are discussed below.

3.4.2.1 Westmead to Parramatta CBD

**Context and background**

The Westmead to Parramatta CBD section contains the Westmead Health Precinct, the major health services hub in Western Sydney. Health and research services represented in the precinct include the Children’s Hospital at Westmead, Westmead Hospital, Westmead Private Hospital, the Children’s Medical Research Institute, the Millennium Institute and Sydney West Area Health Service. The Westmead Health Precinct and Westmead Hospital Master Plan aims to further increase the capacity of the precinct to enhance health, education and research outcomes. The Parramatta North Urban Transformation Area is also part of this section, comprising approximately 146 hectares of land located between the Parramatta CBD and the Westmead Health Precinct, and is currently being redeveloped into a residential, retail and sports hub by UrbanGrowth NSW.

**Description of feasible options**

For the Westmead to the Parramatta CBD section, three main alignment options were identified (refer to Figure 3.5):

» Option 1 – provides a connection to Westmead Station, the Westmead Health and the Parramatta North Urban Transformation area precincts, North Parramatta and the Parramatta CBD via Church Street.

» Option 2 – provides a more direct connection from the Westmead Health Precinct to the Parramatta CBD that generally follows a route adjacent to the T1 Western Line connecting to the CBD via Pitt Street and Macquarie Street.

» Option 3 – combines Option 1 and Option 2 to provide a two-way loop between Westmead, North Parramatta and Parramatta CBD. This option supports connections to all key GPOP priority growth precincts within this section, and provides a direct connection between Westmead and Parramatta CBD.
Assessment of feasible design options

An assessment of the alignment options carried out against the identified assessment criteria is provided in Figure 3.6.

<table>
<thead>
<tr>
<th></th>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
</tr>
</thead>
</table>
| Alignment with Government priorities | ![Color Key](image)
| City building outcomes              | ![Color Key](image)
| Transport outcomes                 | ![Color Key](image)
| Deliverability and risk            | ![Color Key](image)
| Affordability                      | ![Color Key](image)
| Stakeholder support                | ![Color Key](image)
| Economic feasibility               | ![Color Key](image)

**Figure 3.5** Alignment options between Westmead and Parramatta CBD

**Figure 3.6** Assessment of Westmead to Parramatta CBD alignment options
Selection of preferred design option

Option 1 would support the planned growth of new dwellings and jobs projected for the Westmead Health, Parramatta North Urban Transformation area and Parramatta CBD precincts. When compared to Option 2, it would provide better opportunities for high quality public domain improvements within the Parramatta North Urban Transformation Area and Parramatta CBD precincts (e.g. pedestrian areas). Option 1 would also avoid direct impacts on Parramatta Park, which contains the World Heritage listed Australian Convict Sites (Old Government House and Domain).

Option 2 performs relatively poorly against the criteria as it would not provide connections to urban renewal areas in North Parramatta and the Parramatta CBD. When compared to Option 1, the option has additional delivery risks and construction complexity, requires more property acquisition and is more costly. For example, the option would require two crossings of the T1 Western Line, would impact the existing bus T-way and would impact on Parramatta Park. While Option 2 would shorten travel times between Westmead and the Parramatta CBD, it would largely duplicate existing public transport services.

Option 3 would provide similar support to urban renewal projects and overall transport outcomes compared to Option 1. However, the option would be significantly more expensive when compared to other options, and therefore did not justify the additional construction and environmental costs (such as additional impacts on biodiversity and the World Heritage nature of Parramatta Park).

Overall, Option 1 was identified as the preferred route option for this section of the project alignment.

3.4.2.2 Parramatta CBD to Camellia

Context and background

This section of the preferred alignment included the core of Parramatta CBD, containing many jobs, government offices, courts, company headquarters, shops, restaurants and theatres.

Several major government employers have their headquarters or key offices in Parramatta, including the Australian Taxation Office, NSW Police, Sydney Water, the NSW Department of Planning and Environment, the Greater Sydney Commission and UrbanGrowth NSW. The Parramatta Justice Precinct is the primary centre for legal services and court proceedings within the GPOP priority growth area.

A number of major developments are proposed in the next decade for the city centre and at key locations in the GPOP priority growth area that will result in significant further growth in Parramatta. These developments are anticipated to change the nature and scale of the region’s transport demands.

Description of feasible options

For the Parramatta CBD to Camellia section, three main alignment options were considered (refer to Figure 3.7):

» Option 1 – providing a route through the Parramatta CBD via Macquarie Street and Harris Street.

» Option 2 – utilising George Street as an alternate route to Macquarie Street between Church Street and Harris Street.

» Option 3 – utilising a split track system with one track along George Street and one track along Macquarie Street between Church Street and Harris Street.

East of Harris Street, all options would follow the same general alignment along George Street and Tramway Avenue to James Ruse Drive (refer to options assessment in section 3.6.6).
Assessment of feasible design options

An assessment of the alignment options carried out against identified assessment criteria is provided in Figure 3.8.

<table>
<thead>
<tr>
<th>Assessment Criteria</th>
<th>Option 1 Macquarie Street</th>
<th>Option 2 George Street</th>
<th>Option 3 Macquarie Street &amp; George Street split</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alignment with Government priorities</td>
<td>Green</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>City building outcomes</td>
<td>Green</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Transport outcomes</td>
<td>Green</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Deliverability and risk</td>
<td>Green</td>
<td>Red</td>
<td>Red</td>
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<tr>
<td>Affordability</td>
<td>Red</td>
<td>Green</td>
<td>Red</td>
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<tr>
<td>Stakeholder support</td>
<td>Orange</td>
<td>Orange</td>
<td>Orange</td>
</tr>
<tr>
<td>Economic feasibility</td>
<td>Orange</td>
<td>Orange</td>
<td>Orange</td>
</tr>
</tbody>
</table>

Figure 3.7  Alignment options between Parramatta CBD and Camellia

Figure 3.8  Assessment of Parramatta CBD to Camellia alignment options
Selection of preferred design option

As shown in Figure 3.8, Option 1 was identified as the preferred route option as it would provide better integration with Parramatta Station and would attract greater levels of patronage when compared to Option 2. While it would be somewhat more costly to build when compared to Option 2 and would result in increased impacts on Robin Thomas Reserve, Option 1 would provide better support for future urban renewal and connection to the Parramatta CBD (including areas to the south of the T1 Western Line). This option would also provide an improved interchange arrangement with Parramatta Station.

Option 3 was not considered to be a viable option as it would not provide acceptable customer service, operational or project delivery outcomes. The split system would not provide a legible, user-friendly public transport outcome, would significantly increase traffic impacts, and would cost at least double and take longer to construct than the other two options. Furthermore, there is very limited precedent for split light rail systems in major urban areas throughout the world.

Option 1 would also provide greater opportunities to extend and connect to high quality public domain improvements being delivered by City of Parramatta Council (such as Parramatta Square).

3.4.2.3 Camellia

Context and background

Camellia is approximately 424 hectares and is situated about 1.5 kilometres east of the Parramatta CBD. The Department of Planning and Environment, in conjunction with the City of Parramatta Council, currently proposes to transform Camellia into a residential and mixed use precinct (the Camellia Town Centre), while maintaining some areas of existing industrial usage. This is proposed to be achieved through rezoning and improving connectivity to the region. Camellia will also continue to house important industrial land (such as significant petroleum operations in the area) in addition to other existing industrial operations which currently operated within this precinct.

The Department of Planning and Environment and the City of Parramatta Council developed a draft Land Use and Infrastructure Strategy for the Camellia Town Centre which was released for public consultation in 2015. The Strategy outlined a proposed masterplan for Camellia which including an assumed light rail alignment along Grand Avenue east from Camellia towards Sydney Olympic Park.

Description of feasible options

Within this section of the preferred corridor alignment, two shortlisted options were considered for an east-west connection between the T6 Carlingford Line and the proposed location of the stabling and maintenance facility. These options were (refer to Figure 3.9):

- Option 1 – travelling along Grand Avenue.
- Option 2 – use of an existing freight line (the Sandown Line).
Project development and alternatives

Parramatta Light Rail | Stage 1 – Westmead to Carlingford via Camellia
Environmental Impact Statement

Assessment of feasible design options

An assessment of the alignment options carried out against identified assessment criteria is provided in Figure 3.10.

Based on the assessment of the identified criteria, Option 2 was considered the preferred route option as it would:

- Offer greater future place making opportunities associated with the future Camellia Town Centre (currently being investigated).
- Align with the current design for the Camellia Masterplan, allowing for integration with a future transit-oriented town centre.
- Reduce conflict/risks associated with an existing hazardous goods and heavy vehicle route (Grand Avenue), and significant utilities (water and fuel pipelines).
- Have lower constructability and delivery risks, as it would follow a disused rail corridor, would avoid costly utility works (including gas, fuel pipelines and electricity mains), minimise property
acquisition requirements and would minimise interactions between heavy vehicles and light rail vehicles (LRVs) along Grand Avenue.

» Would not preclude further extensions to the network beyond Camellia.

3.4.3 Phase 3 – Preferred route alignment – Parramatta Light Rail (Stage 1)

Based on the MCA, the preferred alignment for the project would comprise:

» Westmead to Parramatta CBD, via North Parramatta (Option 1).
» Parramatta to Camellia, via Macquarie Street (Option 1).
» Camellia, via the Sandown Line (Option 2).

The preferred alignment also includes a route along the existing T6 Carlingford Line between Camellia Station and Carlingford Station replacing existing T6 Carlingford Line train services. Overall, these alignments would maximise the achievement of the project objectives, and would not preclude further extensions to the network beyond Camellia. The preferred project alignment is described in further detail in Chapter 5 (Project description – Infrastructure and operation) of this report.

3.5 Staging options

Following a review of the expected timing for urban renewal along the preferred light rail network corridor and the ongoing development of transport planning to support the GPOP priority growth area, the option to stage the delivery of Parramatta Light Rail network was investigated by Transport for NSW. The options included the initial delivery of:

» A route between Westmead and Carlingford via Parramatta CBD
» A route between Westmead and Sydney Olympic Park via Parramatta CBD and Camellia (excluding Carlingford)
» A route between Westmead and Sydney Olympic Park via Parramatta CBD and Camellia including Carlingford.

The assessment considered the need to:

» Meet the Parramatta Light Rail network objectives and the NSW government’s objectives for the GPOP priority growth area.
» Prioritise areas that would be subject to growth in the short to medium term (five to 10 years) but currently have transport networks with limited capacity to support this growth.
» Maximise integration with existing and future transport network projects, such as the future Sydney Metro West which is currently under investigation.
» Land use planning of key precincts: Camellia, Sydney Olympic Park, Telopea and the Parramatta Road Urban Transformation area (subject to further development).
» Remain cost effective and deliver transport outcomes in the short and long term.

The assessment concluded that the Parramatta Light Rail network would be best delivered in stages, with the first stage consisting of the network between Westmead to Carlingford, via Camellia and Carlingford (Parramatta Light Rail (Stage 1)). Parramatta Light Rail (Stage 1) would support the more immediate planned growth in Westmead, Parramatta CBD and along the T6 Carlingford Line precincts in the next five to 10 years.

In particular Parramatta Light Rail (Stage 1) would:

» Support significant short- to medium-term benefits to the Westmead Health Precinct, Parramatta North Urban Transformation Area, Parramatta CBD, Western Sydney Stadium redevelopment,
the new Powerhouse Museum and Riverside Theatres Hub, and the Parramatta CBD schools precinct. All of these key precincts are currently being further developed or expanded and require improved transport options in the short term.

- Address deficiencies in the existing transport networks in Westmead and Parramatta CBD that would limit capacity to support growth – in particular, it would address the lack of good intermediate connections between residential, commercial, health, educational and entertainment precincts.

- Facilitate more frequent services that are required along the T6 Carlingford Line to respond to forecast growth over the next 10 years.

The implementation of future stages of the Parramatta Light Rail network would be dependent on:

- Resolving the timing of the land use planning in the eastern section of the preferred network, including finalisation of the Camellia Masterplan, Sydney Olympic Park Masterplan and Parramatta Road Urban Transformation Strategy.

- The final alignment and station locations for Sydney Metro West to ensure the project and metro are better integrated.

Paramatta Light Rail (Stage 1), the subject of this Environmental Impact Statement (the project), was identified to key stakeholders and the broader community on 17 February 2017 by the NSW Government. Planning work is currently continuing for Stage 2 of the network with consideration of other strategic transport projects (such as Sydney Metro West). This work is expected to be completed by the end of 2017.

The preferred light rail network, including the proposed alignment for Stage 1, is shown in Figure 3.11.
3.6 Project refinements

3.6.1 Overview

An iterative process of design development and evaluation has been carried out to further refine the preferred project alignment. The definition of each element has evolved as a result of ongoing urban design, engineering, traffic, financial, economic and environmental consideration, as well as ongoing consultations with other NSW Government agencies, local councils, the community and other stakeholders.

Definition of the project has involved an extensive program of consultation and a series of workshops involving project team members, stakeholders and various interdisciplinary groups. This process identified a range of options for definition design elements such as:

» The alignment of discrete sections of the projects alignment, including route alignment options and detailed refinement to avoid potential impacts.

» Stop locations and configurations.

» Stabling and maintenance facility locations.

» Design elements such as overhead wire pole placement and substation locations.
A typical option assessment process adopted for the project included:

» Defining the issue - Clearly identifying the issue to be resolved through alternate option(s).

» Confirming assessment criteria – Listing the criteria that the options were to be assessed against.

» Identification and description of the options – Developing a suite of potential options depending on the design issue or project element and validating the options for feasibility to a level of detail to allow an assessment of the impacts of each option against the assessment criteria.

» Assessment of options and evaluate options including:
  • The key benefits and disadvantages of each option
  • How the option(s) perform against the assessment criteria
  • Whether the alternate option(s) would result in other adverse impacts.

» Decision making – Identifying whether the alternate option(s) address the issue and meet the project objectives.

For each alignment refinement, a range of criteria were considered. These are shown in Table 3.8.

<table>
<thead>
<tr>
<th>CRITERIA</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td>Land use</td>
<td>» Integration with the existing and future developments</td>
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<td></td>
<td>» Connectivity with surrounding land uses</td>
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<td></td>
<td>» Impacts on open spaces, community uses etc.</td>
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<tr>
<td>Traffic and transport</td>
<td>» Impact on existing traffic network (e.g. road network performance,</td>
</tr>
<tr>
<td></td>
<td>intersections, signalling requirements etc.)</td>
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<tr>
<td></td>
<td>» Proximity to interchange opportunities (such as rail, bus, ferry).</td>
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<tr>
<td>Safety</td>
<td>» Operational safety for light rail operations</td>
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<td></td>
<td>» Traffic network impacts</td>
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<td></td>
<td>» Pedestrian and accessibility impacts.</td>
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<tr>
<td>Urban design</td>
<td>» Impact on existing urban domain</td>
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<td></td>
<td>» Potential for improvement/integration opportunities associated with the</td>
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<td>project</td>
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<td></td>
<td>» Potential for improvement/integration opportunities for active transport</td>
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<td></td>
<td>link(s).</td>
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<tr>
<td>Environment</td>
<td>» Impacts on key environmental issues such as:</td>
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<td></td>
<td>• Heritage</td>
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<td></td>
<td>• Biodiversity</td>
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<td></td>
<td>• Street trees</td>
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<td></td>
<td>• Noise and vibration</td>
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<td></td>
<td>• Flooding.</td>
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<tr>
<td>Property</td>
<td>» Impact on private property</td>
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<td></td>
<td>» Land acquisition requirements</td>
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<tr>
<td></td>
<td>» Requirement for additional licences, easements etc.</td>
</tr>
<tr>
<td>Stakeholders</td>
<td>» Consideration of input from key stakeholders and community feedback</td>
</tr>
<tr>
<td></td>
<td>» Integration with future plans by key stakeholders (e.g. UrbanGrowth NSW).</td>
</tr>
<tr>
<td>Cost and program</td>
<td>» Impact on costs for capital works and ongoing operational costs</td>
</tr>
<tr>
<td></td>
<td>» Impact on delivery program/timing of construction works</td>
</tr>
<tr>
<td></td>
<td>» Planning and assessment pathway.</td>
</tr>
<tr>
<td>Other/operations</td>
<td>» Impacts on overall light rail operation</td>
</tr>
<tr>
<td></td>
<td>» LRV fleet requirements</td>
</tr>
<tr>
<td></td>
<td>» Travel times.</td>
</tr>
</tbody>
</table>
The key design refinements carried out along the preferred project alignment are described further in the following sections and shown in Figure 3.12.

Figure 3.12  Key design options considered
3.6.2 Hawkesbury Road section

3.6.2.1 Background

The identified project alignment would travel from the proposed Westmead stop opposite Westmead Station along Hawkesbury Road. Stops are proposed at Westmead Hospital and Children’s Hospital at Westmead, before crossing Parramatta River into Parramatta North and the Parramatta CBD.

The Westmead Health Precinct is a major destination for the project, with Health Infrastructure being a key stakeholder. A masterplan has been approved for the Westmead Hospital site, which includes redevelopment of the precinct over a number of stages. The project would provide a major interface with the Westmead Hospital and Hawkesbury Road, providing a potential gateway to the new health precinct.

To accommodate the potential interface of the project with the redevelopment of the Westmead Hospital site, alternative alignments along Hawkesbury Road were considered, with a focus on the section of Hawkesbury Road between Darcy Road and Jessie Street. Hawkesbury Road between Darcy Road and Jessie Street is a single lane of traffic in each direction with on-street parking where space permits. There are a number of major driveways into the Westmead Health Precinct for Westmead Hospital, medical clinics, the Children’s Hospital at Westmead and private properties on the eastern side of Hawkesbury Road.

3.6.2.2 Description of feasible options

Two main alignment options along Hawkesbury Road were assessed, comprising:

- Option 1 – A centre running alignment within Hawkesbury Road.
- Option 2 – Side running alignment on the north side of Hawkesbury Road, within the Westmead Health Precinct.

Option 1 along Hawkesbury Road would consist of a centre running alignment with a single lane of traffic retained in each direction between Caroline Street and Jessie Street. Right turning lanes would be provided on approach to both Caroline Street and Darcy Road with the remaining right turning movements removed. For the Option 1 alignment, a stop would be provided along Hawkesbury Road, east of Caroline Street. This stop would provide access to Westmead Hospital and the proposed plaza to be delivered in Stage 1 of the hospital redevelopment.

Option 2 would provide a light rail alignment which would run adjacent to the western side of Hawkesbury Road within Heath Infrastructure land associated with the Westmead Hospital. This would allow a stop (potentially side platforms) to be located providing direct access to the Westmead Hospital main entrance and hospital clinics without the need to cross Hawkesbury Road. This option would require limited changes to the current traffic arrangement along Hawkesbury Road for this section of the project, with the exception of the existing major access points for the Westmead Health Precinct.

Indicative alignments for each of the options are shown in Figure 3.13.
3.6.2.3 Assessment of design options

An assessment of the alignment options carried out against identified assessment criteria is provided in Figure 3.14.

<table>
<thead>
<tr>
<th>Land use integration</th>
<th>Option 1</th>
<th>Option 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic and transport</td>
<td></td>
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<td>Safety</td>
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<td>Urban design</td>
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<td>Environment</td>
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<tr>
<td>Property</td>
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<tr>
<td>Stakeholders</td>
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<tr>
<td>Cost and program</td>
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<tr>
<td>Other / operation</td>
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</tbody>
</table>

**Figure 3.14  Assessment of Hawkesbury Road alignment options**

3.6.2.4 Selection of preferred design option

The alignment with Hawkesbury Road (Option 1) would have the following advantages over a stop within the Westmead Hospital site:

» A stop location within the centre of Hawkesbury Road would more equally serve customers from both the Westmead residential area, non-hospital users as well as passengers accessing the Westmead Hospital.

» Reduce modification to the existing signals at Darcy Road and new set of signals on Hawkesbury Road required to cross from the Westmead terminus stop.
3.6.3 Alignment over Parramatta River (North Parramatta)

3.6.3.1 Background

Further to the identification of the preferred alignment from Westmead Station (refer to section 3.4.3), additional investigation identified a refined alignment for the crossing of Parramatta between Westmead and the Cumberland Hospital sites.

3.6.3.2 Description of feasible options

Two alignment options across the Parramatta River at North Parramatta were assessed, comprising:

- Option 1 – A light rail alignment along the same alignment as the existing bridge structure.
- Option 2 – A light rail alignment which would cross the Parramatta River over a new alignment approximately 120 metres to the south of the existing bridge.

The alignment for Option 1 would be located generally along the same alignment as the existing alignment for Bridge Road, including the existing bridge structure over Parramatta River. This alignment would provide for a new structure to replace the existing bridge at this location and would be approximately 60 metres in length.

The alignment for Option 2 would be located approximately 120 metres south of Option 1 along Parramatta River. From the intersection of Hainsworth Street and Bridge Road, Westmead, the alignment for Option 2 would continue along Hainsworth Street to Park Avenue, prior to travelling along the north edge of Parramatta Park, over Parramatta River and through the Cumberland Hospital site. This alignment would consist of a new structure from west to east over Parramatta River with a total length of about 100 metres. Indicative alignments for each of the options are shown in Figure 3.15.

Note: Red line indicates proposed project alignment and stops

Figure 3.15 Alignment options over Parramatta River (North Parramatta)
3.6.3.3 Assessment of design options

An assessment of the alignment options carried out against identified assessment criteria is provided in Figure 3.16.

<table>
<thead>
<tr>
<th>Land use integration</th>
<th>Option 1</th>
<th>Option 2</th>
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<tr>
<td>Traffic and transport</td>
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<td>Environment</td>
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<td>Property</td>
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<td>Stakeholders</td>
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</tr>
<tr>
<td>Cost and program</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other / operation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 3.16 Assessment of alignment options over Parramatta River (North Parramatta)**

3.6.3.4 Selection of preferred design option

Overall, both options would present similar outcomes, with respect to travel time, cost and overall passenger catchment area. While Option 2 would present some benefits including providing an additional transport corridor and river crossing improving light rail and active transport connections between the Parramatta North Urban Transformation area and Parramatta Park, this option would also present a series of potential constraints including greater potential heritage impacts relative to Option 1. These constraints include the need to construct an additional bridge structure within identified view lines to the Old Government House and Domain, increased vegetation and landscape impacts along the Parramatta River banks and increased impacts on the Parramatta North Urban Transformation area.

Based on the options assessment, Option 1, was therefore considered to be the preferred option as it would present the following additional advantages:

- It would utilise an existing street corridor, reducing potential heritage impacts, in particular to Old Government House and Domain and the Parramatta River.
- The alignment would provide a segregated corridor, reducing the potential for uncontrolled interface between LRVs and general traffic.
- Reduced landscape and open space impacts along the Parramatta River.
- It would better integrate with the Parramatta North Urban Transformation area and reduced property impacts on the southern portion of this area in comparison to Option 2.
- It would have a reduced impact on the Former Female Factory site (nominated for National Heritage listing).
- It would have improved environmental outcomes as it would be located further away from a known Grey-Headed Flying Fox colony.

Following identification of Option 1 as the preferred option; however, ongoing consultation discussions with key stakeholders identified that the preferred option would not meet the...
operational needs of the Cumberland Hospital site with respect to maintaining vehicle access between the western and eastern sides of the Parramatta River at this location. The Western Sydney Local Health District has identified that direct access between the eastern and western campuses of the Cumberland Hospital is important to maintain the operation of the hospital. As such, an additional sub-option was considered which consisted of providing a second bridge structure immediately adjacent (to the east) of the existing bridge.

While this option would result in some additional environmental impacts compared to the preferred option (including some additional vegetation impacts and impact on an additional building on the western side of the Parramatta River), it is considered to be a preferable overall option in order to meet the operational needs of the Cumberland Hospital site and would continue to provide a better outcome than the other additional bridge option identified (Option 2).

3.6.4 Alignment through North Parramatta

3.6.4.1 Background

Church Street is a key route for buses entering the Parramatta CBD from the north. The project identified to key stakeholders and the broader community in February 2017 included an alignment which travelled along Factory Street and the northern section of Church Street. To reduce potential impacts on buses travelling along this section of Church Street, an option that would reduce the impact on bus services and general traffic north of the Church Street and Pennant Hills Road intersection was identified.

3.6.4.2 Description of feasible options

Three options for the alignment through North Parramatta were assessed, comprising:

» Option 1 – A light rail alignment along Factory Street and Church Street.

» Option 2 – A light rail alignment along Fleet Street and Fennell Street to the intersection of Church Street.

» Option 3 – A light rail alignment between the Parramatta North Urban Transformation area and Church Street along Albert Street.

Option 1 would continue the light rail alignment in an east-west direction to the east of the Parramatta North Urban Transformation area, along Factory Street to the intersection of Church Street. At this point, the alignment would turn south and travel along Church Street towards the Parramatta CBD.

Option 2 would provide an alignment that avoids Factory Street and Church Street. East of the Parramatta North Urban Transformation area, the alignment would travel south along Fleet Street and then along Fennell Street before turning into Church Street at the intersection with Fennell Street.

Option 3 would provide an alignment that would generally continue in an easterly direction from Parramatta North Urban Transformation area, along Albert Street to the intersection of Church Street. At this point, the alignment would turn south and travel along Church Street towards the Parramatta CBD.

Indicative alignments for each of these options are shown in Figure 3.17.
3.6.4.3 Assessment of design options

An assessment of the alignment options carried out against identified assessment criteria is provided in Figure 3.18.

![Figure 3.18](Image)

### Figure 3.18 Assessment of alignment options through North Parramatta

<table>
<thead>
<tr>
<th></th>
<th>Option 1 Factoy Street</th>
<th>Option 2 Fleet Street</th>
<th>Option 3 Albert Street</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land use integration</td>
<td>![Green]</td>
<td>![Red]</td>
<td>![Red]</td>
</tr>
<tr>
<td>Traffic and transport</td>
<td>![Red]</td>
<td>![Orange]</td>
<td>![Orange]</td>
</tr>
<tr>
<td>Safety</td>
<td>![Green]</td>
<td>![Red]</td>
<td>![Red]</td>
</tr>
<tr>
<td>Urban design</td>
<td>![Green]</td>
<td>![Red]</td>
<td>![Red]</td>
</tr>
<tr>
<td>Environment</td>
<td>![Green]</td>
<td>![Red]</td>
<td>![Red]</td>
</tr>
<tr>
<td>Property</td>
<td>![Orange]</td>
<td>![Orange]</td>
<td>![Orange]</td>
</tr>
<tr>
<td>Stakeholders</td>
<td>![Orange]</td>
<td>![Red]</td>
<td>![Orange]</td>
</tr>
<tr>
<td>Cost and program</td>
<td>![Orange]</td>
<td>![Red]</td>
<td>![Orange]</td>
</tr>
<tr>
<td>Other / operation</td>
<td>![Green]</td>
<td>![Orange]</td>
<td>![Orange]</td>
</tr>
</tbody>
</table>

Note: Red line indicates proposed project alignment and stops
3.6.4.4 Selection of preferred design option

Based on the options considered, Option 1, an alignment following Factory Street and travelling along the length of Church Street, was considered to be the preferred option for the following reasons:

» Option 1 would result in an improved level of patronage in comparison to an alignment along Fleet Street and Fennell Street, in particular as a result of the proposed stop near the intersection of Factory Street and Church Street.

» For the Option 2 alignment, a stop would be located within the vicinity of the administration building for the Former Female Factory. This alignment option would run parallel to the nominated listing boundary along Fleet Street as well as Entrance Road. This option was considered to result in an undesirable visual impact on this nominated heritage item.

» Option 1 would serve a larger catchment of Parramatta North Urban Transformation area than Option 3, and would more effectively allow the opportunity for a future connection to the north (should this be required). Further, a connection from the Parramatta North Urban Transformation area to Albert Street would require grade separation (either a bridge or tunnel) that would be disruptive and not in keeping with the heritage character of the area.

Overall, Option 2 (Fennell Street) was not preferred as this option would impose a significant impact on the Former Female Factory and would increase the distance to a key demand catchment in the vicinity of Factory Street. Option 1 was considered to be the most feasible option for the light rail alignment through North Parramatta.

3.6.5 Alignment between Macquarie Street and George Street

3.6.5.1 Background

Following the determination of the preferred alignment for the light rail along Macquarie Street for the Parramatta CBD section of the alignment (refer to section 3.4.2), a number of alignment options were considered to transition the alignment between the Parramatta CBD and Camellia, in particular within the vicinity of Robin Thomas Reserve.

Two key constraints along this section of the alignment were to avoid, where possible, impacts on Robin Thomas Reserve, including potential impacts on existing significant trees along Harris Street in addition to avoidance of an existing residential redevelopment site on the corner of Macquarie Street and Harris Street.

3.6.5.2 Description of feasible options

Seven key options for the alignment between Macquarie Street and George Street, within the vicinity of Robin Thomas Reserve, were considered, comprising:

» Option 1 – A light rail alignment along Harris Street with a stop on Macquarie Street.
» Option 2 – A light rail alignment along Harris Street with a stop in Robin Thomas Reserve.
» Option 3 – A light rail alignment and stop through the development site (centre of site).
» Option 4 – A light rail alignment and stop along Argus Lane.
» Option 5 – A light rail alignment and stop through the development site (eastern side of site).
» Option 6 – A light rail alignment along Charles Street with a stop on George Street.
» Option 7 – A light rail alignment along Macquarie Street and through Robin Thomas Reserve.

Option 1 would provide an alignment along Macquarie Street with a stop to the west of Harris Street. The alignment would then cross Harris Street at the existing traffic signals, travelling north within the western edge of Robin Thomas Reserve, prior to turning east onto George Street at the existing traffic signals.
Option 2 would provide a similar alignment to Option 1; however, the proposed stop would be located along the western edge of Robin Thomas Reserve, between Harris Street and George Street.

Option 3 would provide for an alignment through the centre of a current residential development site. A stop would be provided at this location.

Option 4 would provide an alternative alignment through an adjacent development site (comprising Argus Lane, 142 Macquarie Street and the Albion Hotel). This alignment would provide a stop on George Street, to the west of the intersection of George Street and Harris Street.

Option 5 would provide a similar alignment to Option 3; however, the alignment would generally pass through the eastern portion of the current development site adjacent to Harris Street.

Option 6 would provide a light rail alignment about 150 to 200 metres to the west of the other alignment options. From Macquarie Street, the alignment would travel along Charles Street before travelling along George Street. A stop would be provided along George Street, between Charles Street and Harris Street.

Option 7 would provide a light rail alignment along Macquarie Street. At the intersection with Harris Street, the alignment would continue in an easterly direction through Robin Thomas Reserve, and connecting with George Street, to the west of Noller Parade.

Indicative alignments for each of the key options considered are shown in Figure 3.19.

Note: Red line indicates proposed project alignment and stops

Figure 3.19  Alignment options along Harris Street

3.6.5.3  Assessment of design options

An assessment of the alignment options carried out against identified assessment criteria is provided in Figure 3.20.
### Selection of preferred design option

Each of the options identified presented opportunities and constraints relative to each other. A summary of the relative opportunities and constraints for each option is presented in Table 3.9.

#### Table 3.9 Shortlisted alternative stop locations considered for the project

<table>
<thead>
<tr>
<th>OPTION</th>
<th>OPPORTUNITIES</th>
<th>CONSTRAINTS</th>
</tr>
</thead>
</table>
| Option 1 | » Minimal impact on development site  
» Minimal impact on traffic along Harris Street. No impact on George Street (west of Harris Street)  
» Stop location would have good proximity for Rowland Hassall School. | » Impact on Robin Thomas Reserve (loss of open space)  
» Removal of up to three mature Fig trees along Harris Street  
» Stop proximity to riverfront and ferry is relatively poor (interchange ability)  
» Impact on heritage item (Ancient Aboriginal and Early Colonial Landscape). |
| Option 2 | » Minimal impact on development site  
» Minimal impact on traffic along Harris Street. No impact on George Street (west of Harris Street). | » Impact on Robin Thomas Reserve (loss of open space)  
» Removal of mature up to three mature Fig trees along Harris Street  
» Stop location would be further away from proposed new high density residential development  
» Would require crossing Harris Street to access majority of passenger demand (safety)  
» Stop is isolated and may have crime prevention through environmental design (CPTED) issues at night. |
## Project Development and Alternatives

### Option 3
- **Opportunities**
  - No impact on Robin Thomas Reserve
  - Stop would be located conveniently to serve existing and proposed high density residential developments
  - Good opportunity to provide high quality public domain around stop location.
- **Constraints**
  - Impact on the proposed development site
  - Would result in traffic impacts on George Street west of Harris Street
  - Construction and ongoing operational requirements between light rail and development site.

### Option 4
- **Opportunities**
  - No impact on Robin Thomas Reserve
  - Stop would be located conveniently for proposed future residential development
  - Minimal impact on traffic along Harris or George Street (west of Harris Street).
- **Constraints**
  - Impact on the proposed development site
  - Would result in traffic impacts on George Street west of Harris Street
  - Turning radius requirements to avoid existing substation requires greater property acquisition at the corner of Macquarie Street and Argus Lane
  - Construction and ongoing operational requirements between light rail and development site
  - Potential impacts along Argus Lane.

### Option 5
- **Opportunities**
  - No impact on Robin Thomas Reserve.
- **Constraints**
  - Would result in traffic impacts on George Street west of Harris Street
  - Impacts on the development site
  - Impacts on the Albion Hotel
  - Construction and ongoing operational requirements between light rail and development site.

### Option 6
- **Opportunities**
  - No impact on Robin Thomas Reserve
  - Stop would have good proximity to ferry terminal (interchange).
- **Constraints**
  - Impacts on traffic along Charles Street
  - Would result in traffic impacts on George Street west of Harris Street
  - Substantial property impacts along Charles Street and Macquarie Street and at the intersections with Macquarie and George Streets.

### Option 7
- **Opportunities**
  - Minimal impact on development site
  - Minimal impact on traffic along Harris or George Street (west of Harris Street)
  - Improved operation for the light rail.
- **Constraints**
  - Substantial impact on Robin Thomas Reserve including loss of and severance of retained playing fields
  - Would result in additional property impacts on Leigh Lodge and St Ioannis Greek Orthodox Church
  - Substantial heritage impact on archaeological resources within Robin Thomas Reserve
  - Potential removal of up to four Fig trees within Robin Thomas Reserve.
While Option 1 was identified to have some potentially negative impacts, including some impact on the open space of Robin Thomas Reserve heritage and the possible removal of up to three Fig trees along Harris Street, this option was considered to be the preferred option for the following reasons:

» Option 1 would result in less traffic impacts. Option 4 would result in a greater impact on traffic along the inner ring road (Harris Street) as it would cross George Street at a location with higher volume and more complex traffic movements. Option 4 would also result in increased adverse impacts on potential queuing on the northern approach to the intersection in comparison to Option 1.

» Option 1 would result in reduced property impacts. Additional licences, easements and land acquisition (including the Albion Hotel site) would be required for light rail operation and construction within the development sites associated with the Option 4 alignment, which would not be required for the Option 1 alignment.

» Option 1 would have a lower impact on heritage values and open space when compared to Option 2.

» Option 4 was determined to be not feasible with respect to traffic impacts and future integration with the proposed major development to the east of Argus Lane.

Ongoing alignment refinements at this location would continue to be considered during the detailed design of the project, including options to further reduce potential impacts on Robin Thomas Reserve.

3.6.6 Alignment between Harris Street and Tramway Avenue

3.6.6.1 Background

The preliminary design for the alignment through Rosehill included an alignment which travelled to the north of George Street, through Queen’s Wharf Reserve and running along Noller Parade to Tramway Avenue. Due to the available width along Noller Parade, a section of shared running between LRVs and private vehicles would be required to allow access to the existing residential properties along Noller Parade.

Following a review of the shared running arrangement, a second option was considered which would provide a safer alternative that would avoid potential conflict between light rail shared running with general traffic in Noller Parade.

3.6.6.2 Description of feasible options

Two alignment options were considered for the section of the project alignment between Harris Street and Tramway Avenue, comprising:

» Option 1 – Alignment along George Street and shared running along Noller Parade to Alfred Street and Tramway Avenue.

» Option 2 – Centre running along George Street and Alfred Street to Tramway Avenue.

» Option 3 – Centre running along George Street to Grand Avenue.

Option 1 would consist of an alignment along George Street to the east of Harris Street, passing through Queen’s Wharf Reserve. To the east of Queen’s Wharf Reserve, the alignment would consist of a shared running arrangement (light rail and private vehicles) along Noller Parade until Alfred Street. The shared running arrangement would be required in order to maintain vehicular access to the residential properties along Noller Parade.

Option 2 would provide a centre running alignment along George Street between Harris Street and Alfred Street, minimising impacts on Queen’s Wharf Reserve. The alignment would then turn north.
into Alfred Street and then east into Tramway Avenue, impacting three houses between George Street and Tramway Avenue.

Indicative alignments for each of the options are shown in Figure 3.21.

**Figure 3.21** Alignment options between Harris Street and Tramway Avenue

### 3.6.6.3 Assessment of design options

An assessment of the alignment options carried out against identified assessment criteria is provided in Figure 3.22.

<table>
<thead>
<tr>
<th></th>
<th>Option 1 Noller Parade</th>
<th>Option 2 George Street</th>
<th>Option 3 George Street (extended)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land use integration</td>
<td>Green</td>
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<td>Red</td>
</tr>
<tr>
<td>Traffic and transport</td>
<td>Green</td>
<td>Orange</td>
<td>Orange</td>
</tr>
<tr>
<td>Safety</td>
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</tr>
<tr>
<td>Urban design</td>
<td>Green</td>
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<tr>
<td>Environment</td>
<td>Red</td>
<td>Orange</td>
<td>Orange</td>
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<tr>
<td>Property</td>
<td>Orange</td>
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<tr>
<td>Stakeholders</td>
<td>Orange</td>
<td>Orange</td>
<td>Orange</td>
</tr>
<tr>
<td>Cost and program</td>
<td>Green</td>
<td>Orange</td>
<td>Orange</td>
</tr>
<tr>
<td>Other / operation</td>
<td>Orange</td>
<td>Orange</td>
<td>Orange</td>
</tr>
</tbody>
</table>

**Figure 3.22** Assessment of alignment options between Harris Street and Tramway Avenue
3.6.6.4 Selection of preferred design option

The alignment along George Street (Option 2) would result in a number of benefits in comparison to the alignment along Noller Parade (Option 1) and extended alignment along George Street (Option 3). These would include:

» Removes potential safety risk and conflict between private vehicles and LRVs utilising the shared running section along Noller Parade (as private vehicles would be required to maintain access along Noller Parade to access existing properties along this street).

» Reduced impact on Queen’s Wharf Reserve and associated amenity landscaping impacts.

» Maintains LRV movements on main roads, leading to improved visibility and accessibility to the project.

» Reduced potential impact from known flood zones along Noller Parade.

» Reduced potential property impacts in comparison to Option 3 (extended George Street option).

However, the alignment along George Street and Tramway Avenue would also result in some disadvantages in comparison to the alignment along Noller Parade including impacts on an additional three residential properties along Alfred Street and additional property acquisition costs associated with these impacts.

Overall, the proposed alignment along George Street has been identified as the preferred option.

3.6.7 Vertical alignment options for crossing James Ruse Drive

3.6.7.1 Background

James Ruse Drive is a State arterial road within the wider Parramatta region and operates as part of the Outer Ring Road network for this region. The preliminary design for the project alignment consisted of an at-grade (surface level) alignment across James Ruse Drive. In order to ensure light rail operations do not result in adverse impacts on the operation of James Ruse Drive, and to ensure that light rail construction would not preclude a proposed future grade separation at James Ruse Drive and Hassall Street by Roads and Maritime Services, an additional option was considered for the crossing of this roadway.

3.6.7.2 Description of feasible options

Two options for the light rail and active transport link crossing of James Ruse Drive were considered, comprising:

» Option 1 – At-grade crossing of James Ruse Drive.

» Option 2 – Grade separated crossing of James Ruse Drive.

Option 1 would consist of a proposed at-grade crossing of James Ruse Drive (i.e. the light rail would cross James Ruse Drive at the same level as other vehicles) at the point where it intersects with Grand Avenue North. This option would require additional traffic signalling at this point to allow for controlled movement of both light rail vehicles and general traffic at the new intersection.

Option 2 would consist of a grade separated (elevated bridge) crossing of James Ruse Drive. To achieve the required clearance for the bridge structure, the light rail would commence on an elevated structure at a point to the east of Arthur Street, ramping over both Clay Cliff Creek and James Ruse Drive before ramping down to a point along Grand Avenue North east of James Ruse Drive.
3.6.7.3 Assessment of design options

An assessment of the alignment options carried out against identified assessment criteria is provided in Figure 3.23.

![Figure 3.23: Assessment of vertical alignment options for crossing James Ruse Drive](image)

<table>
<thead>
<tr>
<th>Land use integration</th>
<th>Option 1: At-grade crossing</th>
<th>Option 2: Grade separated crossing</th>
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</thead>
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<td>Traffic and transport</td>
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<tr>
<td>Environment</td>
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<td><img src="image" alt="Red" /></td>
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<tr>
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<tr>
<td>Stakeholders</td>
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<td>Cost and program</td>
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<tr>
<td>Other/operation</td>
<td><img src="image" alt="Red" /></td>
<td><img src="image" alt="Green" /></td>
</tr>
</tbody>
</table>

**Figure 3.23** Assessment of vertical alignment options for crossing James Ruse Drive

3.6.7.4 Selection of preferred design option

As shown in Figure 3.23, both options would result in a range of benefits and potential issues. Option 1 would result in some positive outcomes in comparison to Option 2 including:

- Reduced capital expense due to simplified construction at the intersection of James Ruse Drive (i.e. does not require the construction of the new bridge structure).
- Reduced potential for overshadowing of adjacent land uses/properties.

However, Option 2, as a grade separated alignment, would provide a range of additional benefits including:

- Maintenance of the existing capacity and functionality of James Ruse Drive.
- Not precluding a future grade separation of James Ruse Drive to support future growth in the Camellia Town Centre and ensure this requirement is met (to be carried out by Roads and Maritime Services).
- Provision of improved safety, reliability and travel time benefits for light rail operations.
- The construction of a grade separation would remove potential conflicts between the light rail construction and any roadworks proposed to be carried out on James Ruse Drive (by Roads and Maritime Services).
- Reducing the potential hazard of a light rail collision with James Ruse Drive road users.

Overall, the proposed grade separation of the project alignment from James Ruse Drive has been identified as the preferred option. This option has also been identified as the preferred option by key stakeholders including Roads and Maritime Services.
3.6.8 Light rail stop options

3.6.8.1 Overview
Following determination of the preferred alignment for the project, potential stop locations for the project were considered. The stop locations were developed based on a set of principles to ensure the stops are appropriately located to meet the objectives of the project and to provide an appropriate level of system access.

3.6.8.2 Stop principles
The development of stops for any transit system needs to provide a good level of system access, recognising the nature and type of land uses along the project alignment, balanced with service speed and physical feasibility of locating stop infrastructure. The level and type of access requirements along the light rail alignment is influenced by factors such as the level of local activity, the type and nature of land uses (residential, commercial, retail, education, etc.) and the associated travel demands and travel patterns.

The key principles for determining stop locations along the project alignment included consideration of the nature and type of key land uses and functionality of stops to provide access to:

- Residential areas.
- Potential inter-modal interchange (to/from rail/bus).
- Strategic land uses and major trip generators (e.g. major centres, town and village centres, business parks, retail precincts, universities, schools, hospitals).
- Future planned major land uses (e.g. Parramatta Square, Parramatta North Urban Transformation area).

In terms of the physical location of light rail stops at a micro (site specific) level, additional factors were considered including:

- Potential role and function of the stop (origin, destination).
- Potential walk-up catchment of the stop – Access needs to each stop also consider typical walk up catchments, recognised internationally as approximately 800 metres or a 10 minute walk.
- Access to modal interchange/transfers (such as to/from bus, heavy rail or ferry services).
- Compatibility and the potential for integration with the proposed light rail priority pedestrian zone along Church Street and Macquarie Street (for proposed Parramatta CBD stops).
- Environmental constraints.
- Constructability (time to construct, potential cost, requirements for earthworks).
- Proximity to existing intersections (a major factor for a predominantly centre running system) and allowance for a good level of stop access utilising existing (or upgraded) pedestrian crossing facilities.
- Site constraints such as existing topography and access arrangements for compliance with relevant disability access requirements and guidelines.
- Stakeholder input.
- Potential patronage and integration with existing and projected population and employment localities (such as the existing urban renewal developments within the Parramatta North, the Parramatta CBD, Camellia and Telopea).
Following the principles outlined above, two levels of stop spacing guidance were determined to inform the design requirements for the project. This included the specification of an outer suburban stop and a more frequent CBD stop spacing for the Parramatta CBD.

**Suburban stops**
A suburban stop spacing of about one kilometre between stops provides a balance between access to the light rail with travel speed between centres and trip generating land uses to support attractive journey times. Stops would be located at key locations along the routes to provide:

> Access to existing and planned residential areas.
> Interchange with bus and/or rail services at strategic locations.
> Access to strategic land uses and major trip generators such as town centres, retail and education centres.

Stops along the Carlingford branch line would be provided typically at the same location as the heavy rail stations currently located along the existing rail corridor.

**Within the Parramatta CBD**
Within the Parramatta CBD, a stop spacing of about 600 metres between stops was adopted. This was to provide access to significant medium to high density development, as well as schools, leisure and retail attractors, restaurants, bars and cafes, and for interchange with regional bus and rail services. This ensures that the majority of the Parramatta CBD is within a five to seven minute walk of the nearest stop, providing easy walking distance access to the project.

### 3.6.8.3 Interchanges

In addition, certain stops were identified as being required to serve interchange functions with other public transport network modes and were therefore required to facilitate interchange movements, ideally with short transfer distances, weather protection and minimal interface with any other access modes or general road traffic. Locations where interchange stops were considered included locations where the project would allow for interchange opportunities with strategic bus routes or with the existing heavy rail network. Potential interchange locations were categorised as either major or minor interchanges.

A major interchange was identified as a location where the project would allow for interchange with multiple bus routes or provide a high volume of interchange patronage to other destinations. A minor interchange was identified as one which has a more limited number of bus routes (and/or lower service frequencies) or where interchange movements are likely to be lower.

The currently identified interchange stops along the alignment include:

- **Major interchange locations:**
  - Westmead Station
  - Parramatta Square.

- **Minor interchange locations:**
  - Factory Street (with buses travelling along Church Street)
  - Prince Alfred Square (with buses travelling along Victoria Road)
  - Dundas
  - Carlingford.

Further discussion regarding these stops is provided in section 5.5 of this Environmental Impact Statement.
3.6.8.4 Stop location options

A summary of the key stop location options considered is provided in Table 3.10. The options assessment presented below was based on available information at the time of the options assessment. As part of the ongoing design development process, further evaluation of stop locations and alternative options is likely to occur in consultation with key stakeholders and the community.

Locations of the stops where key design options were considered for stops along the alignment are shown in Figure 3.12.
Table 3.10 Shortlisted alternative stop locations and arrangements considered for the project

<table>
<thead>
<tr>
<th>OPTION</th>
<th>DESCRIPTION OF OPTIONS</th>
<th>RATIONAL FOR PREFERRED STOP LOCATION, LAYOUT AND FUNCTION</th>
</tr>
</thead>
</table>
| Westmead Station | Four stop options were considered for the Westmead Station stop including:  
  » A stop on Railway Parade about 150 metres from the Westmead Station  
  » A stop on Railway Parade about 300 metres from the Westmead Station  
  » A stop at the corner of Hawkesbury Road and Railway Parade  
  » A stop along Hawkesbury Road on the bridge crossing for the Western train line. | Of the options considered, two options were not considered to provide a good interchange opportunity between the light rail and Westmead Station due to the distance between the two locations. Some of the stop options considered, which would also be located on steep gradients provide challenges with respect to maintaining accessibility to these stop locations and result in larger distances between the light rail stop and Westmead Station as an interchange.  
The stop on the Hawkesbury Road bridge provided a series of disadvantages including traffic and transport impacts, limited ability to provide integration with adjacent land uses and additional operational impacts.  
The terminus at the corner of Hawkesbury Road and Railway Parade would create a significantly improved interchange opportunity with Westmead Station. Additional advantages associated with the Hawkesbury Road location included:  
  » Better urban design outcome  
  » Improved opportunity for integrated property redevelopment surrounding the stop  
  » A simplified arrangement for the Darcy Road and Hawkesbury Road intersection which would remove impacts on the intersection of Railway Parade and Hawkesbury Road. | Overall, the proposed stop at the intersection of Hawkesbury Road and Railway Parade is the preferred option for this stop. |
| The Children’s Hospital at Westmead | Two stop configuration options were considered for the Children’s Hospital at Westmead stop including:  
  » An island stop arrangement  
  » A side platform stop arrangement. | Due to the location of the alignment at the intersection of Hawkesbury Road and Hainsworth Street, the key constraint in providing a stop for the Children’s Hospital at Westmead was space constraints associated with adjoining land uses.  
Options to provide either a side or island stop arrangement were considered with the aim of minimising impacts on adjacent properties, while maintaining accessibility to the stop. Based on the options identified, the island stop was considered to have a lower overall impact than the side platform arrangement and was therefore considered to be the preferred option. |
## Project development and alternatives

<table>
<thead>
<tr>
<th>OPTION</th>
<th>DESCRIPTION OF OPTIONS</th>
<th>RATIONAL FOR PREFERRED STOP LOCATION, LAYOUT AND FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factory Street</td>
<td>For both the Factory Street and Fennell Street stops, two main stop options were considered including:</td>
<td></td>
</tr>
<tr>
<td>and Fennell</td>
<td>» An island stop arrangement</td>
<td>Similar to the options considered for the Children’s Hospital at Westmead stop, the key constraint in providing stops along Church Street was space constraints associated with adjoining land uses. In addition to the stop platform arrangement options considered (side versus island), each stop arrangement also considered the potential for integration of the stop with the potential for shared bus and light rail running (not currently proposed as part of the current project). Overall, side platform arrangements for the Factory Street and Fennell Street stops were identified as the preferred options as they would:</td>
</tr>
<tr>
<td>Street</td>
<td>» A side platform stop arrangement.</td>
<td>» Minimise potential property impacts along Church Street</td>
</tr>
<tr>
<td></td>
<td></td>
<td>» Provide improved operational outcomes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>» Provide improved integration with buses (if required) as part of any future consideration for shared running along Church Street.</td>
</tr>
<tr>
<td>Eat Street</td>
<td>Four main platform locations and arrangements were considered for the Eat Street stop along Church Street:</td>
<td>Of the four arrangements identified, each of the options presented a range of opportunities and constraints. These are summarised below.</td>
</tr>
<tr>
<td></td>
<td>» Mid-block island platform</td>
<td><strong>Mid-block island platform</strong></td>
</tr>
<tr>
<td></td>
<td>» Side platform near Phillip Street</td>
<td>» Opportunities:</td>
</tr>
<tr>
<td></td>
<td>» Side platform mid-block location</td>
<td>» An island platform would maintain additional width for footpath circulation along Church Street to the platform relative to side platform options.</td>
</tr>
<tr>
<td></td>
<td>» Side platform near George Street</td>
<td>» Constraints:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>» The island platform configuration would prevent any widening of pedestrian space on either side of the light rail space, while also removing existing Eat Street dining spaces</td>
</tr>
<tr>
<td></td>
<td></td>
<td>» Stop would create areas of vacant space in the centre of Church Street where the two light rail tracks would separate to go around the island platform.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Side platform near Phillip Street</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>» Opportunities:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>» Closest to the Parramatta River and convenient location to riverside attractions via Phillip Street.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>» Continuous shopfront awnings adjacent to the light rail stop.</td>
</tr>
<tr>
<td>OPTION</td>
<td>DESCRIPTION OF OPTIONS</td>
<td>RATIONAL FOR PREFERRED STOP LOCATION, LAYOUT AND FUNCTION</td>
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<td>--------</td>
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<td>-----------------------------------------------------</td>
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</tbody>
</table>
|        |                         | » Constraints:
|        |                         |   • Stop location would result in the removal of all existing outdoor dining areas along Church Street between Phillip Street and George Street. |
|        |                         | **Side platform mid-block location**
|        |                         |   » Opportunities:
|        |                         |     • Located relatively equally from both Phillip and George Streets and the various amenities available in each of these locations. |
|        |                         |   » Constraints:
|        |                         |     • Stop option would provide limited space for pedestrian circulation at the entrance to the Mayfair Plaza.  
|        |                         |     • Stop location would result in the removal of some existing outdoor dining areas along Church Street between Phillip Street and George Street. |
|        |                         | **Side platform near George Street**
|        |                         |   » Opportunities:
|        |                         |     • Closest location to the George Street court precinct and to Parramatta Park.  
|        |                         |     • Retains all existing outdoor dining operations on Church Street between Phillip and George Streets. |
|        |                         |   » Constraints:
|        |                         |     • Stop option would provide limited space for pedestrian circulation at the entrance to the Mayfair Plaza.  
|        |                         |     • Increase distance from the Parramatta River than other options. |

Based on the opportunities and constraints identified, the side platform near George Street option would be the preferred stop location for the Eat Street stop.
<table>
<thead>
<tr>
<th>OPTION</th>
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<th>RATIONAL FOR PREFERRED STOP LOCATION, LAYOUT AND FUNCTION</th>
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</thead>
<tbody>
<tr>
<td>Rydalmere</td>
<td>Three main stop options were considered for the Rydalmere stop: &lt;br&gt; « One stop, located at the existing Rydalmere Station site &lt;br&gt; « Two stops, including a stop at the existing Rydalmere Station site and an additional stop to the north, servicing the Western Sydney University (Parramatta campus) at Rydalmere &lt;br&gt; « Western Sydney University (Parramatta campus).</td>
<td>The base design for the project consisted of providing a single light rail stop at the existing Rydalmere Station and construction of a new pedestrian link between the Western Sydney University (Parramatta campus) and other key destinations from this stop. Based on feedback from key stakeholders including Western Sydney University and the City of Parramatta Council, a second option was investigated to provide an additional light rail stop adjacent to the Parramatta campus, south of the single stop location at Rydalmere Station. While it was considered that the additional stop would provide some benefits, including improved public transport connections to the Rydalmere campus and potential improvements to the Rydalmere industrial area, the additional light rail stop was also identified to have the following disadvantages: &lt;br&gt; » Minor increased project construction and ongoing maintenance/operational costs due to the construction of a second stop. &lt;br&gt; » An overall increase in travel times for the operation of the project, reducing identified project benefits and therefore reduced patronage of the system. &lt;br&gt; » Would result in reduced potential vegetation impacts, including potential impacts on endangered ecological communities. &lt;br&gt; The provision of a single, consolidated stop at the location of the existing Rydalmere Station was therefore considered to be the preferred option. The project alignment would also not preclude a future additional stop serving the Western Sydney University (Parramatta campus), to the southern edge of the campus in the future, should demand provide an opportunity for this.</td>
</tr>
</tbody>
</table>
### Dundas

<table>
<thead>
<tr>
<th>OPTION</th>
<th>DESCRIPTION OF OPTIONS</th>
<th>RATIONAL FOR PREFERRED STOP LOCATION, LAYOUT AND FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dundas</td>
<td>Two main platform arrangements were considered for the Dundas stop:</td>
<td>To minimise potential impacts on the heritage listed Dundas Station, two main options were considered for the location and arrangement of the Dundas stop platforms. The first option proposed a stop arrangement which provided two new platforms slightly north of the existing Dundas Station platform. This stop would remove the physical association with the historic nature of the station and would be located further away from access points, parking and town centre than the current heavy rail stop.</td>
</tr>
<tr>
<td></td>
<td>» Two new platforms stops</td>
<td>The alternative stop arrangement proposed that the stop be located to the north of the heritage listed platform and buildings, enabling structures to be retained in situ, incorporating the heritage listed building elements into the overall design of the stop. This arrangement was considered to be the preferred option as it would:</td>
</tr>
<tr>
<td></td>
<td>» Incorporation of the light rail stop with the existing Dundas platform</td>
<td>» Avoid the demolition of the heritage listed platform and station building and provides opportunities for the possibility of using heritage structures as part of the light rail stop</td>
</tr>
<tr>
<td></td>
<td></td>
<td>» Allow the stop location to maintain existing proximity to access points, parking and town centre</td>
</tr>
<tr>
<td></td>
<td></td>
<td>» Allow the stop location to be seen from the street, making it a safer part of the town centre.</td>
</tr>
</tbody>
</table>

### Carlingford

<table>
<thead>
<tr>
<th>OPTION</th>
<th>DESCRIPTION OF OPTIONS</th>
<th>RATIONAL FOR PREFERRED STOP LOCATION, LAYOUT AND FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carlingford</td>
<td>The options for the Carlingford stop considered two main alternatives, including:</td>
<td>As part of determining the preferred location for the Carlingford stop, possible extensions from Carlingford towards Epping (as part of a future stage of the network) were considered in order to best future proof the Carlingford stop. Based on an assessment of the two options, it was considered that for the purpose of future proofing for extension of the light rail network, it is unlikely that an acceptable stop location to the south of Pennant Hills Road would allow for extension works without impacts on operational service and the stop. As such, the preferred solution for the Carlingford stop was to utilise the existing station location with two platform faces. The benefits of this option include:</td>
</tr>
<tr>
<td></td>
<td>» Locating the stop at the existing train station site</td>
<td>» Maintaining connectivity to the current developments adjacent to the Carlingford stop site</td>
</tr>
<tr>
<td></td>
<td>» Relocating the stop to the southern side of Pennant Hills Road bridge</td>
<td>» Maintains the existing modal connections to buses along Pennant Hills Road</td>
</tr>
<tr>
<td></td>
<td></td>
<td>» Maximises access for the community to the stop location.</td>
</tr>
</tbody>
</table>
3.6.9 Stabling and maintenance facility

3.6.9.1 Background
The operation of the project would require both heavy and light maintenance operations, as well as a control centre for the ongoing operation of the system. The most efficient way to accommodate these activities is to bring them together at one site, ideally combined with the overnight stabling for vehicles so that all of these operations can occur at one location.

3.6.9.2 Description of design options
As part of the development of the project, four locations were identified which would meet the design criteria for the stabling and maintenance facility site. These locations were (refer to Figure 3.24):

» Option 1: 1 Grand Avenue, Camellia – located to the south of, and adjacent to Parramatta River, to the east of the existing T6 Carlingford Line and to the north of Grand Avenue.

» Option 2: 6 Grand Avenue, Camellia – located on the corner of Grand Avenue and Colquhoun Street in Camellia, adjacent to Rosehill Racecourse.

» Option 3: 10 Grand Avenue, Camellia – located south of Grand Avenue in Camellia, adjacent to Option 2.

» Option 4: Durham Street, Camellia – located on the corner of Durham Street and Grand Avenue.

Note: Red line indicates proposed project alignment and stops

Figure 3.24 Stabling and maintenance facility site location options

3.6.9.3 Stabling and maintenance layout requirements criteria
A series of principal requirements were identified to guide the development and assessment of the stabling and maintenance facility to cater for the estimated size of the light rail fleet, including the potential future expansion of the network.
The key requirements for the stabling and maintenance facility included:
» Stabling tracks for 45 metre LRVs.
» Stabling for an initial fleet size to meet the requirements of Stage 1 with future provision for up to 40 vehicles (allowing for future fleet and network growth).
» Wash and sand plants.
» A maintenance shed sufficient to cater for four maintenance tracks capable of undertaking full inspection and repair of LRVs in addition to:
  • LRV interior and exterior cleaning
  • An underfloor wheel lathe
  • Workshops and stores
  • Paint booth
  • Cleaning facilities and stores.
» An operational control centre to carry out required administrative and operational functions, including:
  • Central control of the light rail network
  • LRV operator and field operations report area
  • Operator, field operations and maintenance training
  • Office accommodation for the operator’s management team.
» Staff facilities and car parking to accommodate all on-site staff, LRV drivers and visitors.
» Access to existing roadways to accommodate access and deliveries.

3.6.9.4 Assessment and selection of the preferred design option
An initial assessment determined that the four nominated sites would each meet the identified functional and operational requirements (as identified above) for the stabling and maintenance facility. Each of the options would be close to the junction of the main alignment through the Parramatta CBD and the T6 Carlingford Line, allowing good access to sections of the light rail alignment for Stage 1.

To distinguish between the options, additional engineering and environmental factors for each of the sites were considered including:
» Additional track alignment requirements
» Current land use
» Flooding.

A summary of each of the location options against these factors is provided in Table 3.11.
### Table 3.11 Comparison of stabling and maintenance facility site locations

<table>
<thead>
<tr>
<th></th>
<th>OPTION 1</th>
<th>OPTION 2</th>
<th>OPTION 3</th>
<th>OPTION 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Additional track work</td>
<td>No additional track work, located adjacent to Carlingford alignment.</td>
<td>Approximately 940 metres of additional track work required.</td>
<td>Approximately 1,040 metres of additional track work required.</td>
<td>Approximately 1,440 metres of additional track work required.</td>
</tr>
<tr>
<td>Current land use</td>
<td>Currently used for container and machinery storage.</td>
<td>The site had been used for general industrial uses; however, the land has been cleared.</td>
<td>A current industrial facility (CSR roofing manufacturing) is currently located at the site.</td>
<td>This site is the current location of the Shell refinery and fuel distribution centre (decommissioned).</td>
</tr>
<tr>
<td>Flooding</td>
<td>Approximately 11,500 square metres or 15 per cent of the site, primarily the north-west corner, is flood-affected based on 1 in 100 year flood data.</td>
<td>Not affected by flooding based on 1 in 100 year flood data.</td>
<td>Not affected by flooding based on 1 in 100 year flood data.</td>
<td>Based on 1 in 100 year flood data, this site is not flood affected itself, but is adjacent to a flood affected area.</td>
</tr>
<tr>
<td>Heritage</td>
<td>Potential risk of impact on State heritage listed Sewage Pumping Station 67, North Camellia.</td>
<td>Local item of heritage ‘tram alignment’ identified along Grand Avenue, which would be required to be crossed to access the site.</td>
<td>Local item of heritage ‘tram alignment’ identified along Grand Avenue, which would be required to be crossed to access the site.</td>
<td>Local item of heritage ‘tram alignment’ identified along Grand Avenue, which would be required to be crossed to access the site.</td>
</tr>
<tr>
<td>Impact on future proposed land uses</td>
<td>Located within the identified site for the future Camellia Town Centre development for mixed land use.</td>
<td>Located adjacent to the proposed future Camellia Town Centre development within land proposed for retention as industrial/warehouse uses.</td>
<td>Located adjacent to the proposed future Camellia Town Centre development within land proposed for retention as industrial/warehouse uses.</td>
<td>Located adjacent to the proposed future Camellia Town Centre development within land proposed for retention as heavy industrial uses.</td>
</tr>
</tbody>
</table>
While all of the identified sites would have potential engineering and environmental challenges (in particular, management of existing contamination), the site at 6 Grand Avenue was considered to be the preferred option. This site was considered to provide the best combination of land outside the identified 1 in 100 year flood event, required limited clearing of existing site facilities and opportunity for good site access.

3.6.10 Options considered for other project elements

3.6.10.1 Shared bus and light rail running

In the section along Church Street between Factory Street and Victoria Road, there is limited space for a designated light rail alignment adjacent to the existing busway without impacting adjoining land uses including residential properties to the west and St Patrick’s Cemetery to the east.

The two options considered were:

» Shared running of light rail and buses in the existing busway
» Providing a designated light rail alignment adjacent to the existing busway.

Key design and operational elements considered in this assessment included:

» Public transport efficiency and reliability
» Safety
» Environmental and amenity impacts
» Impacts on the regional and local traffic network.

In general terms, a dedicated light rail alignment is proposed for the project as it provides a more reliable and efficient public transport service. This would avoid delays to light rail due to bus operations and maintain priority for bus services that do not originate from/service the light rail catchment.

No sections of shared running (with the exception of the requirement to maintain access to an existing car park located along Macquarie Street) are currently proposed along the project alignment.

3.6.10.2 Light rail power supply and design options

A number of alternatives for power supply and design of power infrastructure were considered in the design development phase. This included:

» Light rail power supply options:
  » OHW
  » Wire-free running
» Overhead wire pole configuration – centre or side poles
» Substation numbers and required locations.

Input into the considerations included:

» Consultation with stakeholders, particularly around urban design of the above elements
» Operational requirements
» Review of best practice from other light rail systems around the world
» Design and engineering constraints, for example space-proofing requirements for pole configurations
» Environmental considerations.
**Overhead versus wire-free running**

While wire-free running eliminates OHW, there are a number of constraints including steep grades and high speed running. The distance between stops also provides a constraint to wire-free running, with greater load and distances increasing the length between charging points and thus reducing the feasibility of wire-free running. Overcoming these constraints may not be possible through on-board energy storage wire-free technology.

The current design for the project provides wired overhead running for the full length of the project. Consultation with City of Parramatta Council and other stakeholders (such as the NSW Office of Environment and Heritage) is currently ongoing to identify potential opportunities for the provision of wire-free running along sections of the project such as parts of the Parramatta CBD.

The potential for inclusion of wire-free operation along the project alignment would be determined during subsequent phases of the project’s design.

**Side versus centre poles**

The overhead wire system and associated poles would be one of the most visible aspects of the project, as these would be fixed in the visual landscape. While the wires themselves would be more visually ‘light-weight’, where they are attached to poles, the poles themselves would be more noticeable and therefore, require consideration regarding how best to minimise their impact. Other considerations regarding pole locations along the alignment include:

- **Safety** – specifically around potential for the collision of road vehicles with poles.
- **Space-proofing** – to ensure the servicing of light rail infrastructure is limited to within the rail corridor.
- **Stakeholder inputs** – such as Roads and Maritime Services requirements.

Based on the current project design to provide OHW for the length of the project alignment, two main types of pole arrangements were considered:

- **Side-mounted poles** – if designed and located geometrically, side-mounted poles would provide the opportunity to be combined with other existing services, for example power poles and street lighting. During construction of footings in footpaths, there may be an issue with existing below ground services; however, this can be somewhat mitigated through detailed survey of utilities and consultation with service providers.

- **Centre poles** – centre pole arrangements can create a strong visual element within the centre of a street which could be viewed negatively, especially if street lights and other side-mounted poles exist. Centre poles would also require a greater corridor width. Centre poles would typically have less impact on utilities, services and trees along footpaths; however, as a new physical element, they would create a potential collision point, especially in sections where buses and light rail are co-located.

Centre poles are generally proposed throughout the project (except within the vicinity of the Westmead terminus stop and along sections of Church Street north of the Parramatta River due to space constraints). This is based on providing minimal clutter in the landscape and to enhance overall visual amenity (including sensitive view lines such as those associated with the Old Government House and Domain area). Details of the proposed OHW are discussed further in section 5.11.
Traction power substations

The number of substations required for the light rail system is determined by the power demand of the system, which is influenced by the number and frequency of LRVs on the system. The location of the eight proposed substations were determined in consideration of a number of factors including:

» Close proximity to the alignment.

» Appropriately spaced to provide adequate coverage for the system (typically spaced at 1.5 to two kilometre intervals).

» Within easy access of zone substation connection points in order to maintain the availability of reliable, high quality power supply.

» Placed clear of existing civil infrastructure such as public access ways, cycle routes and utility locations (where there services are known).

» Easily accessible for maintenance purposes.

» Locating in areas which would have minimal environmental and social impacts including:
  - avoiding high archaeological or heritage significance locations
  - open spaces which avoid areas of sensitive vegetation
  - avoiding locations which would result in greater visual amenity impacts
  - considering acoustic cladding to minimise noise impacts of substations (where reasonable and feasible).

Consideration was also given to locations where the sites were already identified for future development or land acquisition (as part of the project), where the existing rail corridor could accommodate the substation footprints (i.e. along Carlingford route) or where the site would allow for the re-purposing of existing infrastructure (such as the proposed location for the Barrack Lane substation site).

The locations of the proposed traction power substations are discussed further in section 5.11.

3.7 Consequence of not proceeding with the project

As indicated in Chapter 2 (Strategic context and need), the NSW Government’s vision for Greater Sydney is a metropolis of three cities – the Eastern City, the Central City and the Western City. The Central City, encompassing the GPOP priority growth area as its core, is anticipated to undergo significant transformation over the next 10 to 15 years with the GPOP priority growth area positioned to cater for a significant proportion of Sydney’s growth in residents and jobs.

This project would be a catalyst for change in the GPOP priority growth area – forming the core public transport spine. Without the project, the potential of the GPOP priority growth area would not be achieved, would be a less attractive opportunity and unlikely to achieve the investment required for the Greater Parramatta and Olympic Peninsula Vision.

In addition, continued expansion of the existing road and bus network would increasingly result in higher levels of congestion with the predicted growth in jobs and dwellings over the next 20 years. Improvements to the Greater Sydney road network through projects such as WestConnex would improve road connection to the GPOP priority growth area but it would not address connectivity issues within the area.

Without the early implementation of the project, the actual and economic costs (due to traffic management and delays) to implement a new public transport mode would increase significantly as density around these areas increases. Delayed action would likely result in cost escalation to implement the project at an increasingly higher rate.
Further discussion regarding the need and benefits of the project have been described previously in Chapter 2 (Strategic context and need).
4 Community and stakeholder consultation

This chapter summarises the stakeholder and community consultation before and during the preparation of this Environmental Impact Statement for the project. It includes details of consultation methods and a list of the stakeholders and government agencies consulted.

The chapter also provides an overview of the key issues raised by stakeholders and the community and where relevant, how these concerns have been addressed through the design of the project and/or through the preparation of the Environmental Impact Statement, and outlines proposed future consultation regarding the project.

4.1 Overview

Stakeholder and community consultation for the project has formed an integral part of informing and scoping investigations for the Environmental Impact Statement.

In December 2015, the NSW government announced the preferred network for Parramatta Light Rail (of which this project forms a part). A comprehensive stakeholder engagement process commenced at this time, focusing on project objectives and consideration of alignment options. In August 2016, a community engagement process commenced, providing information about the project and seeking high level feedback on the project.

Key stakeholders for the project include (but are not necessarily limited to):
» State agencies including agencies that form part of the Transport for NSW cluster, Department of Planning and Environment, UrbanGrowth NSW, Land and Housing Corporation, Property NSW, emergency services, NSW Environment Protection Authority (EPA), NSW Office of Environment and Heritage (OEH), NSW Office of Water, Infrastructure NSW, Health Infrastructure, Sydney Water, NSW Department of Education and NSW Health.
» Commonwealth Department of the Environment and Energy.
» City of Parramatta Council.
» Public utilities, including AGL, Endeavour Energy, Primus Telecom, TPG, Ausgrid, Transgrid, Telstra, NBN, Viva Energy, Jemena, Nextgen Networks, Optus, Uecomm.
» Business and industry groups including Infrastructure Partnerships Australia, Tourism and Transport Forum, Sydney Business Chamber, Sydney Olympic Park Business Group, Parramatta Chamber of Commerce, Strathfield Chamber of Commerce and the Epping Chamber of Commerce.
» Directly impacted communities.
» The broader community and interested community groups.

This chapter describes the engagement activities which have been carried out to date, and activities proposed to be carried out during the exhibition of the Environmental Impact Statement and into the construction phase (subject to project approval).

4.1.1 Engagement strategy and objectives

A Community and Stakeholder Engagement Plan (CSEP) has been prepared to provide a framework for the proactive management of communications with the community and key stakeholders along the project alignment. This includes a comprehensive program of engagement activities with the community, stakeholders and key partners. Consultation started in 2015 and
Community and stakeholder consultation

continued throughout the preparation of the Environmental Impact Statement, with regular updates to the CSEP to capture new information and reflect progressive phases of the project.

The project communication objectives are to:

» Communicate the rationale for the project and the transport, community, economic and broader benefits it will deliver, including how it fits into the NSW government’s plans to increase Sydney’s light rail capacity.

» Identify all relevant stakeholders and their issues and ensure these are addressed as early as possible during the Environmental Impact Statement process for each phase.

» Inform stakeholders about the key features, related issues and benefits of the project.

» Build community and key stakeholder relationships and maintain goodwill.

» Provide information about the planning approvals process and encourage community participation.

» Clearly communicate the timing and proposed staging of the project, including property acquisition processes.

4.2 Consultation and engagement activities prior to preparation of the Environmental Impact Statement

Consultation activities which were carried out prior to preparation of the Environmental Impact Statement included:

» Stakeholder engagement on Parramatta Transport Corridor Strategy from October 2014 to July 2015, outlined in section 4.2.1.

» Stakeholder engagement on Parramatta Light Rail (including options development), which commenced following the announcement of the preferred network in December 2015, outlined in section 4.2.2.

» Industry consultation commencing in March 2016, outlined in section 4.2.3.

» Community engagement between August to November 2016, outlined in section 4.2.4.

Key activities carried out in each of these phases are described in the following sections. Issues and comments raised during this process have been taken into consideration during the project concept design and Environmental Impact Statement compilation and have been addressed as part of this Environmental Impact Statement (as discussed further in section 4.4).

4.2.1 The Parramatta Transport Corridor Strategy stakeholder engagement

Between October 2014 and July 2015, the Parramatta Transport Corridor Strategy team conducted a series of briefings and round table discussions with stakeholders to gain input to, and feedback on, the strategic needs assessment and corridor options for the project (including shortlisted options). Stakeholders included local councils along the four shortlisted options, government agencies and key business and recreational organisations.

Four key issues were identified based on the initial stakeholder engagement:

» The importance of improved connectivity within the Parramatta CBD.

» The need for improved public transport links to support planned development and to serve growing employment centres.
Community and stakeholder consultation

» The potential impacts of WestConnex and the associated rezoning proposed as part of the Parramatta Road Urban Renewal Project.
» The potential impacts of light rail utilising existing roadways (congestion etc.).

4.2.2 Stakeholder engagement on Parramatta Light Rail

Following the announcement of the preferred network in December 2015, Transport for NSW undertook stakeholder consultation with State government departments and agencies, organisations that manage key venues and destinations including Venues NSW, the Museum of Applied Arts and Sciences (formerly Powerhouse Museum), the Riverside Theatres, Rosehill Gardens Racecourse and local councils. This consultation included:

» Explaining the vision and objectives for the whole Parramatta Light Rail project and establishing how these were aligned with stakeholder objectives.
» Seeking feedback on options for the whole Parramatta Light Rail project alignment to determine the final preferred alignment.
» Issues based consultation with key stakeholders to inform the design and/or the delivery of Parramatta Light Rail.

4.2.3 Industry consultation

The Parramatta Light Rail industry engagement program commenced in March 2016 with an industry briefing at Rosehill Gardens Racecourse. Over 450 people attended the briefing including landowners, developers, technical service providers and infrastructure specialists. The briefing addressed the project’s vision and objectives and what professional services would be required. The Parramatta Light Rail team subsequently ran a structured industry consultation process. Sectors consulted included:

» Civil contractors.
» Rolling stock and systems suppliers.
» Operators and maintainers of rolling stock.
» Industry bodies including Infrastructure Partnerships Australia, Tourism and Transport Forum and business chambers.
» Property developers.
» Finance organisations.

The purpose of this consultation was to encourage industry participation in the design of the project and to test key elements of the delivery strategy. This engagement will also ensure that the private sector is well placed to respond to the challenges and opportunities presented by Parramatta Light Rail.

4.2.4 Community engagement

Between August and November 2016, Transport for NSW undertook a community engagement program to inform people about the project, understand how they might use light rail and identify issues that might influence the design of the project. The project team developed a range of information material that explained the vision and objectives of the project, identified the preferred network and described the expected level of service. A website was developed that included this information, as well as providing opportunities for online feedback.

Table 4.1 identifies the key contact and information points that were used to provide up-to-date information to the community and stakeholders between August and November 2016.
Community and stakeholder consultation

Table 4.1 Community contact and information points

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>DETAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community information</td>
<td>1800 684 490</td>
</tr>
<tr>
<td>Community email address</td>
<td><a href="mailto:parramattalightrail@transport.nsw.gov.au">parramattalightrail@transport.nsw.gov.au</a></td>
</tr>
<tr>
<td>Website</td>
<td><a href="http://www.parramattalightrail.nsw.gov.au">www.parramattalightrail.nsw.gov.au</a></td>
</tr>
<tr>
<td></td>
<td>The website includes information about the preferred corridor, precincts</td>
</tr>
<tr>
<td></td>
<td>served and project status. The website also provided a suite of factsheets</td>
</tr>
<tr>
<td></td>
<td>about the project as well as an online survey and forum to allow members</td>
</tr>
<tr>
<td></td>
<td>of the public to provide structured feedback.</td>
</tr>
<tr>
<td>Print communication</td>
<td>A number of brochures and fact sheets were prepared to support</td>
</tr>
<tr>
<td></td>
<td>communication activities.</td>
</tr>
<tr>
<td>Door Knocking</td>
<td>Door knocking along the preferred alignment commenced in September</td>
</tr>
<tr>
<td></td>
<td>2016 and included handing out brochures regarding the project and</td>
</tr>
<tr>
<td></td>
<td>speaking with approximately 200 residences and businesses.</td>
</tr>
<tr>
<td>Pop up information sessions</td>
<td>Pop up information sessions were held at community events, transport</td>
</tr>
<tr>
<td></td>
<td>interchanges, and shopping areas throughout the corridor. Leaflets,</td>
</tr>
<tr>
<td></td>
<td>providing information and seeking feedback were made available at these</td>
</tr>
<tr>
<td></td>
<td>events.</td>
</tr>
<tr>
<td>Media and social media</td>
<td>Facebook updates: <a href="https://www.facebook.com/NSWPublicTransport/">https://www.facebook.com/NSWPublicTransport/</a></td>
</tr>
<tr>
<td></td>
<td>Twitter updates: <a href="https://twitter.com/transportfornsw">https://twitter.com/transportfornsw</a></td>
</tr>
</tbody>
</table>

These activities were accompanied by:

» A series of community information sessions and information points.
» Media releases and advertisements.
» Brochures.
» A series of fact sheets.
» Letterbox drops.

Between August and November 2016, the project team:

» Attended 55 information sessions, pop ups and community meetings.
» Spoke to 4300 stakeholders and members of the public.
» Delivered 75,000 brochures into letterboxes.
» Received 400 comments to the online forum and survey.
» Received more than 13,200 visits to the PLR website.
» Handed out 10,000 brochures.

Table 4.2 provides a list of the community information sessions and pop ups held during this phase. Further community consultation was carried out during the preparation of the Environmental Impact Statement as detailed in section 4.3.
# Table 4.2 Community information sessions and pop ups held prior to announcement of preferred alignment

<table>
<thead>
<tr>
<th>DATE</th>
<th>TIME</th>
<th>LOCATION/ COMMUNITY EVENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saturday 6 August 2016</td>
<td>10 am–1 pm</td>
<td>Pirtek Stadium Open Day</td>
</tr>
<tr>
<td>Tuesday 9 August</td>
<td>12.30 pm–1.30 pm</td>
<td>Westmead Hospital Staff Forum</td>
</tr>
<tr>
<td>Thursday 11 August</td>
<td>12.30 pm–1.30 pm</td>
<td>The Children’s Hospital at Westmead Staff Forum</td>
</tr>
<tr>
<td>Sunday 14 August 2016</td>
<td>12 pm–4 pm</td>
<td>India Day, Old King’s School, Parramatta</td>
</tr>
<tr>
<td>Sunday 21 August 2016</td>
<td>10 am–4 pm</td>
<td>Feragosto Festival, Five Dock</td>
</tr>
<tr>
<td>Monday 22 August 2016</td>
<td>5.30 am–8.30 am</td>
<td>Strathfield Station</td>
</tr>
<tr>
<td>Monday 22 August 2016</td>
<td>4 pm–6.30 pm</td>
<td>Granville Station</td>
</tr>
<tr>
<td>Wednesday 24 August 2016</td>
<td>7 am–9 am</td>
<td>Carlingford Station</td>
</tr>
<tr>
<td>Thursday 25 August 2016</td>
<td>6.30 am–8.30 am</td>
<td>Rosehill Station</td>
</tr>
<tr>
<td>Thursday 25 August 2016</td>
<td>5 pm–7 pm</td>
<td>Telopea Tenants BBQ, Telopea</td>
</tr>
<tr>
<td>Friday 26 August 2016</td>
<td>7 pm–9 pm</td>
<td>Telopea Station</td>
</tr>
<tr>
<td>Saturday 27 August 2016</td>
<td>10 am–2 pm</td>
<td>Telopea School Fair</td>
</tr>
<tr>
<td>Sunday 28 August 2016</td>
<td>10 am–2 pm</td>
<td>Western Sydney University Open Day, Parramatta CBD campus</td>
</tr>
<tr>
<td>Monday 29 August 2016</td>
<td>4 pm–7 pm</td>
<td>Westmead Station</td>
</tr>
<tr>
<td>Monday 29 August 2016</td>
<td>4.30 pm–7 pm</td>
<td>Pirtek Stadium, NRL game</td>
</tr>
<tr>
<td>Tuesday 30 August 2016</td>
<td>7 pm–8 pm</td>
<td>Telopea Tenants BBQ, Telopea</td>
</tr>
<tr>
<td>Thursday 1 September 2016</td>
<td>9 am–3 pm</td>
<td>Centenary Square, Parramatta</td>
</tr>
<tr>
<td>Friday 2 September 2016</td>
<td>1 pm–2 pm</td>
<td>Telopea Revitalisation Event, Telopea</td>
</tr>
<tr>
<td>Saturday 3 September 2016</td>
<td>11 am–3 pm</td>
<td>Eat Street Vibes Church Street, Parramatta</td>
</tr>
<tr>
<td>Sunday 4 September 2016</td>
<td>10 am–4 pm</td>
<td>Strathfield Spring Festival, Strathfield Park</td>
</tr>
<tr>
<td>Monday 5 September 2016</td>
<td>4 pm–7 pm</td>
<td>Parramatta Station</td>
</tr>
<tr>
<td>Tuesday 6 September 2016</td>
<td>8 am–1 pm</td>
<td>The Children’s Hospital at Westmead</td>
</tr>
<tr>
<td>Wednesday 7 September 2016</td>
<td>7 am–9 am</td>
<td>Dundas Station</td>
</tr>
<tr>
<td>Wednesday 7 September 2016</td>
<td>12 pm–2 pm</td>
<td>Telopea Tenants BBQ, Telopea</td>
</tr>
<tr>
<td>Wednesday 7 September 2016</td>
<td>10 am–2 pm</td>
<td>Western Sydney University, Parramatta campus, Rydalmere</td>
</tr>
<tr>
<td>Thursday 8 September 2016</td>
<td>7 am–9 am</td>
<td>Rydalmere Station</td>
</tr>
<tr>
<td>Thursday 9 September 2016</td>
<td>7 am–9 am</td>
<td>Camellia Station</td>
</tr>
<tr>
<td>DATE</td>
<td>TIME</td>
<td>LOCATION/COMMUNITY EVENT</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>------------</td>
<td>------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Thursday 8 September 2016</td>
<td>8 am–1 pm</td>
<td>Westmead Private Hospital, Westmead</td>
</tr>
<tr>
<td>Saturday 10 September 2016</td>
<td>9 am–3 pm</td>
<td>Centenary Square, Parramatta</td>
</tr>
<tr>
<td>Monday 12 September 2016</td>
<td>4 pm–7 pm</td>
<td>Clyde Station, Clyde</td>
</tr>
<tr>
<td>Tuesday 13 September 2016</td>
<td>8 am–1 pm</td>
<td>Westmead Public Hospital, Westmead</td>
</tr>
<tr>
<td>Wednesday 14 September 2016</td>
<td>4 pm–7 pm</td>
<td>Harris Park Station, Harris Park</td>
</tr>
<tr>
<td>Sunday 18 September 2016</td>
<td>11 am–6.30 pm</td>
<td>Let’s Go Greek Festival, Greek Orthodox Parish, 165 George Street Parramatta</td>
</tr>
<tr>
<td>Friday 23 September 2016</td>
<td>9:30 am–6 pm</td>
<td>Paramatta Westfield Shopping Centre</td>
</tr>
<tr>
<td>Saturday 24 September 2016</td>
<td>9 am–6 pm</td>
<td>Westmead</td>
</tr>
<tr>
<td>Sunday 25 September 2016</td>
<td>11 am–3 pm</td>
<td>Wisteria Gardens, 11 Hainsworth Street, Westmead</td>
</tr>
<tr>
<td>Tuesday 4 October 2016</td>
<td>4 pm–7 pm</td>
<td>North Strathfield Station, North Strathfield</td>
</tr>
<tr>
<td>Friday 7 October 2016</td>
<td>10 am–5 pm</td>
<td>Kidtopia Festival, Parramatta Park</td>
</tr>
<tr>
<td>Saturday 8 October 2016</td>
<td>10 am–5 pm</td>
<td></td>
</tr>
<tr>
<td>Sunday 9 October 2016</td>
<td>2 pm–6 pm</td>
<td></td>
</tr>
<tr>
<td>Monday 10 October 2016</td>
<td>10 am–12 pm</td>
<td>Children’s Hospital at Westmead, Westmead</td>
</tr>
<tr>
<td>Tuesday 11 October 2016</td>
<td>4 pm–6.30 pm</td>
<td>Strathfield Station</td>
</tr>
<tr>
<td>Wednesday 12 October 2016</td>
<td>1 pm–3 pm</td>
<td>Campus Life Committee, Rydalmere</td>
</tr>
<tr>
<td>Wednesday 12 October 2016</td>
<td>9 am–1 pm</td>
<td>Westmead Hospital, Westmead</td>
</tr>
<tr>
<td>Thursday 13 October 2016</td>
<td>12 pm–2 pm</td>
<td>Western Sydney University, Parramatta campus, Rydalmere</td>
</tr>
<tr>
<td>Friday 14 October 2016</td>
<td>9.30 am–5 pm</td>
<td>Newington Market Place, Newington</td>
</tr>
<tr>
<td>Saturday 15 October 2016</td>
<td>12 pm–4 pm</td>
<td>Westmead Hospital volunteers, Westmead</td>
</tr>
<tr>
<td>Monday 17 October 2016</td>
<td>10 am–11 am</td>
<td></td>
</tr>
<tr>
<td>Tuesday 18 October 2016</td>
<td>6 pm–7 pm</td>
<td>North Paramatta Resident Action Group</td>
</tr>
<tr>
<td>Thursday 20 October 2016</td>
<td>12 pm–6 pm</td>
<td>Parramatta Centenary Square, Parramatta</td>
</tr>
<tr>
<td>Sunday 23 October 2016</td>
<td>11 am–7 pm</td>
<td>Deepavali Fair Parramatta Park, Parramatta</td>
</tr>
<tr>
<td>Friday 28 October 2016</td>
<td>9 am–5 pm</td>
<td>Carlingford Court Shopping Centre, Carlingford</td>
</tr>
<tr>
<td>Saturday 29 October 2016</td>
<td>10 am–5 pm</td>
<td></td>
</tr>
<tr>
<td>Tuesday 29 November 2016</td>
<td>8 am–5 pm</td>
<td>Boomtown Infrastructure Summit, Sydney</td>
</tr>
</tbody>
</table>
4.2.5 Focus groups

Between September and November 2016, qualitative and quantitative research was completed on behalf of Transport for NSW to gauge levels of community awareness and support for the project, and gain suggestions for managing construction impacts.

Focus group sessions were held with randomly selected residents, small business, and workers in the Greater Parramatta to the Olympic Park (GPOP) priority growth area. This was followed by an online and telephone survey of randomly selected, but demographically representative residents.

Key points to note, in summary, of the feedback from the research were:

- Concern was expressed that infrastructure development will not keep pace with population growth.
- Improving public transport frequency and reliability, as well as reducing road congestion, were considered the transport priorities in the area.
- Most people considered public transport in the area to be good or fair.
- Nearly three-quarters of respondents had heard about the project, but knowledge levels were low.
- Two-thirds of respondents were positive about the project, but support was ‘soft’.
- Support was mainly based on how the project will improve personal circumstances.
- The main reason for a negative opinion of the project was that it will be a waste of money.
- Nearly two-thirds of respondents will definitely or probably use light rail.
- Of those who said they will use light rail, two-thirds said they will use it at least once per week.
- Light rail was considered most useful for leisure related travel, rather than going to school or work.

4.3 Consultation during preparation of the Environmental Impact Statement

Following announcement of the preferred alignment, Transport for NSW continued to carry out a range of consultation and engagement with the community and stakeholders throughout the development of the Environmental Impact Statement. A summary of the key consultation activities carried out are described in the following sections.

4.3.1 Project website

The project website (www.parramattalightrail.nsw.gov.au) has continued to be used to provide a variety of project information, including information about community information sessions, the preferred alignment, precincts served and project status. The website also provides a suite of fact sheets about the project, an animation of the project as well as an online survey and forum to allow members of the public to provide structured feedback.
4.3.2 Place managers

Designated Place Managers commenced work on the project from November 2016. Four Place Managers for the project have been allocated to the project and act as the direct point of contact for the following areas:

» Westmead and Parramatta North
» Parramatta CBD and Rosehill
» Camellia
» Areas along the T6 Carlingford Line.

The Place Managers are the direct point of contact for the community, businesses and other stakeholders on behalf of the project. They are currently conducting on-the-ground assessments, building relationships and providing information to stakeholders along the alignment.

Place Managers provide a vital link in maintaining close and ongoing contact with local communities and stakeholders during preparation of the Environmental Impact Statement and would continue liaising with the community throughout the construction period (subject to project approval). Place Managers seek to understand local issues and bring this feedback to the project team to be incorporated into the light rail solution.

4.3.3 Community update brochures

A second project brochure was letterbox dropped to over 83,000 properties in February 2017 targeting residents and businesses. This brochure provided a project and planning update including the preferred alignment, project contact details and invited community members to Environmental Impact Statement preparation phase community information sessions (refer to section 4.5).

The first edition of the Parramatta Light Rail quarterly newsletter was distributed in April 2017 to 65,000 households and to 1500 email addresses

4.3.4 Project contact mechanisms

An information line (1800 684 490) and email address (paramattalightrail@transport.nsw.gov.au) were established to enable all stakeholders and community to provide feedback on the project and ask questions of the project team. Between the announcement of the preferred alignment on 17 February 2017 and 11 July 2017 the project team has received 393 enquiries by email, 272 phone calls to the project information line and 47 enquiries in person. These details were included in all written communications distributed to the community or made available online. Feedback received has been considered during the preparation of the Environmental Impact Statement.

The translating and interpreting service phone number (131 450) and symbol were also provided on all project communications to assist community members who do not speak English. Translated panels in five community languages (Arabic, Cantonese, Mandarin, Korean and Hindi) were included in publications, these languages are predominantly spoken in the Parramatta LGA.

4.3.5 Community information and feedback sessions

Following the formal announcement of the preferred alignment in February 2017, a number of community consultation activities have occurred for the purpose of collecting feedback from stakeholders and to inform the investigations carried out for the project. The consultation was designed to facilitate stakeholder input into the Environmental Impact Statement and design development process. Key elements of this consultation are outlined below.

» 17 February 2017, media announcement about the preferred alignment by government representatives supported by a media release.
Community and stakeholder consultation

» Newspaper advertisements were placed in the Parramatta Advertiser, Parramatta Holroyd Sun, Inner West Courier and the Northern District Times in March 2017.

» Advertisement and editorial in March 2017 edition of the Western Sydney Business Access.

» A four page brochure with a map of the preferred alignment and project timelines distributed to around 83,000 homes and businesses surrounding the preferred alignment.

» Updated website with information about the preferred alignment, visual of the light rail Frequently Asked Questions fact sheet.

This was followed by a number of consultation activities including:

» Nine community information sessions, which were held at locations near the proposed project alignment to receive local input on the project. The information stands were attended by members of the project team, so that attendees’ questions could be answered and feedback obtained.

» Eighteen pop-up information sessions, which were held at a number of locations including train stations and community events. These assisted with providing members of the community information about the plan for a light rail in Parramatta and details about where they could find more information.

» A Transport for NSW stand at the 2017 Royal Easter Show, where community members engaged with the wider Transport for NSW team over a period of 14 days and information on the project was available.

Details of the sessions held are provided in Table 4.3.

Table 4.3  Community information and feedback session locations

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>DATE</th>
<th>EVENT</th>
<th>TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parramatta Centenary Square</td>
<td>Friday 24 February 2017</td>
<td>Parramatta’s Farmers Markets – Pop-up Information Session</td>
<td>8 am–4 pm</td>
</tr>
<tr>
<td>Parramatta Town Hall</td>
<td>Thursday 2 March 2017</td>
<td>Community Information Session</td>
<td>11 am–3 pm</td>
</tr>
<tr>
<td>Dundas Library – Telopea</td>
<td>Saturday 4 March 2017</td>
<td>Community Information Session</td>
<td>9.30 am–12.30 pm</td>
</tr>
<tr>
<td>Westmead Train Station</td>
<td>Tuesday 7 March 2017</td>
<td>Pop-up Information Session</td>
<td>6.30 am–9 am</td>
</tr>
<tr>
<td>Western Sydney University - (Parramatta campus)</td>
<td>Tuesday 7 March 2017</td>
<td>Community Information Session</td>
<td>2 pm–5 pm</td>
</tr>
<tr>
<td>Western Sydney University - (Parramatta campus)</td>
<td>Tuesday 7 March 2017</td>
<td>Community Information Session</td>
<td>5 pm–8 pm</td>
</tr>
<tr>
<td>Paramatta Station</td>
<td>Wednesday 8 March 2017</td>
<td>Pop-up Information Session</td>
<td>6.30 am–9 am</td>
</tr>
<tr>
<td>Westmead Adult’s Hospital</td>
<td>Wednesday 8 March 2017</td>
<td>Community Information Session</td>
<td>10.30 am–2.30 pm</td>
</tr>
<tr>
<td>Carlingford Bowling Club</td>
<td>Wednesday 8 March 2017</td>
<td>Community Information Session</td>
<td>6 pm–9 pm</td>
</tr>
<tr>
<td>Paramatta Town Hall</td>
<td>Thursday 9 March 2017</td>
<td>Community Information Session</td>
<td>5 pm–8 pm</td>
</tr>
<tr>
<td>LOCATION</td>
<td>DATE</td>
<td>EVENT</td>
<td>TIME</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>---------------------------</td>
<td>-------------------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Prince Alfred Park – Parramatta</td>
<td>Friday 10 March 2017</td>
<td>Parramasala Festival – Pop-up Information Session</td>
<td>10 am–5 pm</td>
</tr>
<tr>
<td>Prince Alfred Park – Parramatta</td>
<td>Saturday 11 March 2017</td>
<td>Parramasala Festival – Pop-up Information Session</td>
<td>10 am–5 pm</td>
</tr>
<tr>
<td>Prince Alfred Park – Parramatta</td>
<td>Sunday 12 March 2017</td>
<td>Parramasala Festival – Pop-up Information Session</td>
<td>10 am–5 pm</td>
</tr>
<tr>
<td>Carlingford Train Station</td>
<td>Monday 13 March 2017</td>
<td>Pop-up Information Session</td>
<td>4 pm–7 pm</td>
</tr>
<tr>
<td>Dundas Train Station</td>
<td>Tuesday 14 March 2017</td>
<td>Pop-up Information Session</td>
<td>6.30 am–9 am</td>
</tr>
<tr>
<td>Westmead Children’s Hospital</td>
<td>Tuesday 14 March 2017</td>
<td>Community Information Session</td>
<td>10.30 am–2.30 pm</td>
</tr>
<tr>
<td>Dundas Community Centre</td>
<td>Tuesday 14 March 2017</td>
<td>Community Information Session</td>
<td>5 pm–8 pm</td>
</tr>
<tr>
<td>Telopea Train Station</td>
<td>Wednesday 15 March 2017</td>
<td>Pop-up Information Session</td>
<td>4 pm–7 pm</td>
</tr>
<tr>
<td>Rydalmere Train Station</td>
<td>Thursday 16 March 2017</td>
<td>Pop-up Information Session</td>
<td>6.30 am–9 am</td>
</tr>
<tr>
<td>Camellia Train Station</td>
<td>Monday 20 March 2017</td>
<td>Pop-up Information Session</td>
<td>4 pm–7 pm</td>
</tr>
<tr>
<td>Clyde Train Station</td>
<td>Tuesday 21 March 2017</td>
<td>Pop-up Information Session</td>
<td>6.30 am–9 am</td>
</tr>
<tr>
<td>Westmead Train Station</td>
<td>Wednesday 22 March 2017</td>
<td>Pop-up Information Session</td>
<td>4 pm–7 pm</td>
</tr>
<tr>
<td>Parramatta Train Station</td>
<td>Thursday 23 March 2017</td>
<td>Pop-up Information Session</td>
<td>4 pm–7 pm</td>
</tr>
<tr>
<td>Carlingford Court Shopping Centre</td>
<td>Friday 24 March 2017</td>
<td>Pop-up Information Session</td>
<td>10 am–2 pm</td>
</tr>
<tr>
<td>Carlingford Court Shopping Centre</td>
<td>Saturday 25 March 2017</td>
<td>Pop-up Information Session</td>
<td>10 am–2 pm</td>
</tr>
<tr>
<td>Parramatta Centenary Square</td>
<td>Saturday 25 March 2017</td>
<td>Pop-up Information Session</td>
<td>12 pm–4 pm</td>
</tr>
<tr>
<td>Clyde Train Station</td>
<td>Wednesday 29 March 2017</td>
<td>Pop-up Information Session</td>
<td>4 pm–7 pm</td>
</tr>
<tr>
<td>Sydney Olympic Park</td>
<td>Thursday 6 April to</td>
<td>Sydney Royal Easter Show</td>
<td>8 am–7 pm</td>
</tr>
<tr>
<td></td>
<td>Wednesday 19 April 2017</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Over 5,000 brochures were distributed to a similar number of community members and feedback received on the preferred alignment. A summary of the feedback received during these sessions is provided below in section 4.4.

### 4.3.6 Interactive online forums

Transport for NSW also sought further feedback from stakeholders via an interactive online forum following the project announcement in February 2017. One of the objectives of the forum was to
collect feedback from the local community on the planning process and how they would like to see the project delivered and impacts managed.

Stakeholders were encouraged to visit the web forum via posts on the Facebook page and via direct email to the project’s email subscription list. Around 174 community members participated in an online survey with the responses to the questions received considered in ongoing project development and preparation of the Environmental Impact Statement.

Key issues raised by the survey include:

» Project construction timeframe.
» Traffic management during construction.
» The need for ongoing communication/consultation.
» Locations of stops.
» Future expansion.
» Connectivity to other transport modes.
» Why the existing T6 Carlingford Line is being replaced by light rail.
» Property acquisition.
» Heritage impacts.
» Safety of pedestrians, commuters and residents during construction and operation of the project.

4.3.7 Property owner engagement

Transport for NSW has commenced engagement with the owners and tenants of properties that would be directly impacted by the preferred alignment of the project. Property owners and tenants who will be subject to acquisition of property for the project have been assigned a Property Manager Acquisitions (PMA) to work directly with them.

A Property Acquisition Engagement Plan, prepared in accordance with the improved property acquisition process announced by the NSW government in October 2016, has been developed to guide this engagement process. The plan incorporates learnings from major transport projects that have carried out residential and commercial property acquisition, such as Sydney Metro, WestConnex and CBD and South East Light Rail projects.

Since February 2017, PMAs have been allocated to owners and tenants of properties directly affected by acquisition along the Parramatta Light Rail preferred alignment, to support and guide them through the process.

The PMAs have been engaging with affected owners and tenants of commercial and residential properties and body corporates. This has involved:

» Door-knocks to owner-occupiers and tenants.
» Telephone calls to strata managers to begin the process of identifying non-occupying property owners.
» Sending of follow-up correspondence to formally notify affected landowners and tenants that their properties have been identified for acquisition, outline the process and allocate a PMA.

The project is allowing at least six months to reach a negotiated settlement with the affected property owners. During this time, activities will include:

» Initial post-announcement meetings between the affected landowner and the project to explain the acquisition process and next steps.
» Follow-up meetings, as required.
4.3.8 Business survey

A business survey was conducted by HillPDA and Transport for NSW as part of the Business Impact Assessment for the Environmental Impact Statement (refer Technical Paper 14 in Volume 7) in early 2017. The business survey was conducted to better understand the operational needs of businesses and the potential impacts on them from the project during construction and operation.

During February and March 2017 a total of 131 businesses were surveyed, including commercial and retail premises located immediately adjacent to the project alignment. Of the businesses surveyed for the Technical Paper 14 - Business Impact Assessment along the project alignment:

- The largest groups of respondents consisted of speciality food or hotel premises (about 27 per cent), general retail stores (about 24 percent) and general commercial services (about 17 per cent of business surveyed). The remaining surveyed businesses included health care services, educational institutions, industrial and recreation organisations.
- Almost 60 per cent stated that they had been located at the same address for over five years.
- Across the surveyed businesses, they generated about 1,350 jobs.
- Monday through to Saturday were identified as the main trading days for most businesses.
- There was an even split between businesses having or not having access to off-street parking. The majority of businesses with off-street parking had access to 10 or less parking spaces and the majority of these were for staff only.
- The majority of businesses identified persons working and living locally were the primary source of customers, with around 31 per cent stated passing trade as the primary source. Around six per cent stated visitors as the primary source of customers.
- Most businesses received deliveries during the working week, between 5 am and 4 pm.

The surveys encompassed a range of questions relating to potential such as the availability and use of off-street parking and business deliveries, level of trade generated from passing trade, and questions regarding the potentially perceived impacts the project may have during construction and operation. Details of the business surveys are provided in Appendix C of the Business Impact Assessment (refer Technical Paper 14 in Volume 7).

4.3.9 Aboriginal stakeholder consultation

Consultation with Aboriginal stakeholders has been undertaken in accordance with Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010 (OEH, 2010b). This included review of the assessment methodology, an Aboriginal Focus Group meeting on 29th July 2017 and a review of the completed draft Technical Paper 5 - Aboriginal Cultural Heritage Assessment. Further detail is provided in Chapter 2 of Technical Paper 5 - Aboriginal Cultural Heritage Assessment.

4.3.10 Government agency consultation

Transport for NSW’s government agency consultation during the preparation of the Environmental Impact Statement has focused on cross-agency integration and communication. Regular meetings have been held with a variety of government stakeholders to ensure key issues are appropriately addressed.

Key government agencies which have been consulted during the preparation of the Environmental Impact Statement include:

- City of Parramatta Council
- Department of Education
Community and stakeholder consultation

» NSW Environmental Protection Authority
» NSW Health (Health Infrastructure, Western Sydney Local Health District)
» UrbanGrowth NSW
» Department of Planning and Environment
» NSW Office of Environment and Heritage
» NSW Land and Housing Corporation
» Property NSW
» Sydney Water
» Emergency services committee (NSW Police, Fire & Rescue NSW, NSW Ambulance)
» State Emergency Services.

A summary of the feedback received during these consultation sessions is provided in section 4.4.

In addition, as part of the Department of Planning and Environment planning process, a planning focus meeting (PFM) with government stakeholders was held on 7 March 2017 to discuss the scope of the Environmental Impact Statement and inform the development of the SEARs for the project. The PFM was also attended by a number of the government agencies identified above including NSW Office of Environment and Heritage, NSW Health, UrbanGrowth NSW and City of Parramatta.

Within the governance structure of the Parramatta Light Rail project team, internal Transport for NSW representatives have been engaged, including Roads and Maritime Services, Traffic Management Centre, the Sydney Coordination Office and Sydney Trains, and issues have been addressed in the development of the project as described in this Environmental Impact Statement.

4.3.11 Urban design consultation

A joint Urban Design Working Group with the City of Parramatta and Transport for NSW was established in March 2017. The objective of this working group is to work collaboratively on establishing the best urban design and public domain outcomes for the project. The Working Group has been working together on the development of the Urban Design Requirements document that is being prepared for the project (refer to section 5.12.1).

Transport for NSW has also been working in close collaboration with stakeholders who are adjacent to the project alignment, including NSW Health, Urban Growth, Western Sydney University and the NSW Land and Housing Corporation to achieve integration and good urban design outcomes with adjacent proposed land-uses.

The project has presented on multiple occasions throughout 2017 to the Transport for NSW Design and Sustainability Review Panel (the Panel), chaired by the Government Architect. The objective of this independent Panel is to provide high level urban, architectural and landscape design review of major projects and programs across the transport portfolio to assist in achieving high quality customer focussed design outcomes. The Panel has reviewed, critiqued and advised on all sections of the project including the following areas:

» The standard of architectural, landscape and urban design.
» Integration of the project in with the public domain, land uses, transport networks and the environment.
» Customer, operational, servicing and maintenance perspective.

This feedback has informed and influenced the urban design outcomes for the project.

The joint Urban Design Working Group and presentations to the Panel would continue as the Urban Design Requirements are finalised (refer to section 5.12.1) and at key future stages of project development.
4.4 Summary of issues raised and responses

The community and stakeholder consultation for the project to-date (as described in the sections above) has resulted in the identification of a series of key issues.

The key issues which were raised by government agencies and key stakeholders prior to and during preparation of the Environmental Impact Statement are listed in Table 4.4 with a cross-reference to where they are addressed in this Environmental Impact Statement. These issues are in addition to the formal requirements set out in the SEARs for the project (refer Appendix A and Appendix B). Key issues raised by stakeholders (non-government) and the community follow in Table 4.5. Key concerns which have been identified at a precinct level have also been summarised in Table 4.6.

### Table 4.4  Key issues raised by government agencies and key stakeholders during preparation of the Environmental Impact Statement

<table>
<thead>
<tr>
<th>STAKEHOLDER</th>
<th>NATURE OF CONSULTATION AND APPLICATION TO THE PROJECT</th>
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</table>
| City of Parramatta Council  
Regular meetings have been held between the City of Parramatta Council and the Transport for NSW project team. | Accessibility of light rail stops  
» Consultation identified the need for light rail stops to be accessible for the elderly and mobility impaired.  
» All light rail stops have been designed to be accessible to the elderly and mobility impaired and would be compliant with the requirements of the Disability Discrimination Act 1992. |
| | Alignment of light rail stops to maximise connectivity for local communities  
» Consultation identified the need for the light rail stops to be positioned so that benefits and connectivity for the communities along the alignment is maximised.  
» While taking into consideration engineering design and road network constraints, Transport for NSW have held multiple workshops with key stakeholders including City of Parramatta Council to identify and agree the most appropriate stop locations along the alignment. |
| | Location of the Westmead Terminus  
» City of Parramatta Council expressed a preference for the location of the Westmead Terminus to be moved from Railway Parade to the corner of Railway Parade and Hawkesbury Road, to provide a direct connection to Westmead Station and avoid the steep gradient of Railway Parade.  
» Transport for NSW, through further assessment and consultation with City of Parramatta Council, moved the terminus location as suggested. |
| | Urban design outcomes at Hawkesbury Road  
» Consultation identified the need for the urban design outcomes along Hawkesbury Road to undergo further development.  
» Transport for NSW would continue to work with NSW Health and the City Of Parramatta Council during detailed design concerning improvements to urban design through this precinct. This may include improved pedestrian interchanges between the project and the heavy rail, interchanges between the project and the T-way bus services on Darcy Road, general improvements to pedestrian accessibility and landscaping. |
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<tr>
<th>STAKEHOLDER</th>
<th>NATURE OF CONSULTATION AND APPLICATION TO THE PROJECT</th>
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<tbody>
<tr>
<td></td>
<td>Location of Prince Alfred Square stop</td>
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<td></td>
<td>» City of Parramatta Council would like the Prince Alfred Square stop to be located on or adjacent to Lennox Bridge.</td>
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<td></td>
<td>» Transport for NSW has agreed to carry out further investigations with the City of Parramatta Council on stop locations along Church Street including Prince Alfred Square stop.</td>
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<td></td>
<td>Grass track implementation</td>
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<td></td>
<td>» The City of Parramatta Council has requested the implementation of grass track for an improved urban design amenity in key precinct areas.</td>
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<tr>
<td></td>
<td>» Transport for NSW would consider opportunities for grass track treatments to mitigate visual impacts on sections of the alignment where it impacts Cumberland Hospital (east) and Robin Thomas Reserve. This would be confirmed during detailed design.</td>
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<td></td>
<td>Active transport link on the T6 Carlingford Line</td>
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<td></td>
<td>» The City of Parramatta Council sought the inclusion of an integrated pedestrian and cycleway network along the existing T6 Carlingford Line.</td>
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<tr>
<td></td>
<td>» The project includes an active transport link between Carlingford and Alfred Street, Parramatta, and Transport for NSW would continue to work with the City of Parramatta to integrate the active transport link with the wider cycleway network.</td>
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<tr>
<td></td>
<td>Loss of on-street parking</td>
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<tr>
<td></td>
<td>» City of Parramatta Council has raised reduction of on street parking due to the project as a concern.</td>
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<td></td>
<td>» Transport for NSW acknowledges that there is a loss of on street parking as a result of the project. Loading bays, disabled parking and service vehicle parking displaced by the project would be replaced as close as possible to the current location. However, other on-street parking would be permanently lost noting that this would be offset in the longer term by the provision of public transport.</td>
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<tr>
<td></td>
<td>Impacts on traffic and pedestrians during construction</td>
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<tr>
<td></td>
<td>» The City of Parramatta Council identified the need to maintain traffic and pedestrian access through city centre during construction, and to provide adequate wayfinding during construction.</td>
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<tr>
<td></td>
<td>» Permanent changes to the road network would be carried out as early as possible in the project staging to minimise impacts on the road network during construction. However, impacts would occur due to construction activity and/or due to the addition of construction vehicles to the road network. This is discussed further in sections 8.2, 11.3, 12.3, 13.3, 14.3 and 15.3.</td>
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<td></td>
<td>» A wayfinding strategy would be implemented to minimise disruption to road users, pedestrians and cyclists.</td>
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### Community and stakeholder consultation

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<tr>
<td></td>
<td><strong>Road and pedestrian safety</strong></td>
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</table>
|             | » The City of Parramatta Council raised concerns about pedestrian and driver safety during operation, and impacts on Kiss and Ride zones and drop off points at schools.  
|             | » Refer to section 8.2.                              |
|             | **Impacts of the project on flooding in Parramatta** |
|             | » The City of Parramatta Council raised concerns about impacts of construction on Council’s drainage assets across the project alignment.  
|             | » Where Parramatta Light Rail would require the replacement of City of Parramatta drainage assets, the project would reconstruct the drainage assets to convey up to a five percent Annual Exceedance Probability (AEP) event. Transport for NSW will continue to liaise with the City of Parramatta Council concerning impacts on its drainage assets and would carry out further detailed flood modelling during detailed design. |
|             | **Impacts on open space**                            |
|             | » City of Parramatta Council raised concerns around the impacts on open spaces along the alignment.  
|             | » Opportunities to further minimise impacts on open space along the alignment would be explored during detailed design. During detailed design, Transport for NSW would consult with City of Parramatta Council when preparing the urban design and landscape plan. This would include urban design responses due to impacts on Robin Thomas Reserve.  
|             | » The urban design and landscape plan would be informed by the Urban Design Requirements, which would establish the desired urban design and public domain outcomes for the project at varying scales. To reach a shared urban design outcome and strategy, the Urban Design Requirements are being prepared in close collaboration with City of Parramatta and relevant NSW government agencies. |
|             | **Removal of trees along the alignment**             |
|             | » City of Parramatta Council has expressed concern about the removal of trees along the alignment, including native species (Turpentine Ironbark, Swamp Oak, Mangrove and Red Gums).  
|             | » Opportunities for retaining trees of medium to high retention value which have been identified as being potentially impacted by the project would be considered where appropriate and feasible through the use of design modification and tree sensitive construction techniques.  
|             | » The urban design and landscape plan (developed during detailed design) would include recommended tree species to be used for replacement planting in each of the precincts, and would be developed in consultation with City of Parramatta Council.  
|             | » Where the loss of trees is unable to be mitigated, trees removed as a result of the project would be offset in accordance with the Transport for NSW’s Vegetation Offset Guide (2016). Trees would be replaced at a ratio of between 2:1 and 8:1 depending on the size of the tree to be removed. This would be documented in the Tree Offset Strategy to be developed for the project.  
<p>|             | » Impacts on biodiversity as a result of the project are discussed further in section 10.2. |</p>
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<th>STAKEHOLDER</th>
<th>NATURE OF CONSULTATION AND APPLICATION TO THE PROJECT</th>
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| Impacts on heritage                             |  » The City of Parramatta Council raised concern with impacts on Aboriginal and non-Aboriginal heritage.  
  » The project would have direct and indirect impacts on heritage along the alignment. Where impacts cannot be avoided, further opportunities to minimise impacts would be explored during detailed design. Further detail on impacts on Aboriginal heritage is provided in section 10.3.  
  » Further detail on impacts on non-Aboriginal heritage is provided in section 11.5, 12.5, 13.5, 14.5 and 15.5.                                                                                                                                                                                                                   |
| Construction impacts on outdoor dining          |  » City of Parramatta Council has expressed concern about construction impacts on the outdoor dining precincts.  
  » Transport for NSW is committed to working with City of Parramatta Council on initiatives to mitigate construction impacts on outdoor dining areas, and will continue to liaise with business to increase the understanding of business requirements along the alignment to help further inform construction management responses.  
  » Transport for NSW would also work with City of Parramatta Council and the Sydney Coordination Office to develop a Business Consultation and Activation Plan prior to the commencement of construction. This would be prepared in conjunction with stakeholders including the Sydney Coordination Office and the City of Parramatta Council and would be finalised in consultation with business representatives and impacted business owners. |
| Social impacts                                  |  » The City of Parramatta Council identified the need for accessible project information for culturally and linguistically diverse communities. Transport for NSW has arrangements in place to provide information about the project in the five community languages predominantly spoken in the Parramatta LGA. Interpreters in these languages are on call and have been used during the consultation for the project.  
  » The City of Parramatta Council raised concern regarding construction impacts on homeless in Parramatta city centre and the maintenance of road access around Prince Alfred Park for ‘outreach’ services. This has been considered in section 13.9.  
  » The City of Parramatta Council raised concern with the potential for construction to impact community events. Transport for NSW would work City of Parramatta Council and the Sydney Coordination Office to minimise impacts on special events and other community events held along the project alignment.  
  » The City of Parramatta Council identified the need for employment outcomes for local communities during construction. A workforce development and industry participation strategy would be developed and implemented during construction (refer to Chapter 16 – Project Sustainability). |
## Community and stakeholder consultation

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<th>STAKEHOLDER</th>
<th>NATURE OF CONSULTATION AND APPLICATION TO THE PROJECT</th>
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<tr>
<td></td>
<td>Construction and operational impacts on City of Parramatta Council’s waste services contractor</td>
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<td></td>
<td>» City of Parramatta Council wish to ensure that the waste services contractor is able to carry out normal collections during construction and that there would be no impact on waste collection services from the project.</td>
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<td></td>
<td>» Transport for NSW (and construction contractors) would work with City of Parramatta Council (and its waste collection service) to ensure waste collections can operate during construction and operation of the project.</td>
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<tr>
<td>Department of Education Including representatives from Westmead Public School, Parramatta North Public School and Westmead Hospital School</td>
<td>Crossing locations</td>
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<tr>
<td></td>
<td>» The Department of Education has raised the need for safe crossing locations along the project alignment in the vicinity of schools.</td>
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<td></td>
<td>» Pedestrian crossings would be provided along the alignment and would be designed to meet relevant road safety standards.</td>
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<td></td>
<td>Construction noise impacts</td>
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<td></td>
<td>» The Department of Education has raised concerns relating to noise and vibration impacts on schools (in particular examination periods and students at Westmead Hospital School), with a number of primary and high schools located along the alignment.</td>
</tr>
<tr>
<td></td>
<td>» Potential impacts on schools due to construction and vibration have been assessed in sections 11.6, 12.6, 13.6, 14.6 and 15.6. Transport for NSW (and its construction contractor) would liaise with the Department of Education and individual schools during detailed construction planning and as construction progresses. This would take into consideration examination periods.</td>
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<td></td>
<td>Changes to access</td>
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<td></td>
<td>» The Department of Education identified the need to maintain school access during week nights and weekends in addition to standard school hours, due to out of hours uses (such as community uses) and vacation care. The Department also identified the need to maintain access for students (such as across Hawkesbury Road, Westmead, or in between schools and Parramatta Park) and to ensure safe drop off/pick up zones are maintained.</td>
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<td></td>
<td>» Transport for NSW (or the construction contractor) would work with the Department of Education and local schools to minimise impacts on access, drop off/pick up zones and parking for school buses during detailed construction planning and while construction is underway. Safe pedestrian access along and across Hawkesbury Road would be maintained during construction.</td>
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### STAKEHOLDER

<table>
<thead>
<tr>
<th>NSW Health</th>
<th>Location of Westmead Hospital stop</th>
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<tr>
<td>Regular meetings have been held with the NSW Health and the Transport for NSW project team.</td>
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<tr>
<td>» NSW Health has sought effective integration of the Westmead Hospital stop with the developments at Westmead Hospital along Hawkesbury Road to ensure good access to the Westmead Health Precinct.</td>
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<tr>
<td>» Design and location of the stop have been agreed between Transport for NSW and NSW Health through regular design coordination meetings.</td>
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<td>» Transport for NSW would also continue to work with NSW Health and the City Of Paramatta Council during detailed design concerning improvements to urban design through this precinct. This may include improved pedestrian interchanges between the project and the heavy rail, interchanges between the project and the bus services on Darcy Road, general improvements to pedestrian accessibility and landscaping.</td>
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<thead>
<tr>
<th>Entrance to the Children’s Hospital at Westmead</th>
<th>Cumulative impacts of Health development and project construction on Hawkesbury Road</th>
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<tbody>
<tr>
<td>» NSW Health has sought integration of the Children’s Hospital stop with the hospital entry plaza, to facilitate pedestrian movement.</td>
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<tr>
<td>» The stop location and design has been agreed between Transport for NSW and the representatives from the hospitals. Further work would be carried out during detailed design as part of the Urban Design Requirements, and the urban design and landscape plan to refine pedestrian access to the Children’s Hospital at Westmead and the Westmead Health Precinct generally.</td>
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<tr>
<td>» NSW Health has identified the need to mitigate construction impacts on the Westmead Health Precinct and hospital operations, including general vehicle and emergency vehicle access, and potential cumulative impacts due to other projects in the Westmead precinct by NSW Health, Western Sydney University and other third parties.</td>
<td></td>
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<tr>
<td>» Construction of the project would be managed to ensure it does not impact normal hospital operations at the Westmead Health Precinct, including the Cumberland Hospital (east and west campuses). Transport for NSW is preparing a detailed construction plan in consultation with NSW Health for works within the Westmead and Paramatta North precinct, which would be provided to NSW Health for endorsement prior to commencement of works.</td>
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<tr>
<td>» Coordination and consultation with the Sydney Coordination Office and other key stakeholders (such as NSW Health) would also be carried out to address potential cumulative construction impacts (refer to Chapter 9 – Regional cumulative impacts).</td>
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<td>STAKEHOLDER</td>
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<tr>
<td></td>
<td>Safety issues associated with the construction and operations through a hospital precinct</td>
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<tr>
<td></td>
<td>» NSW Health identified the need for Transport for NSW to consider how the project would be constructed and operated through the Cumberland Hospital (east and west campuses) in the context of the specialised health services including mental health facilities that are in proximity to the project.</td>
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<td></td>
<td>» Transport for NSW is preparing a detailed construction plan in consultation with NSW Health for works within the Westmead and Parramatta North precinct, which would be provided to NSW Health for endorsement prior to commencement of works.</td>
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<tr>
<td></td>
<td>» Transport for NSW is developing options for treatment of the light rail corridor and surrounding environment to address the safety issues related to the light rail operating through the working hospital campus. Transport for NSW will continue to consult with Health, UrbanGrowth NSW and City of Parramatta Council to develop appropriate safety treatments of the light rail corridor through Cumberland Hospital.</td>
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<td></td>
<td>Internal access</td>
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<td>» NSW Health identified the need for linkages between east and west hospital precincts in Westmead and North Parramatta to be maintained, 24 hours a day. This is important for emergency vehicle access and internal Cumberland Hospital precinct movements (including inpatient and day patient clinics). Access also needs to be maintained to internal access roads.</td>
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<td>» As detailed in section 3.6.3, the project has been modified to provide a second bridge structure immediately adjacent (to the east) of the existing bridge to ensure access is not disrupted by the construction or operation of the project.</td>
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<tr>
<td></td>
<td>» Transport for NSW is preparing a detailed construction plan in consultation with NSW Health for works within the Westmead and Parramatta North precinct, which would be provided to NSW Health for endorsement prior to commencement of works.</td>
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<td></td>
<td>Noise and vibration impacts on sensitive receivers</td>
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<td></td>
<td>» NSW Health has raised concern around noise and vibration impacts on sensitive receivers in the hospital precinct. This includes impacts on acute care patients, the Mental Health Review Tribunal, medical sensitive equipment, research areas (including basements) and a sleep research centre.</td>
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<td></td>
<td>» Potential impacts on Westmead Health Precinct due to construction and vibration have been assessed in sections 11.6 and 12.6.</td>
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<td></td>
<td>» Transport for NSW acknowledges the presence of sensitive receivers, equipment, research facilities and services in the hospital precinct area. Transport for NSW (and its construction contractor) would liaise with the NSW Health during detailed construction planning (including staging) and as construction progresses, to identify reasonable and feasible responses to mitigate and manage potential impacts on uses and receivers in the hospital precinct.</td>
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| UrbanGrowth NSW                                  | Wire free and grass track  
» UrbanGrowth NSW has requested wire-free operations and grass tracks through the Parramatta North Urban Transformation area.  
» Transport for NSW would consider opportunities for grass track treatments and wire free operations to mitigate visual impacts on sections of the alignment where it impacts Cumberland Hospital (east)/Parramatta North Urban Transformation area. This would be confirmed during detailed design (refer to Chapter 17 – Outcomes, environmental management and mitigation). |
| Department of Planning and Environment           | Rezoning in Telopea  
» Department of Planning and Environment are considering a rezoning to the west of the light rail line to support future development. Future development would require increased east-west permeability across the light rail line.  
» The project supports increased permeability across the light rail line. However, this might impact journey times, as speed limits might be required in the vicinity of crossings. The project would remain in ongoing consultation. |
| NSW Office of Environment and Heritage           | Environment and Energy outcomes for the project  
» The Office of Environment and Heritage sought the implementation of the OEH Energy Performance Program for Parramatta Light Rail.  
» Transport for NSW has identified initiatives in Chapter 16 – Project sustainability regarding energy outcomes for the project. |
| Land and Housing Corporation                     | Relocation of the light rail stop at Telopea  
» Land and Housing Corporation requested the relocation of the light rail stop to align with the arrival plaza planned for Telopea in the Telopea Masterplan.  
» Transport for NSW has incorporated the Land and Housing Corporation request by moving the proposed Telopea stop south to align with the proposed arrival plaza planned for the area. |
| Active transport link on the T6 Carlingford Line  |   
» Transport for NSW remains in ongoing discussions with Land and Housing Corporation so new development ties in with the active transport link. |
| Property NSW                                     | Active transport link on the T6 Carlingford Line  
» Property NSW sought the integration of a pedestrian and cycleway as part of the urban solution along the Parramatta Light Rail network.  
» Transport for NSW is working in conjunction with the City of Parramatta Council to integrate an active transport corridor along the T6 Carlingford Line with the wider cycleway network. |
<p>| Location of light rail stop at Rydalmere          | Property NSW supports the requirement for a stop close to Victoria Road near the current Rydalmere Station location in place of the existing heavy rail station. |</p>
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<th>STAKEHOLDER</th>
<th>NATURE OF CONSULTATION AND APPLICATION TO THE PROJECT</th>
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| **Sydney Water**                         | Identification of utilities  
» Sydney Water sought clarification on how utilities had been identified and protected, integration of the project with its major works program, and to ensure continued access to assets during construction and operation.  
» Transport for NSW (and its contractors) would work with Sydney Water to ensure its assets are managed through the design process, and that access is ensured during construction and operation. Sydney Water’s major works program has been considered in the development of the project.  

Impacts on heritage listed assets  
» Sydney Water identified a heritage listed pump station at Rosehill as a significant asset in relation to operations, service and heritage value.  
» The project would have a direct impact on the heritage curtilage but would not impact the pump station building itself. Further information is available in section 14.5.  

Vibration impact assessment on heritage items  
» Sydney Water sought information on what controls the project will put in place to minimise vibration impacts on heritage assets.  
» Potential impacts on heritage structures due to vibration intensive construction activities is provided in sections 11.6, 12.6, 13.6, 14.6 and 15.6, and mitigation measures would be detailed in the Construction Environment Management Plan.  

**State Emergency Services (SES)**  
Flood resilience of light rail  
» SES requested information about flood resilience of the light rail as their primary concern in the project area is flood evacuation management.  
» Light rail has been designed to a 0.2 EY event.  

Evacuation impact of light rail passengers on Parramatta CBD  
» SES sought information on how quickly light rail vehicles could be moved out of the Parramatta CBD in a one per cent AEP event.  
» Light rail vehicles would be moved out of the CBD in fifteen minutes provided bridges remained open.  

Impact of early works and road closures  
» SES requested information on early works and road closures as these would impact access through the project area.  
» Transport for NSW (and its contractors) would ensure SES is on distribution lists for notifications and briefings and would continue to liaise with this stakeholder throughout detailed design and construction.  

The key issues which were raised by other stakeholders and the community prior to and during preparation of the Environmental Impact Statement are listed in Table 4.5 with a cross-reference to where they are addressed in this Environmental Impact Statement.

Table 4.5  Key issues raised by stakeholders (non-government) and the community prior to and during preparation of the Environmental Impact Statement

<table>
<thead>
<tr>
<th>STAKEHOLDER</th>
<th>NATURE OF CONSULTATION AND APPLICATION TO THE PROJECT</th>
</tr>
</thead>
</table>
| Emergency services committee                     | Active transport link on the T6 Carlingford Line  
  » Queries were made concerning the policing and security of and access to the active transport link.  
  » The project design has considered emergency access points and security measures such as lighting in the design. |
| NSW Police, Fire & Rescue NSW, NSW Ambulance      |                                                                                                                                                                                                                                                   |

Support for work to get started as soon as possible on the project.
Support for the project is noted.

Strong support along the T6 Carlingford Line for the project, with the acknowledgment that it would provide a better service than the current services.

Support for connecting existing and proposed university campuses and medical facilities.

Acknowledgment that Parramatta needed increased transport options and light rail was a relatively easy solution.

Concern about the justification for the light rail alignment.

Concern that no publicly available cost benefit study has been provided to justify the project.

Suggestion that the area already has good public transport without the need for light rail.

Concern about overall project costs.

Concern about increased cost for users on the T6 Carlingford Line (the need to use two modes of transport).

Light rail has been identified as the preferred solution to support growth in the GPOP priority growth area, and meet the project’s city shaping and place making objectives, based on a multi-criteria analysis of a range of transport options.

Further detail on the justification for the project is provided in Chapter 2 – Strategic context and need.

The implications of not proceeding with the project is discussed in Chapter 3 – Project development and alternatives.
<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>EIS REFERENCE/COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project options</strong></td>
<td></td>
</tr>
<tr>
<td>Comment that the project should be an underground alignment.</td>
<td>An underground alignment would attract significant costs and is considered to be a more cost effective for other traffic and transport modes, such as a metro-based solution which is under investigation by Transport for NSW (Sydney Metro West).</td>
</tr>
<tr>
<td>Request for specific stop locations at points along the alignment. Request that stops be located where planned residential development is expected to occur.</td>
<td>The stop locations for the project were developed based on a set of principles so that they are appropriately located to meet the objectives of the project and to provide an appropriate level of system access. This included the potential patronage and integration with existing and projected population and employment localities (such as the existing urban renewal developments within the Parramatta North, the Parramatta CBD, Camellia and Telopea). Further detail can be found in section 3.6.8.</td>
</tr>
<tr>
<td>Strong support for light rail to extend to Epping via Carlingford Court.</td>
<td>Opportunities to extend to Epping are currently under investigation by Transport for NSW.</td>
</tr>
<tr>
<td>Other frequently expressed suggestions to extend the project include: Castle Hill, south Westmead, Wentworthville, Granville, Rhodes, Wentworth Point, Sydney Olympic Park and Strathfield.</td>
<td>A number of strategic corridors and alignments were investigated for the project by City of Parramatta Council and Transport for NSW, as discussed in Chapter 3 – Project development and alternatives. Planning work is currently continuing for Stage 2 of the network with consideration of other strategic transport projects (such as Sydney Metro West). This work is expected to be completed by the end of 2017 (refer to section 3.5).</td>
</tr>
<tr>
<td>Journey time compared to existing bus services</td>
<td>Light rail has been identified as the preferred solution to support growth in the GPOP priority growth area, and meet the project’s city shaping and place making objectives.</td>
</tr>
<tr>
<td><strong>Operation</strong></td>
<td></td>
</tr>
<tr>
<td>Comment that light rail vehicles (LRVs) and stops need to be fully accessible.</td>
<td>Each stop would be designed to allow accessibility for persons with a disability, other less mobile persons and passengers with prams, mobility scooters, etc. The project would also allow customers to board with guide dogs or other authorised assistance animals at all times. Further detail is provided in section 5.4.2. To allow for access by passengers with limited mobility or in wheelchairs, the platforms would be constructed to be approximately flush with the LRV floor level. The proposed LRVs to be used would be low floor, and would include accessible priority seating for those with a disability, using a wheelchair, mobility device, the elderly, those travelling with a pram/luggage, etc. Further detail is provided in section 5.15.</td>
</tr>
<tr>
<td>DESCRIPTION</td>
<td>EIS REFERENCE/ COMMENT</td>
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<td>---------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Comment that appropriate wayfinding (signage, etc.) needs to be provided.</td>
<td>Each stop would provide a range of typical facilities including shelters, stop furniture/seating and wayfinding signage. Some stops, including interchange stops at Westmead Station and Carlingford, would include bicycle rack facilities. Further detail is provided in section 5.4.2.</td>
</tr>
<tr>
<td>Comment regarding the level of comfort to be provided by the services.</td>
<td></td>
</tr>
<tr>
<td>Concern regarding perceived safety of late night services.</td>
<td>Crime prevention through environmental design (CPTED) principles have been, and will continue to be, applied throughout the design of the project, in particular in the design of, and key access alignment to, the stops. Further detail is provided in section 5.11.2.</td>
</tr>
<tr>
<td>Concern that the interchange between light rail to heavy rail in the Parramatta CBD would not be ‘easy’ or accessible.</td>
<td>Access to each stop has been an important consideration in the development of the stop design, to ensure a customer-focused service. Particular attention has been paid to providing passengers with convenient access to the light rail network and to integrate the project with other transport modes including existing heavy rail and bus services. Transport for NSW would continue to work with the City of Parramatta Council concerning urban design improvements in the vicinity of Westmead, Parramatta Square and Carlingford interchanges. The primary active transport link proposed as part of the project would be a new connection between Carlingford and Parramatta, generally following the alignment of the existing T6 Carlingford Line and utilising the proposed James Ruse Drive Bridge.</td>
</tr>
<tr>
<td>Concern that distances between stops especially on the T6 Carlingford Line are too long to promote walking.</td>
<td></td>
</tr>
<tr>
<td>Concern regarding loss of existing heavy rail city services.</td>
<td>Customers that use the T6 Carlingford Line are required to change services at Clyde to continue to the Sydney CBD. While customers would now need to change modes at Parramatta, the project would provide more frequent services to key locations in Parramatta CBD and Westmead, which also provide express heavy rail services to the Sydney CBD.</td>
</tr>
<tr>
<td>Concern regarding ticketing and proposed pricing.</td>
<td>The ticketing and fare system for the project would integrate with the Opal ticketing system.</td>
</tr>
<tr>
<td>Integration of the project with the Western Sydney University redevelopment at Westmead.</td>
<td>Transport for NSW and Western Sydney University will continue its regular meetings. As a key stakeholder, the university would continue to be involved in the development of the Urban Design Requirements, and during detailed design, would be consulted during the development of the urban design and landscape plan.</td>
</tr>
<tr>
<td>DESCRIPTION</td>
<td>EIS REFERENCE/ COMMENT</td>
</tr>
<tr>
<td>-------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Construction (general)</td>
<td></td>
</tr>
<tr>
<td>Concern about the duration for construction.</td>
<td>Details on the construction program can be found in Chapter 6 – Project Description – Construction. There is the potential for cumulative construction impacts, depending on the stage of construction activity associated with the project and other major projects in the region (refer to Chapter 9 – Regional cumulative impacts). Transport for NSW would coordinate and consult with the Sydney Coordination Office, City of Parramatta Council and other key stakeholders to address potential cumulative construction impacts.</td>
</tr>
<tr>
<td>Concern regarding consideration of cumulative construction impacts for the local area.</td>
<td></td>
</tr>
<tr>
<td>Impacts on businesses</td>
<td></td>
</tr>
<tr>
<td>Concern about loss of business due to construction – hoardings, noise, vibration, parking.</td>
<td>It is also acknowledged that there would be general disruption and reduction in amenity for businesses that directly adjoin construction activity. Transport for NSW is committed to working with City of Parramatta Council and impacted businesses on initiatives to mitigate construction impacts on businesses, and will continue to liaise with business to increase the understanding of business requirements along the alignment to help further inform construction management responses. This will be detailed in a Business Consultation and Activation Plan prior to the commencement of construction. This plan would be prepared in conjunction with stakeholders including the Sydney Coordination Office and the City of Parramatta Council and would be finalised in consultation with business representatives and impacted business owners.</td>
</tr>
<tr>
<td>Consultation</td>
<td></td>
</tr>
<tr>
<td>Concern about current level of consultation.</td>
<td>Consultation will be ongoing during the Environmental Impact Assessment display and construction.</td>
</tr>
<tr>
<td>Concern regarding the lack of communication regarding stop locations</td>
<td></td>
</tr>
<tr>
<td>Noise and vibration</td>
<td></td>
</tr>
<tr>
<td>Concerned with construction vibration on equipment.</td>
<td>There is the potential for vibration intensive activity to occur within safe working distances. In cases where works would occur in proximity to vibration sensitive equipment, reasonable and feasible alternative construction methods would be explored. Further detail is provided in sections 11.6, 12.6, 13.6, 14.6 and 15.6.</td>
</tr>
</tbody>
</table>
## Community and stakeholder consultation

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>EIS REFERENCE/COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concerns relating to noise and vibration impacts on its Western Sydney University campuses, which are located adjacent to areas of construction. This includes examination periods, and more sensitive land uses within its campuses (such as lecture theatres, on campus child care centres and libraries).</td>
<td>Transport for NSW (and its construction contractor) would liaise with Western Sydney University during detailed construction planning and as construction progresses. This would include the consideration of examination periods in construction scheduling, and sensitive areas within each campus.</td>
</tr>
</tbody>
</table>

### Traffic and transport

- Concern about impacts on local traffic.
- Concern about impacts on existing congestion.
- Concern about the loss of existing road traffic lanes.

- Concern about length of closure of T6 Carlingford Line and inability of buses to operate on congested roads.

To minimise disruption to existing commuters, a shuttle bus service would run between Carlingford and Parramatta, providing existing commuters on the T6 Carlingford Line with connections to the T1 Western and T5 Cumberland Lines. The shuttle bus would operate every 10 minutes during peak periods and hourly in the off-peak periods and evenings. Additional buses would be added as required to meet peak demand (as shown in Figure 6.5). Further detail is provided in section 8.2 and section 15.2.

### Parking

- Concern about loss of parking along the alignment.
- Need to maintain access to loading zone and car parking.

Transport for NSW acknowledges that there is a loss of on street parking as a result of the project. Loading bays, disabled parking and service vehicle parking displaced by the project would be replaced as close as possible to the current location. However, other on-street parking would be permanently lost noting that this would be offset in the longer term by the provision of public transport. Further detail is provided in sections 11.3, 12.3, 13.3, 14.3, 15.3.

- Comment about the need to provide Park-and-Ride facilities.

Access to the light rail stops follows a mode hierarchy that promotes and supports the most efficient and sustainable access modes, with priority focused on pedestrian and cyclist modes. The hierarchy of modal access priority provides the lowest importance to park and ride.

Existing parking spaces at the light rail stops on the T6 Carlingford Line would be maintained during operation, except for the Carlingford terminus. However, replacement park and ride spaces at Carlingford would be investigated to cater to the likely high demand.
<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>EIS REFERENCE/ COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access</td>
<td>Pedestrian access would be maintained where reasonable and feasible, noting that some diversions may be required when construction works are underway. Wayfinding signage would be provided to minimise impacts on pedestrians.</td>
</tr>
<tr>
<td>Need to maintain pedestrian access along riverfront and link to Lennox Bridge</td>
<td>Transport for NSW (or the construction contractor) would work with local schools to minimise impacts on access, drop off zones and parking for school buses during detailed construction planning and while construction is underway.</td>
</tr>
<tr>
<td>Need to maintain access, drop off zone and parking for school buses.</td>
<td>Transport for NSW has been supplied with the university’s shuttle bus routes, and Transport for NSW (and its construction contractor) would liaise with the university prior to and during construction to minimise any impacts on it shuttle services.</td>
</tr>
<tr>
<td>Impacts on the Western Sydney University shuttle service.</td>
<td>Property access would be maintained. If temporary impacts on property access cannot be avoided (for example, due to safety), Transport for NSW (or its construction contractor) would liaise with the affected property owner (or its tenants) to minimise any disruption.</td>
</tr>
<tr>
<td>Impacts on property access, including Parramatta Square and educational facilities.</td>
<td>Some bus services would be amended or removed to avoid duplication of services between buses and light rail. Bus routes or bus stops that could be permanently removed or relocated to support the project would be subject to further analysis and would consider stakeholder feedback.</td>
</tr>
<tr>
<td>Buses</td>
<td>Route 900 Free shuttle bus to be discontinued prior to the commencement of construction. The Windsor Road and Pennant Hills Road bus services would be diverted during construction via Victoria Road to O’Connell Street to service bus stops on O’Connell Street south of Grose Street. This would provide frequent bus services between Parramatta Interchange and O’Connell Street (south of Grose Street). Impacts or changes to bus services are discussed further in section 8.2.</td>
</tr>
<tr>
<td>DESCRIPTION</td>
<td>EIS REFERENCE/COMMENT</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Active transport                 | **Request that connections be provided between bike paths and the project.**  
                                  | Confusion about the concept of active transport link.  
                                  | **Request for provision of bicycle parking.**  
                                  | The primary active transport link proposed as part of the project would be a new connection between Carlingford and Parramatta, generally following the alignment of the existing T6 Carlingford Line and utilising the proposed James Ruse Drive Bridge.  
                                  | The new active transport link would include the provision of a pathway that would service pedestrians and cyclists, and would connect each of the proposed light rail stops along the T6 Carlingford Line. Further detail is provided in section 5.7.  
                                  | Transport for NSW would continue to work with key stakeholders to integrate the active transport link with the wider cycleway network.  
                                  | Bicycle parking facilities would be provided at some stops along the project alignment outside of the Parramatta CBD.                                                                                                           |
| Heritage                         | **Heritage significant locations around Riverside theatre at Prince Alfred Park and Market Street.**  
                                  | The project would have a moderate impact on Prince Alfred Square, which is a local heritage item (nominated for State heritage listing). Further detail is provided in section 13.5.  |
| Impacts on Female Orphan School  | The project would not have an impact on the building.                                                                                                                                                                      |
| Property and land use            | **Comment that the project needs transport connections to existing urban development.**  
                                  | **Comment that the project needs to consider future access plan for Camellia.**  
                                  | **Comment that the project will need to interact with proposed UrbanGrowth NSW developments.**  
                                  | The alignment and stop locations for the project were developed based on a set of principles so that they are appropriately located to meet the objectives of the project.  
                                  | This included the integration with existing and projected population and employment localities (such as the existing urban renewal developments within North Parramatta, Parramatta CBD, Camellia and Telopea).  
                                  | The urban design and landscape plan, prepared during detailed design, would be informed by the Urban Design Requirements, which would establish the desired urban design and public domain outcomes for the project at varying scales. To reach a shared urban design outcome and strategy, the Urban Design Requirements are being prepared in close collaboration with City of Parramatta, UrbanGrowth NSW and relevant NSW government agencies. Further detail can be found in section 3.6.8.  |
| Concern light rail will encourage | **Concern light rail will encourage additional high density development.**  
                                  | Paramatta Light Rail will support growth in the GPOP priority growth area, consistent with strategic planning policies of the NSW Government and City of Parramatta (refer to Chapter 2).                                                                                           |
### Community and stakeholder consultation

#### Residents and businesses along the preferred alignment who are impacted by partial acquisitions concerned about adjustments.

Concem about overall impacts on property, including land acquisition and land values.

- The project would result in full and partial property acquisitions, and impacts on property and land use is discussed in sections 11.7, 12.7, 13.7, 14.7, 15.7. The majority of partial acquisitions would be minor and would not impact current land uses.
- Further information on the acquisition process is provided in section 4.3.7.

#### Concern regarding impacts on public land and green spaces.

- Need to maintain access to Prince Alfred Square for outside productions.
- The project would have direct impacts on public open space, including partial impacts on Prince Alfred Square, Robin Thomas Reserve and Queen’s Wharf Reserve. The majority of these spaces would remain available for public use, and areas temporarily impacted would be returned following the completion of construction.
- Further detail is provided in sections 11.7, 12.7, 13.7, 14.7, 15.7.

#### Cumulative impacts

- Identified the potential for cumulative impacts due to other project occurring concurrent with the project, such as areas within Westmead.
- Coordination and consultation with the Sydney Coordination Office and other key stakeholders (such as NSW Health) would be carried out to address potential cumulative construction impacts (refer to Chapter 9 – Regional cumulative impacts).

### Table 4.6 Key issues raised by the community and stakeholders by precinct

<table>
<thead>
<tr>
<th>PRECINCT</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Westmead</td>
<td>Support for connecting medical facilities and the Westmead Station. Support for a new public transport option. Concern about potential loss of access to residential roads and increased congestion on Hawkesbury Road. The project would require alterations to the intersection arrangements along Hawkesbury Road. While this would change the way in which residents, workers or customers would use the local road network, the change is not considered to have a significant impact. This is further discussed further in section 8.2.</td>
</tr>
<tr>
<td>Parramatta North</td>
<td>Support for pedestrian connections into North Parramatta from the Parramatta CBD Support for the project is noted.</td>
</tr>
<tr>
<td>PRECINCT</td>
<td>DESCRIPTION</td>
</tr>
<tr>
<td>----------</td>
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</tr>
<tr>
<td>Request for consideration of possible future extension to Castle Hill.</td>
<td>Strategic corridor options were considered as part of the Parramatta Transport Corridor Study, including extensions to Castle Hill (refer to section 3.3). As discussed in section 3.3.2, the key challenge for constructing light rail to Castle Hill was the limited capacity for accommodating light rail on the existing road network. The investigations showed that light rail to Castle Hill would result in major disruptions to roads both during construction and once in operation. In addition, compared to the Strathfield via Sydney Olympic Park and Macquarie Park corridors, this corridor presented lower transport demand and less potential for urban renewal.</td>
</tr>
<tr>
<td>Concern regarding potential reduction in buses servicing the area due to light rail.</td>
<td>Some bus services would be amended or removed to avoid duplication of services between buses and light rail. Bus routes or bus stops that could be permanently removed or relocated to support the project would be subject to further analysis and would consider stakeholder feedback. This is further discussed in section 8.2.</td>
</tr>
<tr>
<td>Parramatta CBD</td>
<td></td>
</tr>
<tr>
<td>Concern regarding loss of parking/loading areas for businesses.</td>
<td>Displaced loading docks would be relocated. However, areas of general car parking would be permanently displaced as a result of the project. It is also acknowledged that there would be general disruption and reduction in amenity for businesses that adjoin construction activity. Transport for NSW has committed to working with impacted businesses and the City of Parramatta Council, and initiatives to manage construction-related impacts would be detailed in the Business Consultation and Activation Plan (refer to section 17.4).</td>
</tr>
<tr>
<td>Concern about access to/from business driveways.</td>
<td></td>
</tr>
<tr>
<td>Concern about ongoing impacts on businesses with disruption from construction and loss of outdoor dining space.</td>
<td></td>
</tr>
<tr>
<td>Concern regarding increases in noise at residences on George Street.</td>
<td>There are predicted increases in road traffic noise along George Street due to the redistribution of traffic. This is discussed further in section 13.6.</td>
</tr>
<tr>
<td>Rosehill and Camellia</td>
<td></td>
</tr>
<tr>
<td>Concern regarding the proposed height of the bridge structure over James Ruse Drive</td>
<td>The design of the bridge has been informed by operational requirements for light rail as well as the need to future proof future upgrades to James Ruse Drive by Roads and Maritime Services. As detailed in section 14.2, specific urban design principles have been formulated to guide the detailed design of the bridge.</td>
</tr>
<tr>
<td>Concern about loss of direct access to Rosehill Gardens Racecourse.</td>
<td>Rosehill Station would be replaced with the Camellia light rail stop which is 480 metres from the racecourse facilities. Transport for NSW would continue to consult with the Australian Turf Club to discuss connectivity requirements at Rosehill Gardens Racecourse.</td>
</tr>
<tr>
<td>PRECINCT</td>
<td>DESCRIPTION</td>
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<tr>
<td>----------</td>
<td>-------------</td>
</tr>
<tr>
<td>Concerned with the temporary loss of P2 car parking area for Rosehill Gardens Racecourse, which would be occupied during construction of the project.</td>
<td>The full use of this site would be temporarily unavailable while construction is underway. Opportunities to reduce the disturbance footprint would be refined during detailed design to reduce impacts on this land use. Detailed staging of the project would also be determined during detailed design and would aim to minimise the time that affected land uses are impacted during construction.</td>
</tr>
<tr>
<td>Concern about connection to Sydney Olympic Park.</td>
<td>Planning work is currently continuing for Stage 2 of the network with consideration of other strategic transport projects (such as Sydney Metro West). This work is expected to be completed by the end of 2017 (refer to section 3.5).</td>
</tr>
<tr>
<td>T6 Carlingford Line</td>
<td></td>
</tr>
<tr>
<td>Concern regarding increases in noise and vibration at residences.</td>
<td>The existing noise levels in the Carlingford precinct includes existing rail noise sources associated with heavy passenger rail operations on the T6 Carlingford Line. This repurposing of the T6 Carlingford Line would be likely to result in decreases in existing rail related noise levels at most locations along in the precinct. Exceedances of the operational airborne noise trigger levels are limited to two residential receivers which are located in close proximity to the alignment (around five to 10 metres from the nearest track), and at three other sensitive receivers which are adjacent to a high speed section of the alignment (refer to section 15.6). Reasonable and feasible mitigation measures would be explored during detailed design.</td>
</tr>
<tr>
<td>Concern about lack of provision of commuter parking at stops during operation.</td>
<td>Existing parking spaces at the light rail stops on the T6 Carlingford Line would be maintained, except for the Carlingford terminus. However, replacement park and ride spaces at Carlingford would be investigated to cater the likely high demand.</td>
</tr>
<tr>
<td>Concern about distance of Rydalmere Station from Western Sydney University.</td>
<td>A second option was investigated to provide an additional light rail stop adjacent to the Western Sydney University (Paramatta) campus, south of the single stop location at Rydalmere Station. As discussed in section 3.6.8, this option was not carried forward as while it would provide some benefits, it would have additional project costs, increases to travel times for light rail services (with impacts on patronage), and additional vegetation impacts.</td>
</tr>
</tbody>
</table>
Concern about length of disruption to existing line and lack of certainty of buses replacing trains.

To minimise disruption to existing commuters, a shuttle bus service would run between Carlingford and Parramatta, providing existing commuters on the T6 Carlingford Line with connections to the T1 Western and T5 Cumberland Lines. The shuttle bus would operate every 10 minutes during peak and interpeak periods on weekdays, and hourly in the off-peak periods and evenings. Additional buses would be added as required to meet peak demand (as shown in Figure 6.5).

Concern regarding loss of single direct service to Central from Carlingford.

While customers would now need to change modes at Parramatta, the project would provide more frequent services to key locations in Parramatta CBD and Westmead, which also provide express services to the Sydney CBD.

Concern regarding integration of the project with new development(s) at Telopea.

Transport for NSW will continue to liaise with Land and Housing Corporation concerning the integration the project with the masterplan for the Telopea Priority Precinct. Outcomes would be documented in the urban design and landscape plan, which would be prepared during detailed design.

4.5 Future consultation and engagement

4.5.1 Public exhibition of the Environmental Impact Statement

The Environmental Impact Statement will be exhibited between 23rd August and 23rd October 2017. During the exhibition period, government agencies, interest groups and organisations, stakeholders and the community are invited to make written submissions. A summary of the engagement activities and tools that will be used to encourage community and stakeholder participation during the public exhibition period is outlined below.

4.5.1.1 Environmental Impact Statement display locations

The Environmental Impact Statement will be placed on public exhibition at a number of locations including:

» Department of Planning and Environment, Information Centre Level 22, 320 Pitt St, Sydney NSW 2000.

» City of Parramatta Council, 126 Church Street, Parramatta NSW 2150.

» City of Parramatta Council Library, 1 – 3 Fitzwilliam Street, Parramatta NSW 2150.

» Dundas Valley Branch Library, 21 Sturt Street, Dundas Valley NSW 2117.

» Transport for NSW, Parramatta Light Rail Project Office, Level 10, 130 George Street, Parramatta NSW 2150.

» Transport for NSW Transport Projects, Level 5, Tower A Zenith Centre, 821 Pacific Highway, Chatswood NSW 2067.

» Telopea (Masterplan Office), 6 Shortland Street, Telopea NSW 2117


During this time, display material and hard copies of the Environmental Impact Statement will be made available to the public in order to provide the community, stakeholders and agencies an
4.5.1.2 Promotion of the public exhibition

To promote the Environmental Impact Statement public exhibition period, a project brochure will be distributed to residential and commercial properties along the alignment as well as government agencies and key stakeholders. Advertisements were placed in key suburban and metropolitan newspapers (including the Sydney Morning Herald, Daily Telegraph, Paramatta Advertiser, Parramatta Holroyd Sun, Inner West Courier, the Northern District Times, and community language newspapers El Telegraph (Arabic), Australia New Express Daily (Mandarin), Daily Chinese Herald (Cantonese), Top News Weekly (Korean) to announce the Environmental Impact Statement display. The advertisements provided details of the exhibition and community information sessions, including dates, locations and opening hours and invited community members to write submissions in response to the Environmental Impact Statement. The relevant contact details for lodging a submission were included in the advertisements.

4.5.1.3 Community contact and information points

The project contact points including the project information line (1800 684 490) and email address (parramattalightrail@transport.nsw.gov.au) will continue to operate throughout the Environmental Impact Statement public exhibition period and beyond. Community and stakeholders are encouraged to contact the project team to discuss the Environmental Impact Statement and submissions process. These details continue to be included in all written communications distributed to the community or made available online.

4.5.1.4 Key stakeholder briefings

Meetings will be held with key stakeholders directly and indirectly impacted by the project, including government agencies. The objective of the meetings will be to provide an update on the project and identify any issues, concerns or suggestions for improvement. These meetings will be ongoing throughout the project.

4.5.1.5 Community information sessions

A series of community information sessions are proposed to be held during the public exhibition period. These sessions will provide opportunities for members of the community and stakeholders to discuss the Environmental Impact Statement with the project team and ask questions about the project. The sessions will also provide the community with an opportunity to learn more about the submissions process.

Details of the proposed community information sessions to be held during the public exhibition are provided in Table 4.7.

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>VENUE</th>
<th>ADDRESS</th>
<th>DATE</th>
<th>TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parramatta CBD</td>
<td>PARKROYAL Paramatta</td>
<td>30 Phillip Street, Parramatta NSW 2150</td>
<td>Thursday 31 August 2017</td>
<td>4 pm–8 pm</td>
</tr>
<tr>
<td>Dundas</td>
<td>Dundas Sports and Recreation Club</td>
<td>9 Elder Road, Dundas NSW 2117</td>
<td>Saturday 2 September 2017</td>
<td>10 am–2 pm</td>
</tr>
<tr>
<td>Westmead</td>
<td>One Hotels and Apartment</td>
<td>175 Hawkesbury Road, Westmead NSW 2145</td>
<td>Wednesday 13 September 2017</td>
<td>4 pm–8 pm</td>
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</tbody>
</table>
4.5.2 Ongoing consultation

4.5.2.1 Response to submissions report

Written submissions received by the Department of Planning and Environment during the exhibition period will be forwarded to Transport for NSW for consideration. After reviewing the submissions, a submissions report will be prepared by Transport for NSW that documents all the submissions received and Transport for NSW’s response to them. The submissions report will be publicly available on the Transport for NSW website and the Department of Planning and Environment website.

If there are changes to the project as it is described in this Environmental Impact Statement, a Preferred Infrastructure Report may be prepared. If these changes are significant, this report may be released for public review and additional comment prior to determination of the project.

Transport for NSW proposes to send a letter to all stakeholders who made a submission to advise them of their submission number and where to refer in the submissions report for responses to issues raised. Submissions will not be responded to individually.

The community and stakeholders will be notified about the completion and availability of the submissions report through advertisements in suburban and metropolitan press, the project website and a community newsletter. Key stakeholders will also receive notification of the submissions report via a letter.

4.5.2.2 Business consultation

Engagement with retailers and property owners along the project alignment will continue. In June–July 2017 a survey will take place asking every business to participate along the Parramatta Light Rail alignment. This survey will provide more detail to Transport for NSW on business within the region and expectations and requirements going forward. Support to businesses potentially impacted by the project would be identified through the development of a Business Consultation and Activation Plan. This plan would be prepared in conjunction with stakeholders including the Sydney Coordination Office and the City of Parramatta Council and would be finalised in consultation with business representatives and impacted business owners. This is discussed further in section 17.4.2.

4.5.2.3 Ongoing consultation and engagement activities

Transport for NSW is committed to community and stakeholder engagement beyond the planning phase through detailed design, construction and commissioning of the project. During construction, a plan would be prepared to ensure:

» The community and stakeholders have a high level of awareness of all processes and activities associated with the project.

» Accurate information is made available in an effective and timely manner.

» A timely response is given to issues and concerns raised by stakeholders and the community.
Transport for NSW’s project information line and email address would continue to be available during the future phases of the project and targeted communication activities, such as letters, brochures, emails and website updates, would continue as the project progresses. Stakeholders will continue to be proactively engaged through ongoing stakeholder meetings and other forums.

Consultation during construction

Subject to planning approval, Transport for NSW (and its construction contractor) would continue to engage with the community and key stakeholders prior to and during construction. Community engagement will focus on preparing the public for the realities of construction impacts and working with directly impacted stakeholders to mitigate and reduce those impacts where possible. The approach, methodology and tools proposed for this engagement phase will be included in subsequent updates to the engagement plan.

Transport for NSW would lead a construction stakeholder and community engagement program, with support from contractors in accordance with the Community Consultation Framework (Appendix D). In general, this consultation would involve:

- Development and implementation of a construction communications plan.
- Development and implementation of a Business Consultation and Activation Plan.
- Notification (including targeted letterbox drops) of works that may affect existing transport (such as road closures, changes to pedestrian routes and bus stops).
- 24-hour toll-free community project information phone line.
- Regular updates to the project website (http://parramattalightrail.nsw.gov.au).
- Ongoing use of interactive web-based activities.
- Regular newsletters, information brochures and fact sheets.
- Regular construction updates.
- Clear signage at construction sites.
- Ongoing consultation with key stakeholders, local councils and other government agencies.
- Development and implementation of a community complaints and response management system.
- Media releases and regular project development advertisements in local and metropolitan papers.
- Ongoing role of Place Managers to act as single point of contact for the community.
- Ongoing role of Property Manager Acquisition to act as point of contact for property owners impacted by acquisition.
- Translator and interpreter services.
- Satisfaction surveys and feedback form.

Complaints during construction will be managed in accordance with Transport for NSW’s Community Engagement Policy. A construction response line (1800 775 465) is available for all Transport for NSW projects and would be a 24-hour contact point for complaints regarding construction works for the project.
5 Project description – infrastructure and operation

This chapter provides a description of the project in terms of its operational end state.

5.1 Approach to project definition

5.1.1 Flexibility provisions in the project design

Light rail design and technology is continually evolving with ongoing improvements in track, power and light rail vehicle (LRV) technology as well as improvements in construction techniques. In addition, contractor involvement, together with ongoing government, community and stakeholder engagement throughout the detailed design of a project can identify further opportunities to refine and improve the project design and operation.

To enable these opportunities to be more effectively incorporated into the project, there is a need to provide some flexibility in how the project is defined and subsequently assessed in the Environmental Impact Statement. Having a reasonable degree of design flexibility for particular elements of the project at an early stage in the assessment and approvals process can:

» Allow improvements to project design and enhance economic benefits.
» Enable construction contractor innovations in light rail installation techniques and technology to refine the project.
» Allow consideration of changes resulting from stakeholder comments from government agencies, stakeholders and the wider community to be addressed without the need for additional assessment or approvals and potential associated delays.
» Enable the project to benefit from the lessons learned from work being done on other similar projects (such as CBD and South East Light Rail and Newcastle Light Rail) or from industry innovation.

5.1.2 Assessment approach

To achieve a level of flexibility without compromising the level of impact assessment, the approach adopted for the purposes of the Environmental Impact Statement has been to assess a ‘realistic worst case’ impact for particular project elements where there is a reasonable potential for design refinements / changes to occur – these elements are identified in Table 5.1. For example, while stop locations and arrangements along the project alignment have been identified, there are likely to be opportunities for refinement of the location or design (such as changing an island platform to a side platform) during ongoing design development or as a result of government, community or stakeholder feedback.

As shown in Table 5.1, for each element, two key parameters have been considered:

» The likely maximum degree of flexibility to the design as described in the Environmental Impact Statement.
» The project element’s performance requirements.

These two parameters, when combined, effectively provide the boundaries to what would be considered as the assessed project including a degree of flexibility.
A flexible approach enables the acceptance of changes to the project where the proposed change meets a set of identified performance criteria. The proposed approach to design changes and project flexibility is shown in Figure 5.1.

Any changes to the project made through the flexibility provisions would be tracked and the description of the approved project will be updated to reflect those changes. Any changes to the project made through the flexibility provisions including the revised project description will be made available to the Secretary.

The maximum flexibility assessment parameter applies to the original approved project and not to the project as changed through the flexibility provision unless those changes have been approved through a consistency assessment by Transport for NSW, or by the Minister through a formal modification process.

**Figure 5.1 Proposed approach to design changes and project flexibility**
### Table 5.1 Areas of potential project flexibility

<table>
<thead>
<tr>
<th>PROJECT ELEMENT RELEVANT TO ASSESSMENT</th>
<th>ASSESSED ASSUMPTION(S)</th>
<th>MAXIMUM FLEXIBILITY ASSESSMENT PARAMETER(S)</th>
<th>PROJECT PERFORMANCE PARAMETERS</th>
<th>EXPLANATION OF PROJECT PARAMETER(S)</th>
</tr>
</thead>
</table>
| Stops – including flexibility for:     | Location and arrangement as per Figure 5.6 45 m long stops 16 stops. | Stop lengths between 30-50 m Relocated or additional stops are added with no change to the project alignment. | » Environmental and amenity impacts are assessed by the project environmental representative to be manageable through the implementation of environmental measures as detailed in the Construction Environmental Management Plan (including related technical management plans including but not limited to construction traffic, noise and vibration, business impacts, visual and heritage) or the Operational Environmental Management Plan (including related technical management plans including but not limited to operational traffic, noise and vibration, business impact, visual and heritage) as relevant.  
» No acquisition (temporary or permanent) of property where a negotiated purchase from the property owner is not possible.  
» Does not involve the removal or pruning of a tree or other vegetation that would otherwise require a permit or development consent for removal or pruning.  
» Doesn’t block a road intersection or access to a property.  
» Does not result in operational impacts that would have more than a minor adverse traffic impact (including on intersection performance, road way capacity, bus operations and active transport network) as assessed in the approved project. | An indicative layout and location for each of the stops has been used to inform the assessment of the project. The indicative layouts are based on minimising impacts on environmental elements such as heritage, biodiversity and property impacts, as well as integrating with existing and proposed traffic and access arrangements. |
| » Stop location                          |                          |                                            |                               |                                     |
| » Arrangement (side/ island)            |                          |                                            |                               |                                     |
| » Stop size/length                      |                          |                                            |                               |                                     |
| » Number of stops                       |                          |                                            |                               |                                     |
### Project Description – Infrastructure and Operation

<table>
<thead>
<tr>
<th>Project Element Relevant to Assessment</th>
<th>Assessed Assumption(s)</th>
<th>Maximum Flexibility Assessment Parameter(s)</th>
<th>Project Performance Parameters</th>
<th>Explanation of Project Parameter(s)</th>
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<td>» Involves the installation of a temporary structure on, or the enclosing of, a public place that is under council’s management or control that is likely to cause a disruption to pedestrian or vehicular traffic that is not minor or inconsequential, or</td>
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<td>» Involves excavation that is not minor or inconsequential of the surface of, or a footpath adjacent to, a road for which a council is the roads authority under the Roads Act 1993 (if the public authority that is carrying out the development, or on whose behalf it is being carried out, is not responsible for the maintenance of the road or footpath), or</td>
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### Project Description – Infrastructure and Operation

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<tbody>
<tr>
<td>Length of LRVs</td>
<td>45 m LRVs</td>
<td>LRVs between 30-50 m in length</td>
<td>Would change flood patterns other than to a minor extent but remains consistent with the flood performance criteria. Transport for NSW would not proceed with the change unless it has given written notice to Council of the intention to carry out the change(s) and taken into consideration any response to the notice that is received from Council within 21 days after the notice is given.</td>
<td>Environmental and amenity impacts are assessed by the project environmental representative to be manageable through the implementation of environmental measures as detailed in the Construction Environmental Management Plan (including related technical management plans including but not limited to construction traffic, noise and vibration, business impacts, visual and heritage) or the Operational Environmental Management Plan (including related technical management plans including but not limited to operational traffic, noise and vibration, business impacts, visual and heritage) as relevant. An indicative LRV length has been considered to allow for noise, vibration and traffic modelling based on a 45 m LRV length.</td>
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<tr>
<td>Operational Headway (time between services)</td>
<td>7.5 minute headways</td>
<td>Headways between 6 minutes and 20 minutes</td>
<td>Does not change overall journey time by greater than 10 per cent.</td>
<td>Environmental and amenity impacts are assessed by the project environmental representative to be manageable through the implementation of environmental measures as detailed in the Construction Environmental Management Plan (including related technical management plans including but not limited to construction traffic, noise and vibration, business impacts, visual and heritage) or the Operational Environmental Management Plan (including related technical management plans including but not limited to operational traffic, noise and vibration, business impacts, visual and heritage) as relevant. Future capacity for the service frequency may change (increase or decrease) in response to different patronage demands.</td>
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<td>PROJECT ELEMENT RELEVANT TO ASSESSMENT</td>
<td>ASSESSED ASSUMPTION(S)</td>
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| Tree planting outside project corridor | Not currently identified | Areas within the City of Parramatta area identified for suitable tree planting or revegetation (for vegetation offset requirements). | » No acquisition (temporary or permanent) of property where a negotiated purchase from the property owner is not possible.  
» Meets stakeholder and landowner requirements on identified properties.  
» Transplantation or revegetation works to directly offset the impact of removal as a result of the project. | Vegetation offset requirements may require offset planting beyond what can be accommodated within the project footprint.  
Planting of offset trees will mitigate the impact of removal as a result of the project. |
| Survey/utility/lighting works          | Works to occur within identified project impact footprint | Works within around one kilometre of the identified project impact footprint | » Would, if not for being part of the project, be exempt or complying development.  
» Environmental and amenity impacts are assessed by the project environmental representative to be manageable through the implementation of environmental measures as detailed in the Construction Environmental Management Plan (including related technical management plans including but not limited to construction traffic, noise and vibration, business impacts, visual and heritage) or the Operational Environmental Management Plan (including related technical management plans including but not limited to operational traffic, noise and vibration, business impacts, visual and heritage) as relevant.  
» No acquisition (temporary or permanent) of property where such acquisition results in a dispute with the property owner.  
» Does not involve the removal or pruning of a tree or other vegetation that would otherwise require a permit or development consent for removal or pruning. | Due to the nature of these types of works, the exact location and extent is often not known until works are commenced.  
Works would only be carried out where necessary to facilitate construction of the project. |
<table>
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<tr>
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| Substations and related utilities    | Eight proposed substations as indicated in section 5.11.1, including indicative size and location | Substation can be relocated to allow for improved operational requirements or to improve overall energy efficiency. Additional substation can be included to meet operational requirements. | » Would, if not for being part of the project, be exempt or complying development.  
» Environmental and amenity impacts are assessed by the project environmental representative to be manageable through the implementation of environmental measures as detailed in the Construction Environmental Management Plan (including related technical management plans including but not limited to construction traffic, noise and vibration, business impacts, visual and heritage) or the Operational Environmental Management Plan (including related technical management plans including but not limited to operational traffic, noise and vibration, business impacts, visual and heritage) as relevant.  
» No acquisition (temporary or permanent) of property where such acquisition results in a dispute with the property owner.  
» Does not involve the removal or pruning of a tree or other vegetation that would otherwise require a permit or development consent for removal or pruning. | The final locations of the substations would likely be refined during detailed design to allow for improved operational requirements or to allow for more efficient connection to existing services. |
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<td>» Involves excavation that is not minor or inconsequential of the surface of, or a footpath adjacent to, a road for which a council is the roads authority under the Roads Act 1993 (if the public authority that is carrying out the development, or on whose behalf it is being carried out, is not responsible for the maintenance of the road or footpath), or</td>
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| Minor road network changes including off-corridor works and public transport network changes, such as line marking, car parking adjustments, signal changes, footpath or kerb adjustments, and bus stops. | As identified in Section 5.8 and 5.9 | Where road network changes are required beyond the identified scope to address potential traffic impacts associated with the light rail. | » Would change flood patterns other than to a minor extent but remains consistent with the flood performance criteria, Transport for NSW would not proceed with the change unless it has given written notice to Council of the intention to carry out the change(s) and taken into consideration any response to the notice that is received from Council within 21 days after the notice is given.  
» Would, if not for being part of the project, be exempt or complying development.  
» Complies with the principles for traffic management and access as outlined in section 5.15.7.  
» Would have no greater environmental and amenity impacts are assessed by the project environmental representative to be manageable through the implementation of environmental measures as detailed in the Construction Environmental Management Plan (including related technical management plans including but not limited to construction traffic, noise and vibration, business impacts, visual and heritage) or the Operational Environmental Management Plan (including related technical management plans including but not limited to operational traffic, noise and vibration, business impacts, visual and heritage) as relevant.  
» No acquisition (temporary or permanent) of property where such acquisition results in a dispute with the property owner.  
» Does not involve the removal or pruning of a tree or other vegetation that would otherwise require a permit or development consent for removal or pruning.  
» No greater than minimal impacts on traffic generally beyond those already approved under other terms of this approval. | The final road adjustments/configurations would likely be refined during detailed design to allow for improved traffic operational requirements. |
<table>
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<tr>
<th>Project Element Relevant to Assessment</th>
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</table>
| Active transport link                   | As identified in section 5.7 | Additional connections to adjacent urban areas to those identified in section 5.7 and on Figure 5.2d, Figure 5.2g and Figure 5.2h. | » Complies with the principles and overall design of the active transport line as outlined in section 5.7.  
» Environmental and amenity impacts are assessed by the project environmental representative to be manageable through the implementation of environmental measures as detailed in the Construction Environmental Management Plan (including related technical management plans including but not limited to construction traffic, noise and vibration, business impacts, visual and heritage) or the Operational Environmental Management Plan (including related technical management plans including but not limited to operational traffic, noise and vibration, business impacts, visual and heritage) as relevant.  
» No acquisition (temporary or permanent) of property where such acquisition results in a dispute with the property owner.  
» Does not involve the removal or pruning of a tree or other vegetation that would otherwise require a permit or development consent for removal or pruning. | The final location(s) for integration of the active transport link with adjacent areas would likely be refined during detailed design to allow for improved design outcomes to be achieved and to better integrate with the surrounding urban environment and future development areas/priority precinct(s). |
## Project description - infrastructure and operation

<table>
<thead>
<tr>
<th>Project Element Relevant to Assessment</th>
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</thead>
</table>
| New or widened bridges                 | As identified in section 5.9 | Bridge design refined to allow for improved operational requirements or to allow for improved design outcomes to be achieved in the same location as identified. | » Complies with the principles for traffic management and access as outlined in section 5.15.7  
» Environmental and amenity impacts are assessed by the project environmental representative to be manageable through the implementation of environmental measures as detailed in the Construction Environmental Management Plan (including related technical management plans including but not limited to construction traffic, noise and vibration, business impacts, visual and heritage) or the Operational Environmental Management Plan (including related technical management plans including but not limited to operational traffic, noise and vibration, business impacts, visual and heritage) as relevant.  
» No acquisition (temporary or permanent) of property where such acquisition results in a dispute with the property owner.  
» Does not involve the removal or pruning of a tree or other vegetation that would otherwise require a permit or development consent for removal or pruning | The final arrangement of the proposed new or widened bridge structures would likely be refined during detailed design to allow for improved operational requirements or to allow for improved design outcomes to be achieved. |
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5.2 Project overview

5.2.1 Key features of the project

The Parramatta Light Rail (Stage 1) project (‘the project’) comprises construction and operation of a light rail service between Westmead and Carlingford, via the Parramatta CBD and Camellia. The project would link the following areas in the region:

» Westmead
» North Parramatta
» Parramatta central business district (CBD)
» Camellia
» Rydalmere
» Rosehill
» Telopea
» Dundas
» Carlingford.

The project would consist of a number of elements including the main project alignment (referred to as the project alignment), an active transport link, road modifications and other ancillary project elements. All of the works associated with the project which have been described in this chapter are collectively referred to as ‘the project’.

The key features of the project are provided in Table 5.2. Detailed discussion regarding each of these key features is provided throughout the remaining sections of this chapter.

Table 5.2 Key features of the Parramatta Light Rail (Stage 1) project

<table>
<thead>
<tr>
<th>KEY FEATURE</th>
<th>DESCRIPTION</th>
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<tr>
<td>Project alignment</td>
<td>A light rail network of around 12 km extending between Westmead and Carlingford, via the Parramatta CBD and Camellia, including access to a stabling and maintenance facility at Camellia. The project alignment would comprise a mix of both on-street and dedicated corridor running, including the conversion of the existing T6 Carlingford Line heavy rail corridor between Camellia and Carlingford, and a section of the former Sandown Freight Line for use as a light rail corridor. The project alignment would include dual light rail tracks throughout (with the exception of a single track arrangement under Pennant Hills Road, Carlingford) and would include a series of crossovers and turnouts. The light rail trackform would include a combination of embedded track and ballasted track forms.</td>
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| Stops             | Subject to the flexibility provisions as outlined in Table 5.1:  
» Sixteen stops between Westmead and Carlingford.  
» Each stop would provide a range of typical facilities including shelters, stop furniture/seating, Opal card readers and wayfinding signage.  
» The platforms would be around 45 m long with a range of widths between about three metres (for side platform arrangements) and about 4.5 m (for island platform arrangements).  
» Platform arrangements would consist of either side or central island platforms. |

Parramatta Light Rail | Stage 1 - Westmead to Carlingford via Camellia
Environmental Impact Statement
<table>
<thead>
<tr>
<th>KEY FEATURE</th>
<th>DESCRIPTION</th>
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<tr>
<td>Interchanges with existing rail, bus and/or ferry service facilities along the alignment including Westmead, Parramatta CBD and Carlingford.</td>
<td>At least one pedestrian crossing would be available across the light rail tracks at each stop to provide access to each platform and the precinct.</td>
</tr>
<tr>
<td>Parramatta CBD</td>
<td>Two light rail and pedestrian zones including:</td>
</tr>
<tr>
<td></td>
<td>» Church Street between Market Street and Macquarie Street</td>
</tr>
<tr>
<td></td>
<td>» Macquarie Street between Horwood Place and Smith Street.</td>
</tr>
<tr>
<td></td>
<td>LRVs would travel through the light rail and pedestrian zones at slower speeds compared to other areas of the alignment.</td>
</tr>
<tr>
<td></td>
<td>Emergency vehicles would retain access to the light rail and pedestrian zones 24-hours a day.</td>
</tr>
<tr>
<td></td>
<td>Property owners and delivery and maintenance vehicles would have access within the light rail and pedestrian zones during restricted hours where no alternative exists (to be determined during the detailed design of the project).</td>
</tr>
<tr>
<td>Active transport link</td>
<td>An active transport link (pedestrian and cycling) would be provided connecting Carlingford to the Parramatta Valley Cycleway at Rydalmere, with bridge crossings at Parramatta River and James Ruse Drive, and ending at Alfred Street, Parramatta.</td>
</tr>
<tr>
<td>Road configuration changes</td>
<td>Changes to the road network along the project alignment and adjoining streets would include:</td>
</tr>
<tr>
<td></td>
<td>» Upgrades to intersections, including modification of intersection arrangements/pavement areas, and/or the installation of new traffic signals</td>
</tr>
<tr>
<td></td>
<td>» Pavement works</td>
</tr>
<tr>
<td></td>
<td>» Changes to lane configuration and directional flow</td>
</tr>
<tr>
<td></td>
<td>» Removal of some car parking to accommodate displaced traffic lanes</td>
</tr>
<tr>
<td></td>
<td>» Relocation of loading zones, accessible parking, bus stands, taxi stands and other service vehicle parking areas.</td>
</tr>
<tr>
<td>Bridges and other structures</td>
<td>Key new or modified structures along the project alignment would include:</td>
</tr>
<tr>
<td></td>
<td>» New bridges for the light rail at:</td>
</tr>
<tr>
<td></td>
<td>• North Parramatta, adjacent to the bridge over Parramatta River</td>
</tr>
<tr>
<td></td>
<td>• Clay Cliff Creek and James Ruse Drive, Rosehill</td>
</tr>
<tr>
<td></td>
<td>• Vineyard Creek, Rydalmere</td>
</tr>
<tr>
<td></td>
<td>• Kissing Point Road rail bridge, Dundas (adjacent to the existing bridge).</td>
</tr>
<tr>
<td></td>
<td>» Widening or modification (including minor works such as safety screens) to existing bridge structures at:</td>
</tr>
<tr>
<td></td>
<td>• Parramatta River, Camellia/Rydalmere</td>
</tr>
<tr>
<td></td>
<td>• Victoria Road, Rydalmere</td>
</tr>
<tr>
<td></td>
<td>• Kissing Point Road, Dundas</td>
</tr>
<tr>
<td></td>
<td>• Adderton Road, Telopea</td>
</tr>
<tr>
<td></td>
<td>• Pennant Hills Road, Carlingford.</td>
</tr>
<tr>
<td></td>
<td>» Modification to a number of culverts that provide vehicular or pedestrian access along the alignment</td>
</tr>
<tr>
<td></td>
<td>» Minor modification (including potential strengthening) to Lennox Bridge, limited to installation of tracks and associated infrastructure within the existing road surface.</td>
</tr>
</tbody>
</table>
## Ancillary features

Subject to the flexibility provisions outlined in Table 5.1:

- **Power supply**
  - Poles and overhead wiring (OHW) throughout the project alignment between Westmead and Carlingford to supply electricity to the LRVs.
  - Eight substations throughout the length of the project alignment to provide power to operate LRVs.

- **Stabling and maintenance facility**
  - Stabling and maintenance facility located at 6 Grand Avenue, Camellia operating 24 hours a day. Key elements would include:
    - Stabling tracks and sidings, including overnight stabling
    - A LRV cleaning area
    - Sand and wash plants, including a sand silo
    - Maintenance and repair facilities
    - Infrastructure storage areas for equipment
    - Wheel lathe
    - An operations control centre for the network
    - Staff facilities, including administration
    - Parking for about 125 cars/private vehicles for staff and visitor use.

- **LRV driver amenities at light rail termini at Carlingford and Westmead, and at the stabling and maintenance facility at Camellia.**

- **Replacement of existing rail infrastructure along the former Sandown Line corridor, between the junction of the proposed Camellia stop and the stabling and maintenance facility, including removal of the remaining rail infrastructure, east of the stabling and maintenance facility.**

- **Closure of the existing T6 Carlingford Line north of Parramatta Road including removal of existing rail assets at the existing level crossing such as signalling and boom gates (excluding tracks).**

## Operation

Subject to the flexibility provisions outlined in Table 5.1:

- **LRVs**
  - About 45 m long with a capacity to carry about 250 to 300 passengers per LRV.
  - A fleet of 16 LRVs (including spare LRVs) at the commencement of operation.

- **Service and frequency**
  - ‘Turn-up-and-go’ services, operating from 5 am to 1 am, seven days a week, with additional services during major events.
  - Integrated with the Opal ticketing system.

- **Between 130 and 160 full-time equivalent staff are expected to be required to operate and maintain the project.**

An overview of the key elements of the project is shown in Figure 5.2a to Figure 5.2h. Some elements of the project described in this chapter may be subject to further development during detailed design. Design modifications to those outlined in the Environmental Impact Statement which occur as a result of matters arising during the exhibition of this Environmental Impact Statement.
Impact Statement would be identified in a submissions report, or if the changes are substantial, a preferred infrastructure report.

The works required to deliver the project, including both enabling works and main works, are described in further detail in this chapter. A description of how the project is likely to be constructed (including indicative construction program, methodology and workforce) is provided in Chapter 6 (Project description – Construction).
Figure 5.2a | Key features of the project
Figure 5.2b Key features of the project

- Modification to O'Connell Street to allow 3 lanes of traffic between Barney Street and Board Street
- Intersection modification to provide additional turning movements
- Modification for 2 lanes eastbound and 2 lanes westbound
- Modification to allow 4 traffic lanes between Barney Street and Albert Street
- New traffic signals
- Intersection upgrade works
- Substation
- Signalised intersection
Figure 5.2c  Key features of the project

*Indicative only. Subject to detailed design.

- Light rail stop
- Light rail alignment
- Existing railway station
- Watercourse
- Precinct boundary
- Existing railway
- Light rail and pedestrian zone
- Substation

Parramatta Light Rail | Stage 1
- Westmead to Carlingford via Camellia

Environmental Impact Statement
Figure 5.2d | Key features of the project
Figure 5.2e | Key features of the project

- Proposed reuse of former Randwick Line for light rail alignment
- Removal of existing tracks and ballast along former Randwick Line east of access point to stabling and maintenance facility
- Access to stabling and maintenance facility (new traffic signals)
- Stabling and maintenance facility

*Indicative only. Subject to detailed design.*

Legend:
- Light rail alignment
- Existing railway
- Active transport link
- Precinct boundary
- Watercourse
- Substation
Figure 5.2f | Key features of the project

- Proposed closure of existing railway line, north of Parramatta Road
- Closure of the existing T6 Carlingford Line to Parramatta Road and removal of existing level crossing assets (excluding track)
Figure 5.2g | Key features of the project

- **Key features of the project**

  - New bridge over Kissing Point Road to accommodate light rail
  - Replacement and realignment of pedestrian underpass at Leemington Road
  - Minor modifications to existing bridge to accommodate light rail and active transport link
  - Bridge over Vineyard Creek to be replaced

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*Indicative only. Subject to detailed design.*
Figure 5.2h  |  Key features of the project
5.2.2 Environmental considerations in design

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

» Avoid known structures including buildings, basements, utilities and infrastructure (including other rail and road infrastructure), where suitable alternative options have been identified

» Minimise the potential for direct and indirect impact on heritage items

» Minimise direct impacts on property.

Specific design responses to avoid and minimise adverse impacts are identified in Table 5.3.

Table 5.3 Summary of adverse impacts avoided or minimised through design

<table>
<thead>
<tr>
<th>ENVIRONMENTAL ASPECT</th>
<th>DESIGN RESPONSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heritage</td>
<td>Refinement of the light rail alignment to:</td>
</tr>
<tr>
<td></td>
<td>» Avoid direct impacts on Parramatta Park (World Heritage site and buffer zone)</td>
</tr>
<tr>
<td></td>
<td>» Minimise impacts on buildings within Cumberland District Hospital group, including the Former Female Factory (State heritage)</td>
</tr>
<tr>
<td></td>
<td>» Minimise impacts on St Patrick’s Cemetery (State heritage).</td>
</tr>
<tr>
<td></td>
<td>Stop and alignment design refined to avoid impacts on the Prince Alfred Square war memorial.</td>
</tr>
<tr>
<td></td>
<td>Centre running alignment designed to avoid built heritage within the Parramatta CBD.</td>
</tr>
<tr>
<td></td>
<td>Alignment along Macquarie Street and Harris Street designed to minimise intrusion into Robin Thomas Reserve.</td>
</tr>
<tr>
<td></td>
<td>Light rail alignment refined to minimise permanent impact on Queen’s Wharf Reserve.</td>
</tr>
<tr>
<td></td>
<td>Light rail alignment refined to avoid direct impact on Sewerage Pump Station 67 structure at Camellia (State heritage).</td>
</tr>
<tr>
<td></td>
<td>Alignment and stop design at Dundas modified to minimise impacts on existing station infrastructure (State heritage).</td>
</tr>
<tr>
<td></td>
<td>Stop design at Carlingford modified to avoid Carlingford Produce Store (local heritage item).</td>
</tr>
<tr>
<td>Biodiversity</td>
<td>Alignment design modified to avoid direct impacts on the Grey-Headed Flying Fox colony at North Parramatta.</td>
</tr>
<tr>
<td></td>
<td>Active transport link alignment designed to avoid or minimise impacts on endangered ecological communities.</td>
</tr>
<tr>
<td></td>
<td>Bridge designs modified to minimise impacts on riparian and aquatic biodiversity values.</td>
</tr>
<tr>
<td>Noise and vibration</td>
<td>Provision or design of track forms to minimise potential noise and vibration impacts (to at least minimum noise and vibration criteria).</td>
</tr>
<tr>
<td></td>
<td>Location of the stabling and maintenance facility within a current industrial area to minimise potential impacts on adjacent land owners.</td>
</tr>
<tr>
<td></td>
<td>Location of substations away from sensitive receivers (such as residential areas), where feasible.</td>
</tr>
</tbody>
</table>
### Project description – infrastructure and operation

<table>
<thead>
<tr>
<th>ENVIRONMENTAL ASPECT</th>
<th>DESIGN RESPONSE</th>
</tr>
</thead>
</table>
| Socio-economic       | Stop and light rail alignment has been refined to minimise/avoid potential impacts on public open spaces such as Prince Alfred Park, Robin Thomas Reserve and Queen’s Wharf Reserve.  
Stop locations have been selected to serve key existing and future land uses.  
Light rail and pedestrian priority zone locations selected to provide a traffic-free environment with more space for pedestrian activity at Eat Street and Parramatta Square. |
| Traffic and transport| Light rail alignment has been refined to provide a grade separated crossing at James Ruse Drive to minimise impacts on the existing traffic network.  
Active transport link has been designed within or adjacent to the T6 Carlingford Line rail corridor where possible to minimise grade change and reduce interactions with traffic. |
| Property and land use| Potential property and land use impacts minimised through ongoing light rail alignment and stop design refinement.                                                                                                       |
| Trees                | Light rail alignment, active transport link and off-corridor roadworks have been refined to reduce potential impact on existing trees along the project alignment, wherever possible. Key sites of investigation included trees:  
» Within the Cumberland Hospital site  
» Along Harris Street, within Robin Thomas Reserve  
» Along George Street, within Queens Wharf Reserve. |

### 5.3 Project alignment

The project alignment scope outlined in this section is indicative and based on the current construction planning and level of design. This design is continuing to develop as more engineering and assessment work is completed and would be subject to further input from stakeholders and the community.

#### 5.3.1 Alignment and track layout

The project alignment would comprise approximately a 12 kilometre alignment from Westmead to Carlingford via the Parramatta CBD and Camellia, and would comprise a mix of both on-street and dedicated corridor running. Between Westmead and Camellia, the project alignment would generally be located along existing streets within Westmead, the Parramatta CBD and the suburbs of Rosehill and Camellia. To the north of Camellia, the project alignment would be located within the existing T6 Carlingford Line rail corridor.

The project would typically consist of dual light rail tracks utilising existing streets and the alignment of the existing rail line to Carlingford. The project alignment has been optimised to suit the levels of the existing road surface or, where applicable to a raised level (such as to avoid areas of potential flooding impacts) through the use of grade separation of the alignment. The project would also include a series of crossovers (a track crossing point that would enable a LRV to cross between tracks) and turnout points (a junction where a LRV could change between two routes) at various points along the alignment (refer to section 5.3.2). Four new bridges and modification of six existing bridge structures would also be constructed to accommodate required project infrastructure (refer to section 5.9).
An overview of the proposed light rail alignment has been shown in Figure 5.2a to Figure 5.2h. The project alignment would be subject to further refinement during detailed design (prior to construction).

5.3.2 Track form

The light rail track form would be site specific and would comprise either embedded track and ballasted track forms. Potential track forms which may be used for the project are described below. The final track forms would be determined during detailed design of the project.

5.3.2.1 Embedded track

Embedded track systems would be used for sections of the project alignment outside the converted T6 Carlingford Line. This would typically comprise on-street environments where the track would need to be trafficable by both rail and road vehicles to allow for situations such as:

» Access for emergency services vehicles
» Shared road sections at road junctions, cycle and pedestrian crossings along the project alignment.

The majority of the rail would be level with or slightly below the road surface level to provide a trafficable surface for pedestrians and other road users (except for locations such as where track turnouts or switching points are located along the project alignment). For the embedded track arrangement, the tracks would sit within a concrete base within the ground.

An indicative cross-section of an embedded track arrangement is shown in Figure 5.3.

Note: Indicative design shown. Subject to detailed design.

Figure 5.3 Typical embedded track cross-section

5.3.2.2 Ballasted track

The existing T6 Carlingford Line is currently a single track rail line with ballasted track and sleepers suitable for a suburban rail line. Ballasted track would continue to be used for this section of the project alignment, as it would be fully segregated from the road and motor vehicles would not drive on the track. Some sections along this section of the project alignment may use alternative
track materials (subject to detailed design) such as where the project is proposed to integrate with the future Camellia and Telopea town centres.

An indicative cross-section of a ballasted track arrangement is shown in Table 3.3.

Crossovers and turnouts

The project would provide a series of turnout points (a junction where a LRV could change between two routes) and crossover points (a track crossing point that would enable a LRV to cross between two parallel tracks) along the length of the project alignment. The location and layout of the proposed crossovers and turnouts would be finalised during the detailed design to facilitate efficient light rail operations.

Single track alignment at Pennant Hills Road Bridge

The project would include dual light rail tracks for the whole of the project alignment with the exception of a single track arrangement under Pennant Hills Road, Carlingford. Due to constraints associated with the width of the existing road bridge at this location, it is proposed that the track arrangement to pass under the bridge would be reduced to a single bi-directional track. Signalling equipment would be provided to allow for controlled movement of LRVs along this section of track.

The single track arrangement would also allow for the provision of the active transport link to extend under Pennant Hills Road.

5.4 Light rail stop design

5.4.1 Platform arrangements

The project would include the construction of 16 stops. Stop design considers topographical and other environmental site constraints, while remaining consistent with the overall light rail stop designs. Indicative stop names have been identified which aim to be geographically accurate, while recognising any historic or iconic values of the location and maximising community ownership. The final stop names for the project would be determined during detailed design with stakeholder and community feedback and would be required to be approved by the Geographic Names Board of NSW.
5.4.1.1 Design of the project stops

This section provides a general overview of design of the light rail stops for the project. While individual stops would each be designed to fit within their immediate surroundings, the stop layout and integration with adjoining areas would generally provide similar features and stop facilities. Stops for the project would be readily identifiable, with branding incorporated into signage and wayfinding. Stops within the light rail and pedestrian zones along Church Street and Macquarie Street would also be designed to integrate with the broader urban context of these locations (refer to section 5.6).

The platforms would be approximately 45 metres long with a range of widths between about three metres (for side platform arrangements) and about 4.5 metres (for island platform arrangements). The final placement of the platforms would be confirmed during the detailed design of the project and the requirements outlined in section 5.1. To allow for access by passengers with limited mobility or in wheelchairs, the platforms would be constructed to be approximately flush with the LRV floor level.

At least one pedestrian crossing would be provided across the light rail tracks at each stop. Each crossing would have a width that would allow for less mobile passengers (including wheelchairs) and other pedestrians to cross simultaneously. Paving for the platforms and paths would be non-slip. Warming tactile indicators would also be installed along the platforms and around the stops.

Platform arrangements

Three main types of platform arrangements are proposed through the project alignment. These platform types are identified and summarised below:

- Central island platform – Central island platforms are typically used where the existing street is limited in width. Island platforms would have a central spine that supports a wider canopy covering both sides of the central platform.

- Side platform (with adjacent traffic zone or within the Carlingford corridor) – Side platforms are typically used where the project alignment is proposed to travel along the middle of existing roadways to allow for the retention of traffic lane(s) on one or both sides of the track. Additionally, this style of stop is typically proposed along the T6 Carlingford Line where the tracks would be within a dedicated corridor.

- For stops adjacent to traffic zones, a safety barrier (such as a fence) would be provided between the back face of the platform and the traffic lane, while maintaining some degree of visual transparency and permeability. Similar barriers would be utilised to separate the dedicated light rail corridor from surrounding land uses along the T6 Carlingford Line. These elements would be further refined during detailed design. An example of this platform type is the Westmead Station stop in Figure 5.10.

- Side platform (within light rail and pedestrian zones) – The intent of the stops within the light rail and pedestrian zones along Church Street and Macquarie Street is to maximise the pedestrian flow to and from the project. Where possible, the stop platforms would be integrated into the surrounding footpath levels to create a seamless transition, allowing easy access and extending the available space within the street for pedestrians. An example of this platform type is the Eat Street stop in Figure 5.14.

Some stops may consist of a combination of the above platform types – both traffic and footpath interfaces. The final type of platform arrangements at each stop would be determined during detailed design.

5.4.2 Access to the stops

Access to each stop has been an important consideration in the development of the stop design to ensure a customer-focused service. Particular attention has been paid to providing passengers
with convenient access to the light rail network and to integrate the project with other transport modes including existing heavy rail and bus services.

The Disability Standards for Accessible Public Transport 2002 (DSAPT) is the main document that provides a set of minimum technical requirements and operational guidelines by which public transport infrastructure and vehicles can comply with the Disability Discrimination Act 1992 (DDA). Access to each of the stops would be designed to comply with (where feasibly possible) the DDA, DSAPT, the Australian Standards and National Construction Code (Part H2) (AS 1428) as well as the relevant provisions of the Building Code of Australia.

Each stop would be designed to allow accessibility for persons with a disability, other less mobile persons and passengers with prams, mobility scooters, etc. The project would also allow customers to board with guide dogs or other authorised assistance animals at all times. Additionally, the platform levels along the outer edge of the platforms within the light rail and pedestrian zones along Church Street and Macquarie Street would tie into the existing footpath levels where practicable, allowing easy access between the light rail platform and adjacent footpaths (refer to section 5.6).

For stops located outside of the light rail and pedestrian zones (such as within the road corridor or along the T6 Carlingford Line), access ramps would be provided to enable a graded approach to the stop. Where the stop is constrained, ramps would be provided to meet relevant accessibility requirements.

The exact location and detail of the access elements at each stop (such as the final placement/design of ramps, stairs, etc.) would be subject to further detailed analysis during the detailed design of the project.

5.4.3 Stop facilities

Each stop would provide a range of typical facilities including shelters, stop furniture/seating and wayfinding signage. Some stops, including interchange stops at Westmead Station and Carlingford, would include bicycle rack facilities. These facilities are described in detail below.

5.4.3.1 Signage

The project would incorporate signage that meets the standards for light rail operators in addition to applying consistent branding codes for bus, train, ferry and light rail in accordance with Transport for NSW requirements. The final branding, wayfinding and signage designs would be developed during the detailed design in accordance with existing Transport for NSW design standards and would integrate with the existing overall urban design and public domain objectives for the project.

Signage would generally include the following items on poles or totems located on and around the stop or fixed to shelter structures:

» Wayfinding or directional signage to locations around the light rail stops, including directions to interchanges with other transport modes (such as train stations or ferry wharfs).

» Statutory warning signs.

» Customer information including:
  • stop name
  • real-time service information
  • fare information
  • network map
  • locality map
  • local public transport information.
5.4.3.2 Stop furniture

A range of stop furniture and facilities would be provided at each stop and would include seating within a shelter, help points, Opal card readers, ticket machines and general waste rubbish bin(s).

Each stop would include a level of weather protection. The shelter at each stop would allow for both standing and seating space including space for wheelchairs and prams. The design of the shelters across precincts would remain similar, providing consistency across the wider project. The shelters would typically comprise a modular steel frame canopy structure with either a glazed/solid panel wall and roof to provide weather protection on each platform. In some locations along the alignment, such as along Church Street, weather protection at stops may also include the use of existing building awnings (to be determined during detailed design).

A typical example of a stop shelter design showing both island and side platform configurations is provided in Figure 5.5. This design would be subject to detailed design refinement and ongoing stakeholder engagement.

![Figure 5.5 Typical stop and shelter configurations for island (left) and side (right) platform arrangements](image)

Bicycle parking facilities would also be provided at some stops along the project alignment outside of the Parramatta CBD.

The final design and materials for the stop furniture for the project would be developed during detailed design. This would be carried out in consultation with the City of Parramatta Council and would then be applied to elements such as furniture, vertical screens and shelter canopies. Further discussion regarding the proposed public domain and urban design approach for the project is provided in section 5.12.

5.5 Project stops and interchanges

5.5.1 Overview

The locations of the stops for the project have been designed with the consideration of a range of factors including Transport for NSW design requirements, and site specific opportunities and constraints. These factors included:

» Integration with the urban environment and surrounding land uses, both existing and future planned land use (such as the Westmead Hospital Precinct, Western Sydney University, Parramatta Square, the Parramatta North Urban Transformation area and Camellia Town Centre).

» The level and type of access requirements to the project at various locations.

» Topography of the environment.
The proposed design of these stops (i.e. side or island platform arrangement) are based on the current project design and have been developed to respond to the specific opportunities and constraints including street widths, requirements for vehicular access and integration with the urban environment and public safety. Following ongoing consultation and further refinement of the stops during detailed design, the arrangement of these stops may be amended (e.g. from a side platform arrangement to an island platform arrangement) to better accommodate the stop requirements or to respond to additional design information.

Larger platforms may be provided at key transport interchanges (Westmead, Parramatta CBD and Carlingford) and at special event stops, where necessary. Special event stops would also be designed to facilitate crowd management before and following each event. Special event stops along the project alignment would be in the vicinity of Parramatta Park, Western Sydney Stadium and Camellia.

The following sections provide an overview of each stop proposed along the project alignment between Westmead and Carlingford including an indicative design for these stops. An overview of the current stop arrangements for the whole of the project alignment is shown in Figure 5.6. It should be noted that the current stop arrangements are indicative and would be subject to detailed design and ongoing consultation with relevant stakeholders.

The provision for additional future light rail stops would be safeguarded as part of the project along the Sandown Line, east of the proposed Camellia stop and along the Carlingford section of the project alignment, north of the Parramatta River to allow for potential stops (such as an additional stop near the Western Sydney University (Parramatta campus). The final location and design of these stops (should they be determined to be required) would be developed alongside strategic land use planning for these precincts and in consultation with relevant stakeholders. The construction and operation of these stops would also be subject to separate planning approval(s).
5.5.2 Westmead Precinct

Three stops are proposed within the Westmead precinct. These stops would typically service residential areas, the Westmead Health Precinct (including the Westmead Hospital, the Children’s Hospital at Westmead, and associated medical services) as well as providing transport interchange opportunities for passengers transferring to other transport modes including heavy rail (Westmead Station), bus (North-West T-way from Rouse Hill) and taxis.

5.5.2.1 Westmead Station stop

The Westmead Station stop would be the westernmost stop of the project and would be located on the eastern side of Hawkesbury Road at the intersection with Railway Parade. This stop would serve as the main interchange stop between the other modes of transport for the Westmead precinct, and would provide access for the Western Sydney University Westmead campus.

The current design for the Westmead Station stop would include three terminating tracks located adjacent to Hawkesbury Road to the west of Railway Parade, with one central island platform and
one side platform. The design would also allow for integration with the existing adjacent commercial buildings along Hawkesbury Road and Railway Parade.

An indicative section for the stop is shown in Figure 5.7 with indicative plan shown in Figure 5.8.

Note: Indicative design shown. Subject to detailed design.

Figure 5.7 Indicative section - Westmead Station stop
Note: Indicative design shown. Subject to detailed design.

**Figure 5.8**  Indicative plan - Westmead Station stop
5.5.2.2 Westmead Hospital stop

The Westmead Hospital stop would be located between Caroline Street and Helen Street and would primarily serve the catchment for Westmead Hospital and the residential area to the east of Hawkesbury Road.

The current design for the Westmead Hospital stop consists of a side platform arrangement. Pedestrian crossings would be provided at both ends of the stop, including a signalised crossing at one of the crossings.

An indicative section for the stop is shown in Figure 5.9 with an indicative plan shown in Figure 5.10.
Note: Indicative design shown. Subject to detailed design.

Figure 5.10  Indicative plan - Westmead Hospital stop
5.5.2.3 The Children’s Hospital at Westmead stop

The Children’s Hospital at Westmead stop would be located between Jessie Street and Hainsworth Street. It would primarily serve the catchment for the Children’s Hospital at Westmead and the northern portion of the residential area to the east of Hawkesbury Road.

The current design for the Children’s Hospital at Westmead stop consists of an island platform arrangement to allow for the constraints associated with providing a stop at this location, minimising adjacent land use impacts, and maintaining two road traffic lanes at this location. Pedestrian access to the stop would be provided at the southern end of the platform across Hawkesbury Road.

5.5.3 Parramatta North Precinct

5.5.3.1 Cumberland Hospital stop

The Cumberland Hospital stop would be located to the west of the intersection between Fleet Street and Factory Street in North Parramatta, within the existing Cumberland Hospital (east) site. This stop would primarily serve the proposed development associated with the Parramatta North Urban Transformation area currently being developed by UrbanGrowth NSW. The Parramatta North Urban Transformation area is proposing to accommodate around 2,700 new homes and create around 2,000 additional jobs through a mix of new commercial, retail and community facilities.

The current design for the Cumberland Hospital stop consists of a side platform arrangement. The stop would include two platforms in the centre of the proposed new street network for the Parramatta North Urban Transformation area with one lane of traffic provided on each side of the stop platforms. This arrangement would integrate with the proposed road network for the Parramatta North Urban Transformation area and the location of the proposed village centre. Pedestrian access to the stop would be provided at the western end of the platform.

5.5.3.2 Factory Street stop

The Factory Street stop would be along Church Street to the south of the intersection with Factory Street, North Parramatta. This stop would primarily serve the existing residential areas within North Parramatta. The Factory Street stop would also provide an interchange opportunity between light rail and existing bus routes which travel along Church Street.

The current design for the Factory Street stop consists of a side platform arrangement. The stop would include two platforms in the centre of Church Street with one lane of traffic provided along Church Street on each side of the stop platforms.

5.5.3.3 Fennell Street stop

The Fennell Street stop would be along Church Street between Harold Street and Fennell Street. This stop would primarily serve the commercial and retail precinct along Church Street north of the Parramatta River and the existing residential areas to the east and west of the stop.

The current design for the Fennell Street stop would have a similar platform arrangement to the Factory Street stop, being a side platform arrangement within the centre of Church Street. One lane of traffic would be provided in each direction along Church Street. A new signalised pedestrian crossing across Church Street at Fennell Street would also be provided to allow access to the stop.

The Cumberland Hospital, Factory Street and Fennell Street stops would have similar typical stop arrangements to the Westmead Hospital stop as shown in Figure 5.9 and Figure 5.10.
5.5.4 Parramatta CBD Precinct

5.5.4.1 Prince Alfred Square stop

The Prince Alfred Square stop would be located on Church Street adjoining Prince Alfred Square, a key local park in Parramatta. The stop would be located to the south of Victoria Road and would be integrated into Prince Alfred Square. The Prince Alfred Square stop would primarily service nearby commercial and retail areas along this section of Church Street and Western Sydney Stadium as well as providing an interchange point for bus services along Victoria Road. The design of this stop was developed to avoid impacting the existing memorial within the park and to accommodate potential crowds associated with events at Western Sydney Stadium.

The current design of the Prince Alfred Square stop would provide a configuration which includes two side platforms including one side platform within the centre of Church Street for LRVs travelling towards Parramatta (southbound), and a second side platform integrated with the footpath at Prince Alfred Square for LRVs travelling towards Westmead (northbound). Two lanes of traffic (one lane in each direction) would also be maintained to the east of the stop. Pedestrian crossings would be provided at each end of the stop.

The stop would also require the realignment of the pedestrian footpath and some of the existing urban domain within Prince Alfred Square to accommodate the proposed stop. The design of the stop would incorporate a new frontage to Church Street for Prince Alfred Square to replace the existing landscaped area, including new tree planting. More detailed concepts for this interface would be developed during detailed design in conjunction with City of Parramatta Council.

An indicative section for the Prince Alfred Square stop is shown in Figure 5.11 with an indicative plan shown in Figure 5.12.

Note: Indicative design shown. Subject to detailed design.

Figure 5.11  Indicative section - Prince Alfred Square stop
Note: Indicative design shown. Subject to detailed design.

Figure 5.12  Indicative plan - Prince Alfred Square stop
5.5.4.2 Eat Street stop

The Eat Street stop would be located within the proposed light rail and pedestrian zone along Church Street between Philip Street and George Street. The Eat Street stop would service a range of retail and commercial areas at the northern end of the Parramatta CBD, in addition to the range of dining and entertainment uses associated with the ‘Eat Street’ area along Church Street.

The current design of the Eat Street stop would consist of two side platforms that would each tie into the proposed light rail and pedestrian zone. Pedestrian crossings across the light rail tracks would be provided at both ends of the platforms as part of the design of the stop, connecting the platforms to the wider light rail and pedestrian zone which would be provided along this section of the alignment (refer to section 5.6 for further details).

An indicative section for the Eat Street stop is shown in Figure 5.13 with an indicative plan shown in Figure 5.14.

Note: Indicative design shown. Subject to detailed design.

**Figure 5.13  Indicative section - Eat Street stop**
Figure 5.14  Indicative plan - Eat Street stop

Note: Indicative design shown. Subject to detailed design.
5.5.4.3 Parramatta Square stop

The Parramatta Square stop would be located on Macquarie Street, between Horwood Place and Smith Street. The location of the Parramatta Square stop is under further design consideration in consultation with City of Parramatta Council to ensure efficient integration with the surrounding development and connections via the civic link. Parramatta Square stop would generally service the southern and eastern part of the Parramatta CBD, including Arthur Phillip High School to the east and Westfield Parramatta to the south. The stop would allow for interchange with existing train services at Parramatta train station (via the proposed future Civic Link, refer to Figure 5.16) and bus routes along Smith Street and Argyle Street.

Similar to the arrangement of the Eat Street stop, the current design of the Parramatta Square stop would consist of two side platforms that tie into the light rail and pedestrian zone between Horwood Place and Smith Street. A pedestrian crossing would be provided at the western end of the platform with an additional pedestrian crossing of the car park access driveway.

An indicative section for the Parramatta Square stop is shown in Figure 5.15 with an indicative plan shown in Figure 5.16.

Note: Indicative design shown. Subject to detailed design.

Figure 5.15   Indicative section - Parramatta Square stop
Note: Indicative design shown. Subject to detailed design.

Figure 5.16 Indicative plan - Parramatta Square stop
5.5.4.4 Harris Street stop

The Harris Street stop would be located on Macquarie Street, between Argus Lane and Harris Street. The Harris Street stop would service the eastern and south eastern end of the Parramatta CBD as well as Robin Thomas Reserve. The stop would also serve as the closest stop to the Parramatta Ferry Wharf and allow for interchanges with bus routes along Harris Street/MacArthur Street.

The current design of the Harris Street stop would provide two side platforms. The southern platform would tie into the existing footpath along Macquarie Street, allowing for a future link with the current development site at the intersection of Harris Street and Macquarie Street. The northern platform would be accessed via new pedestrian crossings to the east and west of the platforms. A single traffic lane (eastbound) would be retained along Macquarie Street to the north of the stop, allowing for both left and right turning movements into Harris Street.

In 2014 City of Parramatta Council approved a Masterplan for Robin Thomas & James Ruse Reserve. An updated Masterplan is in preparation, and TfNSW would develop the project so not to be inconsistent with that plan. In particular the project would preserve the feasibility of the playing fields.

An indicative section for the Harris Street stop is shown in Figure 5.17 with an indicative plan shown in Figure 5.18.

Note: Indicative design shown. Subject to detailed design.

Figure 5.17 Indicative section – Harris Street stop
Note: Indicative design shown. Subject to detailed design.

Figure 5.18  Indicative plan - Harris Street stop
5.5.5  Rosehill and Camellia Precinct

5.5.5.1  Tramway Avenue stop

The Tramway Avenue stop would be located along Tramway Avenue between Alfred Street and Arthur Street. The stop would generally serve the existing (and future) residential areas surrounding the stop as well as the existing industrial precinct to the north.

The current design of the stop would provide a central island platform arrangement with access from both ends of the platform. Single east and westbound traffic lanes would be located on either side of the stop and new pedestrian crossings would be provided at the western end of the platform.

5.5.5.2  Camellia stop

The Camellia stop would be located approximately at the current location of the existing Camellia train station (which would be removed as part of the construction of the Camellia stop). The Camellia stop would generally service the Rosehill Gardens Racecourse and the proposed future town centre at Camellia. Planning for this precinct is currently being carried out by the Department of Planning and Environment.

The current design for the Camellia stop would provide for two side platforms to be located within the existing rail corridor. The final design and location of the stop would be determined as part of the ongoing design of the Camellia redevelopment precinct in order to more effectively integrate with the proposed design of the future town centre in consultation with key stakeholders including the Department of Planning and Environment and the City of Parramatta Council.

The Camellia stop would service the Rosehill Gardens Racecourse and would be integrated into the precinct for event access purposes, with easy pedestrian access between the stop and the venue.

The Camellia stop would have similar typical stop arrangements to the Rydalmere stop as shown in Figure 5.19 and Figure 5.20 below.

5.5.6  Carlingford Precinct

5.5.6.1  Rydalmere stop

The Rydalmere stop would be located in the same location as the existing Rydalmere train station on the T6 Carlingford Line. The Rydalmere stop would primarily serve the adjoining Western Sydney University (Parramatta campus) to the west of the stop, providing a direct connection between the light rail and the university. The stop would also provide access to the residential area immediately north of Victoria Road and the existing industrial precinct to the east of the existing rail corridor.

The current design of the stop would provide for two side platforms. Footpath connections along the western side of the rail corridor to Victoria Road and the Western Sydney University (Parramatta) campus would be provided as part of the active transport link along this section of the project alignment. The existing station and platforms would be demolished as part of the project. Following completion of construction, the area to be used as a construction compound (south of the stop) would be made good. The opportunity to provide additional parking spaces near the stop would be considered during the ongoing design development.

An indicative plan for the Rydalmere stop is shown in Figure 5.19 with indicative sections shown in Figure 5.20.
Figure 5.19  Indicative plan - Rydalmere stop

Note: Indicative design shown. Subject to detailed design.
5.5.6.2 Dundas stop

The Dundas stop would be located adjacent to the existing Dundas train station along the existing T6 Carlingford Line. The Dundas stop would primarily serve the local residential catchment within the suburbs of Dundas and Oatlands, as well as Dundas Public School.

The current design of the stop provides for two side platforms. The arrangement of the stop would also include a new pedestrian footpath adjacent to the light rail alignment. This footpath would provide access to the existing pedestrian access way between the rail corridor and Kissing Point Road as part of the active transport link. Footpath connections to the east would also be provided, similar to those provided for the current train station.

The existing station building and platform (listed as part of the Dundas Railway Station Group on the State Heritage Register) would be retained as part of the project.

5.5.6.3 Telopea stop

The Telopea stop would be located immediately to the south of the existing Telopea train station on the T6 Carlingford Line. The Telopea stop would primarily serve the local residential catchment as well as the proposed future town centre at Telopea. Planning for this precinct is currently being carried out by the Land and Housing Corporation and the City of Parramatta Council.

The stop would provide a similar platform arrangement to the Rydalmere stop, with two new side platforms. Pedestrian access to the stop would be provided as part of the active transport link. The design of the stop would also allow for future integration with the new proposed plaza at this location (to be developed by others). The existing station would be demolished as part of the project.

An indicative plan for the Telopea stop is shown in Figure 5.21 with indicative sections shown in Figure 5.22.
Figure 5.21 Indicative plan - Telopea stop

Note: Indicative design shown. Subject to detailed design.
5.5.6.4 Carlingford stop

The Carlingford stop would be a terminus stop of the project, located at the existing Carlingford Station. The Carlingford stop would serve the immediate catchment of Carlingford residential and retail area and interchanging passengers from buses travelling from the north and east of Carlingford such as West Pennant Hills and Epping.

The stop would have a side platform arrangement and incorporate a widened footpath allowing for increased passenger numbers associated with passenger interchange between existing bus routes and the light rail at this stop. The stop design enables retention of the Carlingford Produce Store and does not preclude any future extension of the light rail to the north.

A new pedestrian path would provide access to the stop and the T6 Carlingford Line section of the active transport link commencing north of the stop and running south and connect to the active transport link. Associated changes to the public domain and parking around the stop would also be carried out. This would include:

- Provision of pedestrian crossings at each end of the stop.
- Integration with the proposed new town square west of the stop.
- Integration with the bus interchange to the east.
- Parking changes to the existing commuter car park, and on-road parking between the stop and Jenkins Road.

An indicative section for the Carlingford stop is shown in Figure 5.23 with an indicative plan shown in Figure 5.24.
Note: Indicative design shown. Subject to detailed design.

**Figure 5.24  Indicative plan - Carlingford stop**
5.6 Parramatta CBD light rail and pedestrian zones

The establishment of two light rail and pedestrian zones within the Parramatta CBD would be a key feature of the project. The light rail and pedestrian zones would provide a distinct public domain environment for the Parramatta CBD, allowing pedestrians to experience a traffic free environment with opportunities for improved urban domain elements (such as new/additional seating and/or landscaping) and additional space to move around. LRVs would travel through these areas at lower speeds than along other sections of the project alignment.

The project alignment would be distinguished from the surrounding environment, either through the use of a different material colour, finish, texture or size of paving, so that pedestrians could visually and texturally distinguish between the light rail tracks and areas for pedestrians.

The main light rail and pedestrian zones would be established at the following locations (refer to Figure 5.2c):

» Along Church Street between Market Street and Macquarie Street and would include about 600 metres of paved area shared between pedestrians and the light rail.

» A section of Macquarie Street between Horwood Place and Smith Street to link with the Parramatta Square pedestrian boulevard. The Parramatta Square stop would be located to provide an efficient interchange with Parramatta Station via the light rail and pedestrian zone and Parramatta Square boulevard. Access to the existing entrance to the car park at 169 Macquarie Street (adjacent to the eastern end of the zone) would be maintained during operation of the project.

Permanent infrastructure associated with the light rail would be kept to a minimum and be as transparent as possible to maintain views through the light rail and pedestrian zones. Public domain furniture, landscaping and wayfinding devices would also be provided within the light rail and pedestrian zones. The final form and location of these features would be determined during the detailed design of the project in consultation with key stakeholders, including the City of Parramatta Council. Further discussion regarding the proposed public domain and urban design approach for the project is provided in section 5.12.

Emergency vehicles would retain access to the light rail and pedestrian zones 24-hours a day. Property owners and delivery and maintenance vehicles would retain access to existing driveways and laneways within the light rail and pedestrian zones during restricted hours (to be determined during the detailed design of the project).

During operation of the project, motor vehicles would continue to be able to travel along each street which crosses Church Street where this occurs within the light rail and pedestrian zone. Signalised crossing facilities would continue to be provided at each traffic intersection to provide controlled crossing points for vehicular traffic, light rail and pedestrian movements similar to the current arrangement.

An indicative section of the light rail and pedestrian zone along Church Street is shown in Figure 5.25.
5.7 Active transport

5.7.1 Active transport link alignment

The primary active transport link proposed as part of the project would be a new connection between Carlingford and Parramatta, generally following the alignment of the existing T6 Carlingford Line and utilising the proposed James Ruse Drive Bridge. The new active transport link would connect each of the proposed light rail stops along the converted T6 Carlingford Line and the Parramatta Valley Cycleway. Figures 5.2e to 5.2g provide an overview of the indicative active transport link.

Generally, the active transport link would be located within the existing rail corridor and would travel parallel to the light rail tracks passing under the existing bridge structure at Pennant Hills Road and over the modified bridge structures at Victoria Road, Kissing Point Road and Parramatta River.

Due to space constraints, the active transport link would leave the rail corridor to the north of the Adderton Road Bridge and travel along existing roadways before re-entering the corridor about 100 metres south of Manson Street.

At locations along the length of the active transport link, appropriate cycling facilities (including bike racks) would be provided, as well as regular access points and connections to the surrounding road/active transport network. Connections to adjacent streets and other cycling infrastructure would be determined in consultation with the City of Parramatta Council during the detailed design of the project.

Indicative cross-sections of typical arrangements for the active transport link are provided in Figure 5.26 and Figure 5.27.
5.7.2 Active transport link design

The dimensions to be used for the active transport link would be consistent with relevant standards for active transport links and be designed in consultation with the City of Parramatta Council. The current design of the active transport link is based on a 3.6 metre wide pathway which would support both cycling and pedestrian activity. The active transport link may be wider in certain areas such as around stops or busier pedestrian areas such as the Western Sydney University (Parramatta) campus.

The proposed pathway at the Parramatta River truss bridge would be about 2.5 metres wide, subject to ongoing detailed design and bridge constraints. Future links across the river would be considered as part of the future Camellia Town Centre.
The surface and structural design of the active transport link would vary depending on the surrounding environment. Typical treatments for the active transport link which would be considered across the project would include:

» An asphalt or concrete surface for a majority of the pathway.

» Slightly elevated decked surfaces (to be considered during detail design) where areas of sensitive vegetation have been identified and cannot be avoided by providing a different alignment (such as land use or corridor constraints). This could avoid disturbance to tree roots, allowing trees to be retained in places.

» Existing footpaths and roadways (for bicycles) where the active transport link travels along local streets or outside of the existing rail corridor and where a shared path cannot be accommodated. Where the active transport link is proposed to be installed on existing roadways, bicycles would be segregated from motor vehicles with new painted markings on the road surface as required.

The final design of the active transport link would be determined during detailed design.

5.7.3 Access and path gradients

Access to the active transport link would be provided at a number of locations along its alignment. Indicative locations for these access points are provided on Figure 5.2e to Figure 5.2h and would be finalised during detailed design. The active transport links to the light rail stops would also be designed to be accessible for people with disabilities, enabling independent travel for all passengers accessing the light rail.

5.7.4 Safety on the active transport link

5.7.4.1 Lighting principles

Lighting would be provided along the active transport link. Lighting design would seek to minimise light spill impact on adjacent areas, especially where this would otherwise impact on residents, and would be finalised during detailed design in accordance with relevant standards. The final lighting requirements for the active transport link would be determined in consultation with the City of Parramatta Council.

5.7.4.2 Segregation and fencing principles

The project alignment and the active transport link would require a degree of segregation. The following segregation principles would typically be applied to the project:

» The minimum clearance between the track centre line and active transport link would be about two metres (subject to detailed design and operational clearance requirements which would be determined using a risk assessment for each location along the alignment of the active transport link).

» Fencing between the active transport link and the light rail alignment within the existing T6 Carlingford Line corridor where required clearances are not achievable/feasible due to space constraints within the existing rail corridor or where a risk assessment for the location requires it.

» Appropriate separation of the light rail and active transport link on the proposed new James Ruse Drive Bridge would be developed during detailed design, and may include visual differentiation and kerb treatments and/or fencing.

The final fencing designs would be determined during detailed design. The final designs would seek to minimise visual and other environmental impacts, while maintaining a suitably safe environment.

Access points to the active transport link would be provided at a series of locations along the corridor to allow for access to the surrounding road/active transport network. These connections would be provided at regular intervals (where possible) to improve community access to the active transport network.
transport link and to minimise long sections of active transport link which may pose potential (perceived) safety risks. The final connections to adjacent streets and other cycling infrastructure would be determined in consultation with the City of Parramatta Council during the detailed design of the project.

5.7.5 Signage

Signage would be provided along the active transport links to provide directional advice. The signage would meet relevant Roads and Maritime Services and City of Parramatta Council standards for bicycle signage and would also be designed in consultation with City of Parramatta Council to meet any specific urban design requirements. Signage would also be provided to assist with segregation between bicycles and motor vehicles where the active transport link travels along local streets (where required).

5.8 Road configuration changes

A large portion of the project would be integrated within the existing street environment. To accommodate the light rail and public domain infrastructure, changes would be required along the road network that would be directly impacted by the project, particularly where the project would impact on key roads within the Parramatta CBD network such as Church Street, George Street and Macquarie Street.

5.8.1 Road network changes associated with the project

Changes to the road network would include (but would not be limited to) modified or new traffic signals, upgrades to intersections, pavement works, changes to lane configuration and directional flow and/or removal of car parking to accommodate displaced traffic lanes.

The key road configuration changes along the alignment of the project are summarised below and shown on Figure 5.2a to Figure 5.2h):

» The creation of two light rail and pedestrian zones (refer to section 5.6) where general traffic is proposed to be excluded including:
  - Church Street, between Market Street and Macquarie Street.
  - Macquarie Street, between Horwood Place and Smith Street.

» Modifications to the operation of Hawkesbury Road and Hainsworth Street in Westmead including:
  - Removal of right-turn movements at some intersections between Darcy Road and Hainsworth Street for vehicles travelling northbound along Hawkesbury Road.
  - Permitted right-turns onto Hawkesbury Road to be removed at some intersections including Queens Road and Jessie Street.
  - Removal of all current parking provisions along Hawkesbury Road and existing parking provisions along Hainsworth Street west of Bridge Road.
  - New pedestrian signals to be located at the Westmead Hospital stop and Children’s Hospital at Westmead stop.
  - New traffic signals to be located at the entrance to Westmead Hospital Plaza and the intersection of Bridge Road and Hainsworth Road.

» Incorporation of the project alignment within the proposed road network for the Cumberland Hospital and the Parramatta North Development area. This would be carried out in consultation with Health NSW and UrbanGrowth NSW respectively.
Modifications to Factory Street including:

- Restriction of the Factory Street/Fleet Street/New Street intersection to left-in, left-out only with no through movement between New and Fleet Streets (a fourth western leg of this intersection is proposed to be constructed as part of the Parramatta North Development area).
- Signalisation of the Factory Street/O’Connell Street intersection maintaining the current restriction on right turns.
- Restriction of the Factory Street/Galloway Street intersection to left-in, left-out only.
- Removal of current parking provisions between Fleet Street and Church Street.

Modifications to Church Street including:

- Removal of the northbound right-turn arrangement from Church Street into Factory Street.
- Removal of the dedicated northbound and southbound bus-only lanes, south of Factory Street.
- Reconfiguration of existing traffic lanes between Factory Street and Market Street to maintain one lane of traffic in each direction with turning lanes at key intersections.
- Removal of all existing parking (including temporary parking) along Church Street.

Modifications through the Parramatta CBD including:

- Restriction of traffic along Macquarie Street to one eastbound lane between Church Street and Harris Street with the exception of the section between Horwood Place and Smith Street which would be light rail only.
- Existing access from Macquarie Street to Civic Place to be removed.
- Removal of current parking provisions along Macquarie Street and along George Street between Harris Street and Alfred Street.
- Closure of Arthur Street at Tramway Avenue.

Modifications through Rosehill and Camellia including:

- Removal of current parking provisions along Tramway Avenue and Grand Avenue North.
- Reconfigure right hand turn from James Ruse Drive into Grand Avenue North.
- Signalisation of the intersection of the light rail and Grand Avenue, at the entrance to the stabling and maintenance facility.

5.8.2 Off-corridor road network changes

In addition to the road and traffic changes identified along the project alignment, a series of additional road and traffic changes would be required to manage the interactions between the proposed road alterations associated with the project, and the resultant changes this would have on the operation of the surrounding road network. The changes proposed are listed below and summarised on Figure 5.2b and Figure 5.2c):

Westmead:
- Provision of a new right hand turning storage lane from Hawkesbury Road into Railway Street.

North of Factory Street:
- Modification of an existing signalised intersection at Barney Street and Church Street with provision of a double right hand turning lane from Church Street (southbound) to Barney Street. Two lanes westbound to be provided in Barney Street.
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- Provision of a new signalised intersection at Board Street and Church Street with double left hand turning lane from Board Street to Church Street. Two lanes eastbound to be provided in Board Street.
- Line marking along Bamey Street (between Church Street and O’Connell Street) to allow for two traffic lanes eastbound and two traffic lanes westbound.
- Removal of existing on-street parking along Broad Street and Bamey Street between Church Street and O’Connell Street.
- Creation of a dedicated right turn bay (Church Street northbound) between Dunlop Street and By Street.
- Upgrade O’Connell Street to three lanes between Bamey Street and Board Street (two northbound and one southbound).
- Provision of new traffic signals at O’Connell Street and Bamey Street.
- Provision of four traffic lanes and strip widening of O’Connell Street from Factory Street to Bamey Street (two lanes in each direction).

» South of Factory Street:
- Provision of four traffic lanes on O’Connell Street between Factory Street and Albert Street (two lanes in each direction), including kerb adjustments (where required).
- Removal of on-street parking along O’Connell Street between Factory Street and Albert Street.
- Modification to the current Albert Street/O’Connell intersection including traffic signal adjustments.
- Provision of new traffic signals at the intersection of Fennell Street and O’Connell Street.
- Upgrade of the existing O’Connell Street/Victoria Road intersection including provision of a dual left turn lane (southbound) and widening of Victoria Road (southern kerb).
- New line marking and signage to the intersection of Market Street and Marsden Street.

» South of Parramatta River:
- Reconfiguration of George Street between O’Connell Street and Harris Street to allow for bi-directional traffic movements, including removal of some parking.
- Remove heritage tram tracks and re-profile street cross fall to allow for truck and tall vehicle movements (where required).
- Signal adjustments and line marking along Marsden Street, Smith Street, Charles Street and Harris Street to allow bi-directional flow.
- Reconfigure line marking, signposts and signal phasing on Marsden Street to facilitate eastbound traffic to access George Street and Macquarie Street.

» Provision of bus priority (changes to traffic signalling) to and from Victoria Road along Wilde Avenue.

» Removal of left hand turning lane along Arthur Street at River Road West.

» Signalisation of the crossing point and intersection upgrade of the light rail crossing at Grand Avenue adjacent to the proposed stabling and maintenance facility.

Further details regarding the proposed traffic access management changes resulting from the project are provided in Chapters 11 to 15 and Technical Paper 2 and Technical Paper 3 (refer Volume 2). Alternate designs to transition traffic from Church Street to O’Connell Street are currently under consideration, including using alternate streets such as Bamey Street. Opportunities to
improve traffic outcomes, rationalise property impacts and reduce impacts along O’Connell Street are also under consideration.

5.9 Bridges, structures and other works

5.9.1 Bridges and other structures

As described previously, the project would generally be located along existing streets within the Greater Parramatta locality, typically responding to the existing topography of these streets. However, the project would cross over or travel under a variety of roads and waterways. This would require a series of new structures including the following infrastructure:

» New bridges at:
   - North Parramatta, adjacent to the bridge over Parramatta River (the North Parramatta Bridge).
   - Clay Cliff Creek and James Ruse Drive, Rosehill (James Ruse Drive Bridge).
   - Vineyard Creek, Rydalmere (Vineyard Creek Bridge).
   - Kissing Point Road, Dundas (Kissing Point Road rail bridge) adjacent to the existing bridge to accommodate the light rail.

» Widening or modifications to existing bridge structures at:
   - Church Street, Parramatta (Lennox Bridge).
   - Parramatta River, Camellia/Rydalmere (Parramatta River Bridge).
   - Victoria Road, Rydalmere (Victoria Road Bridge).
   - Kissing Point Road, Dundas (Kissing Point Road Bridge) which would be repurposed as part of the active transport link.
   - Adderton Road, Telopea (Adderton Road Bridge).
   - Pennant Hills Road, Carlingford (Pennant Hills Road Bridge).

» Changes to other structures along the alignment such as culverts and other drainage structures. The key works associated with these structures are described in greater detail below. The location of the proposed bridges and other structures are indicated on Figure 5.2a to Figure 5.2g.
5.9.1.1 North Parramatta Bridge

The project would include the construction of a new bridge structure over the Parramatta River at North Parramatta. This would be located about five metres to the south of the current bridge structure. The new structure would be about 60 metres in length and would be located parallel to the alignment of the current bridge. The bridge would include a new, wider structure to support:

» Two light rail tracks (which would also be used by emergency vehicles only).
» Incorporation of an active transport link within the new bridge structure.

An indicative cross-section of the new bridge is provided in Figure 5.28.

Note: Indicative design shown. Subject to detailed design.

Figure 5.28 North Parramatta Bridge cross-section (indicative)
5.9.1.2  Lennox Bridge

Lennox Bridge is an existing arch bridge over the Parramatta River on Church Street. The bridge consists of a single span arch which was constructed in 1839 and is listed on the NSW State Heritage Register.

For the project, the existing bridge would be retained, including the recently constructed active transport portals through the approaches, and would serve as a crossing for light rail and pedestrians only (i.e. no general road traffic, with the exception of emergency vehicles). The existing road formation would be excavated below the existing road surface to allow for the installation of the light rail tracks. The existing pedestrian pathway would be retained to provide access for pedestrians and active transport users.

An indicative cross-section of the Lennox Bridge crossing is provided in Figure 5.29.

Note: Indicative design shown. Subject to detailed design.

Figure 5.29  Lennox Bridge cross-section (indicative)
5.9.1.3 James Ruse Drive Bridge

A new bridge would be constructed to span Clay Cliff Creek and James Ruse Drive between Albert Street, Parramatta (near the intersection of Tramway Avenue) and Grand Avenue North (in the vicinity of the existing Camellia Station). There is currently a small pedestrian and utilities structure at Clay Cliff Creek which would require removal (including utilities relocation) as part of the project.

The James Ruse Drive Bridge would consist of a curved bridge deck on concrete piers supporting the two light rail tracks as well as an active transport link on the northern side of the bridge. The bridge would consist of around eight spans with a total length of about 240 metres and a maximum bridge height of around 10.5 metres (including anti-throw screens) above the existing surface level of James Ruse Drive. The bridge has also been designed to allow for a possible future upgrade (widening) to James Ruse Drive (not part of this project).

An indicative illustration of the proposed James Ruse Drive Bridge is provided in Figure 5.30.

Note: Indicative design shown. Subject to detailed design.

Figure 5.30 James Ruse Drive Bridge cross-section (indicative)
5.9.1.4 Parramatta River Bridge

The existing truss bridge over Parramatta River along the T6 Carlingford Line consists of a three span steel truss structure and caters for a single heavy rail track. The red face brick arch abutments, remnants of a past bridge structure, are listed on the section 170 Heritage Register.

To accommodate the project, the existing structure would be retained and refurbished. This would involve the replacement of the main structures of the end spans and the widening of bridge approaches and abutments following the deconstruction of the heritage listed brick arch abutments. The existing single heavy rail track would be replaced with two new light rail tracks and a cantilevered structure would be constructed to the west to accommodate the active transport link (refer to section 5.7 above).

An indicative cross-section of the Parramatta River Bridge is provided in Figure 5.31.

Note: Indicative design shown. Subject to detailed design.

**Figure 5.31 Parramatta River Bridge cross-section (indicative)**

5.9.1.5 Vineyard Creek Bridge

The existing bridge over Vineyard Creek comprises a two span concrete bridge about 18 metres in length. To accommodate the project, the existing structure would be replaced with a longer two span bridge. The new structure would carry two light rail tracks as well as an active transport link, located on the western side of the bridge.
5.9.1.6 Victoria Road Bridge
The existing Victoria Road Bridge consists of a three span precast structure, with the existing T6 Carlingford Line passing under the bridge.

Both vertical and horizontal clearances would be adequate for the safe passage of the light rail and the active transport link through the central span. Minor works to the bridge, including a new safety screen, would be required to meet required safety standards.

5.9.1.7 Kissing Point Road Bridge
The existing Kissing Point Road Bridge would be retained to accommodate the active transport link. An additional bridge would also be constructed in order to accommodate the two light rail tracks. The new bridge structure would be constructed on the north western side of the existing bridge. The new structure would have a similar configuration to the existing bridge, comprising three spans of about 17 metres and one span of about 30 metres.

5.9.1.8 Adderton Road Bridge
The existing Adderton Road overbridge is a single span precast structure. The existing structure is adequate for two light rail tracks to pass under Adderton Road and minor modifications would be carried out to provide additional protection safety screen attachments to the bridge structure.

The active transport link would deviate from the existing rail corridor in the vicinity of the bridge, as there is insufficient space for the path to pass under Adderton Road (refer to Figure 5.2g).

5.9.1.9 Pennant Hills Road Bridge
The existing structure which supports Pennant Hills Road over the existing T6 Carlingford Line is a three span bridge supported on reinforced concrete abutments and steel trestle piers. One single track currently runs through the centre span of the bridge, with steep embankments located within the two end spans.

The single track would be maintained at this location (refer to section 5.3.2). Minor works to the bridge piers would be required to meet required safety standards, and the eastern embankment would be excavated to accommodate the active transport link.

5.9.1.10 Other structures
To accommodate the project, a number of modifications would be required to culverts that provide vehicular or pedestrian access:

» Replacement of a vehicular underpass at Camellia in the vicinity of the Parramatta River Bridge (known as James Hardie underpass) (refer to Figure 5.2d).

» Replacement and realignment of a pedestrian underpass at Leamington Road, Dundas (refer to Figure 5.2g).

5.10 Existing train line closures

5.10.1 Sandown Line closure
As part of the project, the disused Sandown Line (east of the connection with the existing T6 Carlingford Line) would be closed in accordance with Transport Administration Act 1988.

The existing track and ancillary infrastructure within the Sandown Line would be removed, and part of the line (around 800 metres of the Sandown Line east of Camellia Station) would be converted to a dedicated light rail corridor (as part of the project or in future stages of Parramatta Light Rail).
The long-term use of the eastern section of the line (east of the proposed connection to the stabling and maintenance facility) that is not required for the project would be considered in future urban planning for the Camellia precinct. The works proposed along the Sandown Line would not preclude any future extension of the light rail further to the east.

5.10.2 T6 Carlingford Line closure

As part of the project, the T6 Carlingford Line between Parramatta Road and Carlingford would be closed in accordance with Transport Administration Act 1988. This would include the removal of rail assets at the existing level crossing such as signalling and boom gates (excluding tracks), and installing gates to restrict entry to the rail corridor. This would require an order under section 99A(1A) of the Transport Administration Act 1988.

It would also include closure of Rosehill Station. Rosehill Gardens Racecourse would be serviced by the nearby Camellia stop, which would be located approximately 450 metres north of Rosehill Station and around 210 metres north of Rosehill Gardens Racecourse. The section of track between Parramatta Road and Clyde would continue to be available for use by Sydney Trains.

At this stage, consideration is being given (pending further investigations during detailed design) to whether the closure of the T6 Carlingford Line between Camellia (south of Grand Avenue North) and Parramatta Road would also include the removal of the rail infrastructure (such as tracks, station platforms associated with Rosehill Station, etc.) pending further investigation during design development.

5.11 Ancillary facilities, light rail infrastructure and services

5.11.1 Power supply and substations

5.11.1.1 Overhead wiring and catenary pole arrangement

The project would use poles and OHW throughout the alignment to supply electricity to the LRVs. The design proposes to utilise a centre pole arrangement (i.e. poles located towards the centre of the alignment) for a majority of the alignment (except within the vicinity of the Westmead Station stop and Parramatta North), with these structures placed so as not to obstruct existing infrastructure, footpaths or cycle routes.

The OHW structures would typically comprise foundations and masts, contact wire, tensioners, conductors, cut-in insulation and bridge attachments (as required) to the required standards for light rail construction and operation. The feeding structures would also have appropriate mechanical protection for the high voltage feeder cabling and earthing of the poles.

The OHW structure types would depend on specific site characteristics along the length of the project. It is not proposed to affix OHW fixtures to existing buildings along the project alignment. The tracks and other infrastructure associated with the project would also be earthed so as to minimise the risk of any potential earth leakage.

The final configuration and design of the OHW and catenary pole arrangement would be determined during the detailed design in consultation with the City of Parramatta Council and other key stakeholders. This would include consideration of elements such as the integration of street lighting and traffic signals to develop a visually acceptable design for all stakeholders. The opportunity to operate selected sections of the project wire-free is currently being investigated as part of the ongoing detailed design of the project.
5.11.1.2 Electrical supply substations

A direct current (DC) electrical charge would power the LRVs, supplied from the existing electrical (Endeavour Energy) supply network. It is intended that high voltage bulk power supplies would be taken from Endeavour Energy’s 11 kV network with each substation being connected to separate Endeavour Energy substations in order to maximise reliability.

Eight substations would be required for the project (inclusive of a proposed substation within the stabling and maintenance facility at Camellia). These locations are identified in Figure 5.2a to Figure 5.2g. The final locations would be refined during detailed design.

The substations would provide 750-volt DC electricity supply and would typically require about 60 to 80 square metres of area, to allow for maintenance access, crane access for equipment replacement, parking, etc. A typical substation would comprised a pre-fabricated, modular building (about 12 metres by 4.5 metres with a height of around four metres) which can be fitted with an external facade to blend into specific local, urban environments (refer to Figure 5.32).

Note: Indicative example shown of Lindfield substation, Lindfield

Figure 5.32 Example substation arrangement

The substation within the Parramatta CBD would be located within an existing building which currently contains an unused Endeavour Energy substation in Barrack Lane, Parramatta.

5.11.2 Security and safety

All stops along the project alignment would be lit and located in highly visible areas which allow for both passive and active security systems for customers. A number of security measures would be provided including:

- Closed circuit television (CCTV) cameras for passenger security and to deter vandalism. The CCTV system would provide a direct link between each stop and the operations control centre (at the stabling and maintenance facility) for the light rail network. It is envisaged that CCTV cameras would be provided at locations including:
  - stops
  - substations
  - the stabling and maintenance facility at Camellia
along designated staff walking routes between staff facility and driver boarding locations (where these are not inside the stabling and maintenance facility)

on-board the LRVs.

An appropriate level of lighting would be provided to maximise passenger safety (at each stop, along access paths and the active transport link) and to enable the operation of CCTV. Lighting levels would be determined during the detailed design of each stop.

An emergency telephone/help point and warning signs would be provided at each stop.

Crime prevention through environmental design (CPTED) principles have been, and will continue to be applied throughout the design of the project, in particular in the design of, and key access route to the stops. CPTED refers to the application of a range of design initiatives to a site, location or area to maximise crime prevention and minimise the potential for that site to facilitate and support criminal behaviour. The consideration of CPTED is based on four key principles: surveillance (both active and passive); access control, territorial reinforcement; and space management.

A summary of how the project has considered the principles of CPTED and the measures that would be implemented, is provided in Table 5.4.

<table>
<thead>
<tr>
<th>CPTED PRINCIPLE</th>
<th>HOW THE PROJECT HAS CONSIDERED CPTED PRINCIPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surveillance</td>
<td>The design for the project has considered the use of passive and active methods of surveillance. Active measures for the project would include:</td>
</tr>
<tr>
<td></td>
<td>» CCTV camera coverage at stops and integration with other systems where possible (such as City of Parramatta Council CCTV systems)</td>
</tr>
<tr>
<td></td>
<td>» Ensuring adequate street and stop lighting including access and pathways (such as the active transport link along the T6 Carlingford Line)</td>
</tr>
<tr>
<td></td>
<td>» Coordinating street lighting with stop lighting to ensure consistent coverage.</td>
</tr>
<tr>
<td></td>
<td>Passive measures which have been incorporated into the project include:</td>
</tr>
<tr>
<td></td>
<td>» Maintaining clear sight lines across platforms</td>
</tr>
<tr>
<td></td>
<td>» Reducing clutter and creation of dark corners through lightweight stop design (e.g. shelter structures)</td>
</tr>
<tr>
<td></td>
<td>» Placing stops so as to maintain clear sight lines to/from stops to the surrounding streets/public domain areas.</td>
</tr>
<tr>
<td>Access control</td>
<td>Access to stops is critical to the success and function of the project. This includes the provision of safe access from adjacent streets and surrounding areas. Measures for the project include:</td>
</tr>
<tr>
<td></td>
<td>» Ensuring stops are identifiable and legible to find, at street level without obstructions, where possible</td>
</tr>
<tr>
<td></td>
<td>» Compliance with accessibility requirements to provide easy access</td>
</tr>
<tr>
<td></td>
<td>» Designing out the need for fencing where possible – to avoid creation of areas where someone can be trapped</td>
</tr>
<tr>
<td></td>
<td>» Locating stops away from direct impact on private property, where possible/reasonable.</td>
</tr>
</tbody>
</table>
### CPTED PRINCIPLE

<table>
<thead>
<tr>
<th>CPTED PRINCIPLE</th>
<th>HOW THE PROJECT HAS CONSIDERED CPTED PRINCIPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Territorial reinforcement</td>
<td>To ensure that the stops are defined as safe public spaces, the following measures would be incorporated into the project:</td>
</tr>
<tr>
<td></td>
<td>» Designing all stops and pathways to be open in nature, and where landscaping exists or is proposed, it does not obstruct views nor create hiding spots</td>
</tr>
<tr>
<td></td>
<td>» Maintaining sight lines</td>
</tr>
<tr>
<td></td>
<td>» Clear and identifiable branding and signage</td>
</tr>
<tr>
<td></td>
<td>» Ensuring that the stop designs clearly delineate between the project and adjoining areas (such as through the use of different materials etc.)</td>
</tr>
<tr>
<td></td>
<td>» Notification of CCTV presence.</td>
</tr>
<tr>
<td>Space management</td>
<td>Spaces which are well managed and maintained enhance feelings of safety, reduce illegitimate use, and increase legitimate use. Measures for the project include:</td>
</tr>
<tr>
<td></td>
<td>» All stops and pathways designed to provide an open plan design including adequate proximity between adjoining vegetation</td>
</tr>
<tr>
<td></td>
<td>» Designing out potential hiding spaces including obstruction of views.</td>
</tr>
</tbody>
</table>

A full review and assessment in accordance with the CPTED principles (surveillance, access control, territorial reinforcement and space management) would be carried out for each stop and along the project alignment during detailed design.

#### 5.11.3 Other services

Infrastructure for services required along the project alignment would include the following:

» Cabling for communications systems (e.g. for CCTV system, emergency telephones/help points, public address, lifts, passenger information displays, signaling and electrical supply for LRVs.

» Cable paths (including access pits) for the above cabling in addition to connection of substations to electrical supply locations (refer to section 5.11.1).

» Trackside signaling equipment (e.g. post-mounted signals, location cabinets, track circuits, etc.).

Conduits to allow for the future installation of ‘third party’ services may also be provided along and across the project alignment during construction. Transport for NSW would collaborate with the City of Parramatta Council, utility service providers and other stakeholders to ensure utility works align with any requirements for future projected works, where practical. This would reduce the risk of future underground services requiring works that may impact the operation of the project. The design, location and provision for these services would be determined during detailed design.

#### 5.12 Public domain and urban design

##### 5.12.1 Urban design overview

To achieve urban design excellence by the project, Urban Design Requirements are currently being prepared by Transport for NSW. This document will establish the desired urban design and public domain outcomes for the project at varying scales, and would guide the urban and landscape design during detailed design.
The Urban Design Requirements cover four focus areas:

» City Scale - A this scale, Parramatta Light Rail would be positioned within the history and context of Parramatta and its evolving context including the NSW Government’s strategic vision for Parramatta; current and future city scale projects; and significant developments. The overall Parramatta Light Rail design strategy for the corridor would be described and address the project response to landscape setting; urban context, corridor wide transport network and catchments. Information would be strategic and illustrative.

» Precinct Scale - At the precinct scale, project alignment would be broken down into specific precincts based on character and use. Precincts would include a precinct overview and vision, pedestrian catchments and movements, urban design principles and a public domain strategy.

» Streets, Stops and Interchanges - Stepping down to a pedestrian scale, this section would define street character and customer experience and would include stop integration information and scaled street and public domain integration. Stop drawing plans (to scale), description of key characteristics and typical arrangement and special conditions would be documented.

» Design and Operational Requirements - There are many elements along the corridor that would be informed by design and operational requirements. This section would include a register of stop elements including furniture and cabinetry, stop materials, wayfinding, lighting and corridor wide parameters such as fencing and special safety requirements.

To achieve integration and good urban design outcomes for the project and adjacent proposed land uses, the Urban Design Requirements are being prepared in close collaboration with City of Parramatta Council as well as relevant NSW government agencies and key stakeholders (such as NSW Health, UrbanGrowth NSW, Western Sydney University and NSW Land and Housing Corporation). This includes a Joint Urban Design Working Group with City of Parramatta Council, established in March 2017. The project (and Urban Design Requirements) would also continue to be subject to the Transport for NSW Design and Sustainability Panel, chaired by the Government Architect at key phases of project development.

The Urban Design Requirements would be used to inform Transport for NSW’s procurement stage of the project. The final document is scheduled to be completed by late 2017.

5.12.2 Revitalisation of the public domain

Some areas of the public domain would be impacted as a result of the construction of the project. These areas include Hawkesbury Road, the Parramatta North precinct, Church Street (including the Eat Street precinct to the south of Parramatta River), Prince Alfred Square, Robin Thomas Reserve, Queens Wharf Reserve and the existing T6 Carlingford Line. During construction, limited opportunities for revitalisation of these areas would occur; however, sequencing of construction activities would be managed to ensure that impacts on public spaces are minimised. Where possible, construction works would also be sequenced to allow for progressive opening of upgraded public domain areas.

Clear signage around construction compounds utilising open spaces or other public domain areas would be provided advising of the project, timing, access arrangements and contact details for complaints. Further potential impacts and the proposed mitigation measures during construction are detailed in each of the precinct chapters in Chapters 11 to 15.

Following construction of the project, areas of the public domain and other public spaces utilised or impacted during the construction of the project (such as for construction compounds) would be reinstated. Areas of potential revitalisation of the public domain and existing public spaces which would be considered include:

» Provision of the light rail and pedestrian zones along Church Street and Macquarie Street.

» Reinstatement or domain improvements for impacted open spaces such as those at Prince Alfred Square, Robin Thomas Reserve and Queen’s Wharf Reserve.
 Provision of new public domain elements (such as stop and track material designs) which will allow for future integration with proposed future developments including:

- The Parramatta North Urban Transformation area
- The Camellia Town Centre
- Telopea Town Centre Masterplan.

To assist potential opportunities for revitalisation of existing public spaces and the public domain along the project alignment, a series of urban design objectives and principles have been developed for each precinct which would assist in guiding urban design outcomes during the detailed design of the project. These objectives and principles are shown in Table 5.5 below.

Table 5.5 Project urban design principles

<table>
<thead>
<tr>
<th>PROJECT ELEMENT/OBJECTIVE</th>
<th>KEY URBAN DESIGN PRINCIPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project-wide urban design objectives</td>
<td>Draw on site and context analysis to inform design direction. Provide connectivity and permeability for pedestrians. Integrate the project with the surrounding area. Maximise the amenity of the public domain. Protect and enhance heritage features and significant trees where possible. Design an efficient and functional transport solution which enhances and contributes to local amenity and prosperity. Provide value for money design solutions that achieve high quality low maintenance architectural and urban design outcomes that have longevity.</td>
</tr>
</tbody>
</table>
| Project-wide place-making outcomes | Parramatta Light Rail would catalyse the development and renewal of dense, liveable and jobs-rich urban precincts in western Sydney. The project would: 
  » Deliver high quality public domain integration with urban centres along the corridor, including Westmead, Parramatta North Urban Transformation area, the CBD extension for North Parramatta, Parramatta CBD and the proposed new town centre at Camellia. 
  » Enhance pedestrian permeability with new or upgraded connections across the T6 Carlingford Line at Rydalmere, Dundas, Telopea and Carlingford, as well as a new grade-separated pedestrian link over James Ruse Drive to the new Camellia Town Centre. 
  » Build on the existing character and commercial success of Parramatta’s ‘Eat Street’ with a centrally located light rail stop complemented by increased pedestrian space at the southern end, new paving, street tree planting and additional opportunities for outdoor dining. 
  » Provide frequent evening services to ensure communities are well served, safe and accessible late into the evening, with services until 1 am. 
  » Contribute to the health, liveability and transport choice of communities by providing around six kilometres of new separated active transport link, connecting to major regional cycle routes such as the Parramatta Valley Cycleway. |
<table>
<thead>
<tr>
<th>PROJECT ELEMENT/OBJECTIVE</th>
<th>KEY URBAN DESIGN PRINCIPLES</th>
</tr>
</thead>
</table>
| Stop design | The light rail stops would consist of elements that will be integrated into the local context. The following principles would apply to stop design:  
  » Sited in consideration of their location.  
  » Customer centred design.  
  » Low visual impact with a simple and elegant approach to shelter design.  
  » Modular and scalable design consistent with Transport for NSW’s kit of parts for stops.  
  » Integrated architecture, urban design and landscape design elements.  
  » Maximise accessibility and pedestrian priority. |
| Active transport | The project would provide an active transport link between the Carlingford stop and Alfred Street, Parramatta, as well as active transport connections at various locations along the corridor. The following principles would apply:  
  » Provision of a high quality active transport link that would include lighting and landscaping.  
  » Provide connections and links to key destinations.  
  » Design to provide a safe and user friendly combined cycle and pedestrian environment.  
  » Minimise the removal of trees where possible.  
  » Utilise existing landform and minimise earthworks where possible. |
| Public art | Public art will be an integrated part of the design, construction and operation of the system. During construction, hoarding design could incorporate public art. Opportunities to include public art would be investigated at stops and other project structures to aid place making and to enhance local amenity. |
| Water sensitive urban design | Water Sensitive Urban Design (WSUD) principles would be investigated for use along the corridor. This may include:  
  » Minimise loss of existing permeable surfaces.  
  » Optimise the use of permeable surfaces where possible.  
  » Consider stormwater management as part of the unified design of the project.  
  » Investigate opportunities to implement WSUD elements within verges and medians.  
  » Incorporate bioswales within the project where reasonable. |
| Landscaping | The following landscape principles would be considered through the detailed design:  
  » Provide hard and soft landscapes that meet or enhance existing civic quality and create an attractive public realm around stops.  
  » Consideration of clustering elements to seamlessly integrate into the streetscape and avoid visual clutter.  
  » Suitable species selection that responds to the context and reflects the existing character along the corridor.  
  » Minimise the removal of existing trees where possible, and implement a replacement strategy where offsets are required. |
<table>
<thead>
<tr>
<th>PROJECT ELEMENT/OBJECTIVE</th>
<th>KEY URBAN DESIGN PRINCIPLES</th>
</tr>
</thead>
</table>
| Sustainability            | The following sustainability principles would be considered through detailed design:  
» The inclusion of WSUD elements where possible.  
» Lifecycle assessment of selected proposed materials.  
» Achieving clear and direct walk-up space connections, signage and wayfinding and facilities which promote access to the corridor.  
» Design stop canopies to ensure sufficient levels of shade with the selection of appropriate materials.  
» Utilisation of waterways and existing topographic features as green corridors and active transport opportunities for walking and cycling. |

5.13 Stabling and maintenance facility

A stabling and maintenance facility would be provided at 6 Grand Avenue, Camellia for the storage of LRVs and to allow for ongoing maintenance of the entire LRV fleet. The stabling and maintenance facility would be located on a former industrial site adjacent to the Rosehill Gardens Racecourse within the Rosehill and Camellia precinct (refer to Figure 5.2e). The stabling and maintenance facility would be accessed via an alignment along the former Sandown Line.

The major features of the stabling and maintenance facility would include:

» Stabling tracks and sidings, including overnight stabling. This would include storage of LRVs during non-peak and overnight periods prior to returning to service (or for storage overnight) for up to 16 LRVs with ultimate capacity of around 40 LRVs (to allow for future capacity requirements). Nightly preparation inspection by a driver would also be carried out at the stabling area.

» A LRV cleaning area (including interior and exterior cleaning of LRV).

» Maintenance and repair facilities (contained within a single maintenance building) for LRVs, LRV infrastructure and emergency recovery, including:
  • service and inspection facilities
  • workshops
  • underfloor wheel lathe and inspection pits
  • bogie lifting and storage areas
  • vehicle sanding plant (including sand storage silo)
  • vehicle wash facility.

» Infrastructure storage areas (internal and external) for equipment associated with maintenance of the light rail network including track, OHW materials, signalling infrastructure as well as spare bogies and storage for ancillary vehicles, such as forklifts and bogie trolleys.

» Water detention basin(s).

» An operations control centre for the network.

» Staff facilities, including administration and office areas.

» A substation for LRV operations.
The facility would operate 24 hours, seven days a week. An indicative layout of the stabling and maintenance facility is shown in Figure 5.33 with indicative sections provided in Figure 5.34 and Figure 5.35.

In addition to the storage of LRVs, the stabling and maintenance facility would provide facilities for maintenance, repair, refurbishing, upgrading, stabling, cleaning and a base for infrastructure maintenance activities. The maintenance facility would consist of up to five maintenance inspection tracks (inclusive of two tracks for future capacity requirements) within a two-storey maintenance building.

The maintenance building would provide for both general and more major periodic maintenance activities (such as bogie/underframe inspections and other major equipment exchange). The maintenance building would include workshops and storage areas, inspection pits and elevated walkways (for inspection of LRVs), a wheel lathe, bogie pit and bogie wash, paint shop and crane lifting facilities. Light maintenance or repair work would include LRV sanding (topping up the sand boxes within the LRVs for use on wet/slippery tracks). Maintenance operations would include undertaking inspections, maintenance and component exchange on LRVs.

Sand and wash plants would be located on the entry track of the facility. This would allow sand replenishment (refer to section 5.15.1) and washing, if needed, to be carried out as LRVs enter the stabling and maintenance facility.

Administration and staff facilities as well as the operations control centre for the light rail network would be located within the maintenance building. Parking for about 125 cars for staff and visitor use would be provided within the site, along with maintenance vehicle parking.

The stabling and maintenance facility layout has been configured to provide LRV access/egress to the project alignment via an entry/exit point on Grand Avenue. Vehicular access would be provided via separate access/egress points on Grand Avenue (for general staff access) and Colquhoun Street (for delivery and large vehicle access). An internal access road network would provide for general circulation while providing appropriate separation to LRVs (with limited crossing points). The site would also be fenced from general public access and lighting would be used at night for safety and security of the site.
Note: Indicative design shown. Subject to detailed design.

Figure 5.33 Camellia stabling and maintenance facility - indicative layout
Note: Indicative design shown. Subject to detailed design.

**Figure 5.34**   Indicative elevation of the stabling and maintenance facility layout (maintenance shed and train wash facilities)

Note: Indicative design shown. Subject to detailed design.

**Figure 5.35**   Indicative section of the stabling and maintenance facility (maintenance shed)
To accommodate the development of the stabling and maintenance facility, and reduce the potential for interaction with contaminated material during construction, the finished level of the stabling and maintenance site would be raised by about two metres. This would be achieved through the placement of appropriate fill material across the site to raise the existing level.

The site for the stabling and maintenance facility currently requires remediation of any existing contaminants to make the site suitable for future use in accordance with the current zoning. Subsurface remediation of the site is being carried out to make the site suitable for a broad range of industrial and commercial uses. The subsurface remediation is subject to a separate environmental assessment and approvals process. It does not form part of the project.

5.13.1 Operational staff

It is anticipated that up to 130 to 160 full-time equivalent staff would be required to operate and maintain the project, including the operation and maintenance of LRVs, stops and tracks. Staffing would be subject to future operator requirements.

5.13.2 Provision of over-facility development

Opportunities for over-facility development at the stabling and maintenance facility could be explored as part of the ongoing design development for the project. Any approval for development over the stabling and maintenance facility outside of the works required for the project would be subject to separate environmental planning approvals and would not form part of the project.

5.14 Property acquisition

The project would require the acquisition of a number of properties, including series of full property acquisitions and partial property acquisitions (many of which would only require a small area of land).

All property acquisition would be managed in accordance with the Land Acquisition (Just Terms Compensation) Act 1991. A Property Acquisition Strategy has been developed to guide this process incorporating the Land Acquisition reforms announced by the NSW Government in October 2016. The strategy includes learnings from major transport projects such as Sydney Metro, WestConnex and CBD and South East Light Rail projects. The project’s preference is to achieve a negotiated agreement with the affected landowner with the compulsory acquisition used as a last resort. The compensation payable is pursuant to section 55 of the Land Acquisition (Just Terms Compensation) Act 1991 which includes provisions for market value and disturbance items such as associated legal costs, valuation fees, relocation and removal expenses, and mortgage costs.

The permanent footprint of the project would be largely within existing road reserves or land currently owned by Transport for NSW (such as the proposed stabling and maintenance facility site at Camellia). However, some permanent and partial property acquisition would be required to facilitate operation of the project. Additionally, some areas of land would need to be temporarily leased during the construction of the project for site compounds and other work sites.

5.14.1 Subdivision

The project would involve the subdivision of private and public land. In some cases, whole lots would be acquired to avoid creating small unusable lots. In seeking project approval, Transport for NSW is also seeking, where relevant, approval for subdivision of all lots acquired to construct the project. Where a part of any lot is identified as being surplus to operational requirements or requiring boundary adjustment following the completion of construction, detailed Deposited Plans of subdivision would be developed and lodged at Land and Property Information NSW for the subdivision of such land.
5.15 Operation of the project

5.15.1 Light rail vehicles

The proposed LRVs to be used would be about 45 metres long, electric-powered, low floor and air conditioned with real-time information provided on services via audio and visual displays (refer to Figure 5.36). Each LRV would provide seating and standing areas for about 250 to 300 passengers. Accessible priority seating for those with a disability, using a wheelchair, mobility device, the elderly, those travelling with a pram/luggage, etc. would also be incorporated into the final LRV design.

To accommodate the proposed service frequency for the project at the commencement of operations, approximately 16 LRVs (including spare LRVs) would be in operation. The new LRVs would be procured using proven ‘off the shelf’ rolling stock technologies. The LRVs would have overhead power similar to the existing fleets used for the Inner West Light Rail and the future CBD and South East Light Rail.

To accommodate the proposed service frequency for the project at the commencement of operations, approximately 16 LRVs (including spare LRVs) would be in operation. The new LRVs would be procured using proven ‘off the shelf’ rolling stock technologies. The LRVs would have overhead power similar to the existing fleets used for the Inner West Light Rail and the future CBD and South East Light Rail.

Figure 5.36 Indicative LRV design

5.15.1.1 Track sanding

The LRVs would use sand to improve grip with the rails in slippery conditions, such as wet weather. When required, the LRV would automatically spray a small amount of sand in front of the wheels to help it gain better grip.

5.15.2 Service and frequency

5.15.2.1 Hours of operation

When the project opens, services would operate from 5 am to 1 am, seven days a week. Additional services would also be provided as required to meet demand for special events (e.g. New Year’s Eve or events at the Western Sydney Stadium and Rosehill Gardens Racecourse).

Services would operate on a ‘turn-up-and-go’ basis. The different service schedules in place for weekdays, weekends and public holidays are designed to meet passenger demand, as outlined in Table 5.6 and Table 5.7 below. The operator would have sufficient flexibility to adapt the services in response to demand and usage changes.

Table 5.6 Summary of proposed weekday services

<table>
<thead>
<tr>
<th>TIME OF DAY</th>
<th>OPERATING HOURS</th>
<th>INDICATIVE TIME BETWEEN SERVICES</th>
<th>VEHICLES PER HOUR (EACH DIRECTION)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early morning</td>
<td>05:00 – 07:00</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>Morning peak</td>
<td>07:00 – 09:00</td>
<td>7.5</td>
<td>8</td>
</tr>
<tr>
<td>Day</td>
<td>09:00 – 16:00</td>
<td>7.5</td>
<td>8</td>
</tr>
</tbody>
</table>
5.15.2.2 Indicative travel times

Indicative travel times between each of the key centres along the project alignment are shown in Figure 5.37. These travel times include the following approximate journey times:

- Four minutes between Westmead terminus and the Children’s Hospital at Westmead.
- Eight minutes between Westmead and Factory Street (for bus interchange along Church Street).
- Eight minutes between the Parramatta CBD and Camellia (for access to Rosehill Gardens Racecourse).
- Ten minutes between the Parramatta CBD and the Western Sydney University (Parramatta) campus.
- Twelve minutes between the Cumberland Hospital (future Parramatta North Urban Transformation area) and the Parramatta CBD.
- Eighteen minutes between Parramatta CBD and Carlingford.
- Thirty-eight minutes between Westmead and Carlingford.
5.15.3 Segregated, separated and mixed running corridors

The form of light rail track would depend on the specific site characteristics along the length of the project alignment and would comprise a combination of the following track forms (refer to section 5.3.2):

» Segregated track form, where general traffic may run adjacent to the light rail track, or general traffic may need to cross the alignment where it crosses existing roads.

» Mixed use track form, where LRVs would share its corridor with other vehicles, typically buses only with other types of vehicular traffic excluded.

» A separated track form, where a LRV would have its own corridor and access for general traffic would not be permitted (except during an emergency), including the existing rail corridor along the T6 Carlingford Line and the former Sandown Line.

» Light rail and pedestrian zone (as discussed previously in section 5.6).
The project would operate within a segregated track corridor for a large proportion of the project alignment. This would help to improve the speed and reliability of the service leading to better journey times. Traffic signals (and pedestrian crossing signals, where required) would be provided where the segregated track has to cross an existing road or intersection. Operation in a segregated corridor would provide a safer environment than where the light rail system is shared with road traffic, as the number of interactions with other vehicles would be significantly reduced.

5.15.4 Ticketing system and passenger information

5.15.4.1 Ticketing

The ticketing system for the project would integrate with the Opal ticketing system. Opal card readers would be located at each stop and passengers would be required to validate their card before boarding the LRV. Opal card top-up and ticket machines would also be installed at selected stops. Opal card readers and top-up machines would be located so as to not impede passenger flow and avoid pinch points on stop platforms. The location of the Opal card top-up machines would be determined during detailed design.

5.15.4.2 Passenger information displays

Passenger information displays would be located at each stop to provide passengers with the information necessary to make early, informed decisions on journey plans, both routinely and in response to abnormal conditions. The passenger information displays would provide up to date service information both specific to the stop and general information.

5.15.5 Infrastructure maintenance

Maintenance would be required at times along the light rail track. Maintenance activities would likely include:

» Regular activities such as track and OHW inspections and inspection and cleaning of the track drainage system.

» Preventative maintenance and repair and minor repairs to failed infrastructure components as required.

» Maintenance of landscaping and appropriate clearances to overhead trees (branch trimming).

» Cleaning of passenger facilities.

» Track grinding and periodic replacement of track and other light rail infrastructure.

5.15.6 Communications system

The communications system for the project would provide timely, safe and reliable transmission of voice, data and video traffic from key operational locations throughout the light rail system. Equipment for the communications system would be located at light rail stops, at traffic intersections, within substation sites, in a central control room (at the operations control centre), and at the stabling and maintenance facility.

The communications system would consist of the following sub-systems:

» A communications backbone network – to provide timely, safe and reliable transmission of voice, data and video traffic from key operational locations throughout the light rail system to the operations control centre located at Camellia.

» Radio system – to provide wireless communications for the efficient and reliable operation of the light rail, capable of delivering voice and data communications between the operations control centre and the staff on the system (including drivers, operations and maintenance staff).
Combined service route – to provide the required conduits and pits for the light rail system services. This would include a combination of a number of conduits and pits dedicated to either electrical, communications or signalling services.

Stop communications systems – which would link the following:
- CCTV
- emergency help points
- public address systems (including hearing aid loops for the hearing impaired)
- clock systems
- ticketing systems
- passenger information displays.

The communications system network for the project would be refined during the detailed design.

5.15.7 Traffic management and access

A number of principles have been considered to guide the development of the future road network and maintain property access along the length of the project alignment (where this currently exists). The principles were considered to ensure that the project would successfully integrate the light rail network with the existing road network.

The key principles considered are outlined below:
- State arterial roads would be maintained at existing capacity and functionality (where they interface with the project).
- Where light rail is introduced on regional and local roads, through traffic capacity may be reduced where necessary.
- Existing access will be retained for emergency services.
- There will be no shared running with general traffic; however, for local access shared running may be required at some locations.
- Consolidation of right turn and U-turn movements across the project alignment with these only permitted at signalised intersections (this provides light rail reliability benefits as well as traffic capacity and safety improvements by minimising uncontrolled conflicting vehicle movements).
- Providing pedestrian crossing treatments based on a risk assessed basis in consideration of the network environment.
- Kerbside buffer treatments would be used through busy retail areas to maintain pedestrian amenity.
- Retaining property accesses along the whole of the project alignment.
- Lane widths will be appropriate for the relevant design vehicle; however, at pinch points, risk based assessments will be used to design non-standard lane widths and separation distances.

As the project would be integrated within the surface street environment, it would require a number of changes to the way in which the road network operates and is designed. The key changes have been identified previously in section 5.8.

5.15.8 Public transport network changes

A series of changes would be required to the current public transport network to accommodate the operation of the project. These changes would include amendments to both existing train and bus services.
5.15.8.1 Bus services

The introduction of the project would provide a catalyst for changes to the bus network to support an integrated transport network and the broader needs of the Greater Parramatta to the Olympic Peninsula (GPOP) priority growth area. Initial work carried out by Transport for NSW has identified the following focus areas for the bus network:

» Maintaining existing Rapid routes within the study area (T80, T65, M52, M60, M54, M91), as outlined in Sydney’s Bus Future.

» Maintaining the existing Suburban route within the study area (525), as outlined in Sydney’s Bus Future, for Stage 1 of the project. There may be the potential for changes to this route once the outcomes of work on future stage(s) are known.

» Reviewing local bus routes within the study area. There is the potential to:
  • Introduce new routes to meet existing and future customer travel patterns.
  • Optimise services that access the Parramatta CBD to balance demand and customer travel patterns with effective operations, particularly during peak periods.
  • Truncate some services to better integrate with the project and the broader transport network.
  • Change route paths to avoid identified road network constraints.
  • Discontinue some routes with alternate travel options in place.
  • Consider opportunities for on demand services in the study area.

Further work will be carried out by Transport for NSW to confirm the preferred approach for the bus network. There may be opportunities for some of these changes to be introduced in the short term, aligned with demand, customer travel patterns or the construction phase of the project.

In addition, some minor changes to bus stop infrastructure and locations would be required to avoid proposed light rail infrastructure. The final design of these changes would be determined during detailed design.

5.15.8.2 Heavy rail train services

As described in section 5.9.3, the project would result in the permanent closure of the T6 Carlingford Line between Carlingford and Parramatta Road. During project operation, services to these precincts would be replaced by the project with more frequent services directly to key locations in Parramatta CBD and Westmead, as outlined in section 5.15.2.

5.15.9 Event management

A number of special events occur within the Parramatta region throughout the year which may require amended operation scenarios for the project (including the potential need to operate periods of 24-hour operation). The various events occur predominantly in Parramatta Park, Prince Alfred Square, Centenary Square and Parramatta River Foreshore, as well as at the Western Sydney Stadium and Rosehill Gardens Racecourse.

Key events which have been identified include:

» Sporting events and other exhibitions at regional attractors such as:
  • Western Sydney Stadium, including football and rugby league events.
  • Rosehill Gardens Racecourse, including race days and other events (such as the exhibitions, conferences and school events such as exam venues).
Community events within Greater Parramatta, including Parramatta Park, such as:

- Sydney Festival
- Tropfest
- Lunar New Year
- Paramasala
- Burringarra Family Day (NAIDOC week)
- Sydney Symphony concert(s)
- Parramatta Lanes Festival
- Loy Krathong (Thai Water festival)
- Winterlight
- Christmas in Parramatta.

Public holiday events such as:

- Australia Day
- New Year’s Eve.

Of the events identified, events at Western Sydney Stadium and Rosehill Gardens Racecourse would generate the largest demand for special event services. The redeveloped Western Sydney Stadium (refer to Chapter 9 - Regional cumulative impacts) is projected to annually host the following:

- Around 45 events per year, including NRL games (Parramatta Eels) and other organised events.
- Up to 12 Western Sydney Wanderers games.
- Around three other separate events (e.g. concerts/friendly internationals for various sports/finals series).

The Rosehill Gardens Racecourse also hosts around 28 race days and over 200 non-race day events each year, with a majority of the large non-race day events occurring over a number of days or weeks.

5.15.9.1 Special event services

Most special events would typically be held outside of peak hours and therefore spare LRVs may be required to supplement normal services. The operator would advise customers of upcoming special events and the additional services and/or service changes available via social media, on board and platform passenger information displays in the days leading up to an event, or as detailed in a special event plan. Customer service officers and active management of crowds may also be necessary at stops during special events.

Special event services may run beyond the standard hours of operations (refer to section 5.15.2) including the potential to provide 24-hour operations for certain special events (such as New Year’s Eve event(s)). Where considered necessary, special event timetables of events at locations such as Western Sydney Stadium, Rosehill Gardens Racecourse, Parramatta Park and other major events would be developed and implemented during operation of the project as required. It is anticipated that around six to eight additional services would operate during special event running periods for the identified routes below.

Western Sydney Stadium would be serviced by the Prince Alfred Square stop and Rosehill Gardens Racecourse would be serviced by the Camellia stop. Special event service routes for Western Sydney Stadium and Rosehill Gardens Racecourse are shown in Figure 5.38 and Figure 5.39 respectively.
Figure 5.38  Special event services - Western Sydney Stadium: Westmead to Parramatta interchange

Figure 5.39  Special event services - Rosehill Gardens Racecourse: Parramatta Square to Camellia
5.15.10 Road and light rail vehicle safety

The operator of the project would have responsibility for the safe and efficient operation of the total system.

The LRVs would be driven on line-of-sight operation. In on-street sections, LRVs would form part of the general road traffic and LRV drivers would be required to observe the relevant provisions of the NSW Road Rules. The LRV drivers would also be required to give due consideration to traffic flows and pedestrian movements, assessing LRV speeds and braking requirements against their perceptions of actual or potential hazards.

Traffic signals will also be utilised along the project alignment to allow for safe operation of the light rail within the existing road network. Where required, additional signals will be installed to maintain safe operation of the existing road network with the light rail network (such as along Grand Avenue to allow for LRVs entering or leaving the stabling and maintenance facility).

5.15.10.1 Speed limits

Generally, LRVs would operate up to the existing posted road speeds for adjacent roadways. Where the proposed project alignment is separated from road traffic, such as within the Parramatta CBD or along the T6 Carlingford Line, specific operating requirements would apply. Maximum speeds in the dedicated corridor section of the existing T6 Carlingford Line would be similar to the existing heavy rail service (a maximum of about 70 kilometres per hour).

5.15.10.2 Disruptions to light rail services and incident management

During operation of the project, incidents may disrupt light rail services, preventing parts of the network from being operated. The operator would have processes and procedures in place to minimise the occurrence of potentially dangerous situations. Such incidents could include:

» Road traffic accidents (including a collision involving a LRV).
» Major fault or failure of a LRV, requiring police attendance to divert traffic until the disabled LRV has been recovered.
» Infrastructure faults (e.g. track, OHW and signals).
» Derailment of a LRV.
» Overhead power supply failure.
» Unruly or ill passenger(s).
» Environmental factors (such as flooding).

All emergency or incident responses will be subject to safe management processes including risk assessments, staff training, working agreements with the emergency services, utilities management and safe working procedures crossover locations.

5.15.11 Customer safety

The operator would be responsible for the safety of customers and staff at all times, and the public where they interact with the light rail system. The operator would maintain a customer safety plan (or similar management plan) identifying how customers would be made aware of the safety risks associated with being in the proximity of LRVs. This plan would be agreed and implemented in consultation with Transport for NSW and would form part of the operator’s accreditation process (required by law) prior to commencement of operations.

The operator would also be responsible for the security system for the light rail network (active and passive security).
6 Project description – construction

This chapter outlines the likely key activities that would occur during the construction of the project. The construction methodology described in the following sections is indicative only and may change as a result of design development. Prior to commencement of these works, a detailed construction environmental management plans (CEMP) would be prepared by the contractor(s) to manage potential adverse construction impacts (as discussed in Chapter 17).

The CEMP would cover the enabling works, main works and commissioning programs and ensure that the management and mitigation measures and Conditions of Approval are implemented and adhered to.

6.1 Overview

The proposed construction activities to be carried out for the project broadly include:

- Relocation of services and utilities.
- Modifications to the surrounding road network.
- Property acquisition and adjustment including boundary fencing and temporary hoardings (as required).
- Demolition of buildings and structures along the project alignment.
- Construction of tracks, overhead wiring and associated infrastructure (track infrastructure).
- Construction of light rail stops.
- Construction of new, and modification of, existing bridges and culverts.
- Construction of the stabling and maintenance facility in Camellia.
- Construction of substations and associated electrical works.
- Establishment of construction compounds along the construction alignment for stockpiling and storage of materials.
- Demobilisation, rehabilitation and landscaping of impacted areas prior to the commissioning phase.

A number of minor construction activities would be carried out before the start of substantial construction works. These ‘enabling works’ are described in section 6.4.

6.1.1 Environmental considerations informing construction methodology

The construction methodology for the project has been influenced by a number of environmental considerations. Specific construction methods developed to avoid and minimise adverse impacts are identified in Table 6.1. Construction methodologies for the key activities listed in Table 6.1 are described in further detail in sections 6.4, 6.5 and 6.6.
### Table 6.1 Adverse construction impacts avoided or minimised through design

<table>
<thead>
<tr>
<th>ENVIRONMENTAL ASPECT</th>
<th>DESIGN RESPONSE</th>
</tr>
</thead>
</table>
| Traffic and transport     | » Development of haul routes to minimise impacts on the road network.  
                              » Staging of off corridor works to minimise disruption to CBD road network.  
                              » Development of temporary traffic lanes along James Ruse Drive and Kissing Point Road to minimise traffic and transport impacts during construction of the associated light rail over bridges.  
                              » Implementation of a bus replacement strategy along the existing T6 Carlingford Line during construction to maintain passenger access along the corridor. |
| Property and land use      | » Minimised additional land take for temporary construction sites.  
                              » Development of a construction impact footprint which is consistent with operational footprint (as far as practicable/feasible) to minimise additional temporary property acquisition or impacts. |
| Heritage                   | » Compound establishment method selected to avoid disturbance to areas of archaeological heritage potential.                                                                                                     |
| Biodiversity               | » Implementation of construction compound establishment principals which include avoidance of tree removal and vegetation clearance (where practicable/feasible).                                              |
| Noise and vibration        | » Arrangement of haul routes to minimise the use of local roads.  
                              » Ballast and spoil handling area(s) identified to occur adjacent to the existing industrial area in Camellia. This will minimise potential noise and vibration impacts.  
                              » Construction compounds and work sites to include appropriate hoardings/fencing to reduce potential noise impacts to adjacent areas.                                                   |
| Socio-economic             | » Maintaining east-west connectivity between hospital campuses during construction.                                                                                                                                 |
| Waste and sustainability    | » Opportunities for ballast recycling/reuse to minimise material.  
                              » Opportunities for steel and concrete recycling and maximisation of reuse and repurposing of spoil.  
                              » Implementation of sustainability initiatives identified in the sustainability sections of this Environmental Impact Statement such as water and energy efficiency measures.                        |

### 6.2 Indicative project program

Construction of the project would commence in mid-2018 (subject to planning approval). The project would commence operations in 2023. An indicative project program overview is provided in Figure 6.1. This program is based on the current design and construction staging. The final sequencing and staging would be determined by the appointed contractor(s).
6.3 Staging

A summary of the indicative construction staging and key activities associated with each stage of the project is provided in Table 6.2.

<table>
<thead>
<tr>
<th>STAGE</th>
<th>KEY CONSTRUCTION ACTIVITIES</th>
</tr>
</thead>
</table>
| Enabling works (between three to nine months in duration in each precinct) | » Establishment of traffic management plans.  
» Establishment of site and installation of safety barriers around the work sites and site compounds associated with enabling works.  
» Property access modifications along the project alignment, including the relocation of existing facilities.  
» Demolition of buildings and other structures.  
» Relocation and protection of major services and utilities relocation.  
» Establishing ancillary facilities and construction sites.  
» Carrying out heritage investigations, protection and archival recordings.  
» Implementation of local bus diversions (outlined in Table 12.19) to manage the impact on bus operations during construction of the project.  
» Implementation of road configuration changes.  
» Road modification works including kerb realignment, drainage works, line marking and signage.  
» Critical pre-works outside the project corridor (e.g. street changes to accommodate the traffic management requirements during the main construction works).  
» Tree and vegetation removal and offset planting (as required).  
» Kerb realignment and drainage improvement works.  
» Line marking and signage installation.  
» Roads and Maritime Services traffic signal works.  
» Potential remediation works (excluding the stabling and maintenance facility and where contaminated materials are encountered, refer to section 10.7).  
» Light rail works, such as preparation works for the track slab construction. |
### Project Description - Construction

#### Key Construction Activities

<table>
<thead>
<tr>
<th>Stage</th>
<th>Main Construction Works (between three to nine months in duration in each precinct)</th>
<th>Testing and Commissioning (between three to nine months in duration in each precinct)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>» Establishment of additional site compounds and installation of safety barriers around the work sites. In most cases the site compounds may need to be established at the start of the enabling works to support these works.</td>
<td>» Commissioning and trial running of the alignment.</td>
</tr>
<tr>
<td></td>
<td>» Construction of site access for plant mobilisation/demobilisation and construction deliveries.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Installation of erosion and sediment controls.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Property boundary readjustments where identified.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Utility protection and relocations, where required.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Demolition works including disposal.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Tree and vegetation removal and offset planting (as required).</td>
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<td></td>
<td>» Pavement works (rail and traffic) including construction of footings for poles. Works would be carried out in linear sections along the alignment.</td>
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<tr>
<td></td>
<td>» Construction of track infrastructure once a clear corridor along a substantial part of the project alignment has been established, following utility services diversions (where necessary). Construction of track infrastructure would progress linearly within sections of the alignment between intersecting streets, with the intersections generally constructed behind or in advance of the adjacent sections.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Progressive construction of light rail stops as separate work sites so as to not interfere with the track infrastructure works. These would need to be carried out after the track infrastructure construction has progressed past the stop locations.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Restoration of the road for pedestrians and, where proposed as part of the operational configuration for the project, road traffic.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Installation of poles and overhead wiring.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Bridge crossing works and construction of other major structures.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Construction of the Camellia stabling and maintenance facility.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Substation construction.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Construction and restoration of impacted footpaths, kerbs and driveways.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Drainage improvement works along the alignment (where required).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Landscaping and public domain works.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Restoration of site compounds and laydown areas.</td>
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</tr>
</tbody>
</table>

#### 6.4 Enabling Works

Enabling works for major infrastructure are typically carried out before the start of substantial construction to ‘make ready’ the key construction sites and provide protection to the public. These works would be critical as they would reduce the duration of the civil construction works (particularly within the Parramatta North and Parramatta CBD precincts) and associated...
disruptions to traffic and surrounding sensitive land uses. The enabling works for the project are identified in Table 6.2 above and are described further in the respective sections of this chapter.

Subject to landowner or asset owner agreement, property condition surveys would be completed for various infrastructure (including residences, roads, buildings, heritage items, etc.) prior to the commencement of vibration intensive construction works (e.g. piling, excavation or any vibratory impact works including jack hammering and compaction) and post-construction (unless property/infrastructure is otherwise determined as being not adversely impacted by a qualified geotechnical engineer). These property surveys would be carried out to determine the existing condition of property/assets and to ensure that any damage resulting from the works is able to be identified and rectified. Landowner/asset owner consent would be obtained to access private property to complete these property surveys.

Where required, vibration monitoring would be carried out during vibration intensive works to confirm vibration predictions. Further discussion on potential vibration impacts and environmental management measures that would be implemented to manage potential vibration impacts is provided in section 11.6 (Westmead Precinct), 12.6 (Parramatta North precinct), 13.6 (Parramatta CBD precinct), 14.6 (Rosehill and Camellia precinct), and 15.6 (Carlingford precinct).

The enabling works are anticipated to commence in mid-2018 (subject to planning approval) and would generally be completed before main works commencement start at any particular location. The enabling works would be staged so as to minimise impacts to traffic flow. Enabling works would be carried out with traffic control behind barriers during day time. Locations where works cannot be carried out during daytime hours would be planned for night works and/or weekends to meet particular location issues (as discussed in section 6.10). Consultation with City of Parramatta Council and Sydney Coordination Office would be carried out to minimise the potential for enabling works construction to impact on special events, particularly those within the Parramatta CBD.

6.5 Site establishment

6.5.1 Protection of environmentally sensitive areas

Environmentally sensitive areas within and adjacent to the proposed construction footprint shown in Figure 6.2a to Figure 6.2h (such as heritage items, trees to be retained and sensitive community land uses), and as identified in Chapters 8 to 15 of this Environmental Impact Statement, would be demarcated and protected to minimise adverse impacts associated with construction works. Areas would be fenced off and marked as ‘Environmentally Sensitive Area – No go zone’.

6.5.2 Installation of construction erosion and sediment control measures

Erosion and sediment control measures would be designed and installed in accordance with the ‘Blue Book’ Managing Urban Stormwater: Soils and Construction (Landcom 2004). Potential erosion and sedimentation impacts associated with the project are discussed in section 10.6.

6.5.3 Establishment of construction compounds, work site and temporary access

Ground levelling works or installation of capping material may be required to establish construction compounds and general work site areas. The establishment of site offices and facilities would include deliveries of demountable office facilities, establishing utility connections to the compound sites (where required), erecting fencing and hoarding, signage and gates, establishing stockpiles and materials storage areas within the sites, and the delivery of construction plant and equipment. Further details on construction compound sites are provided in section 6.12.

Before construction works begin, suitable barricades and traffic management measures would be implemented to protect the public and to prevent public access onto the work site. Where
required, temporary site access would be constructed to facilitate the delivery of plant and equipment to work sites.

6.5.4 Services and utilities protection and relocation

Where necessary, services and utilities would be protected, upgraded or relocated, in consultation with the relevant asset owners. Indicative construction activities that would occur during services and utilities protection and relocation would include:

- Establishment of safe work environments and traffic controls.
- Tree and vegetation removal (as required).
- Services and utilities location identification.
- Potholing to confirm locations.
- Construct a new services or utilities alignment either by open trenching or non-destructive excavation.
- Lay the new services (duct, cable, pipe) as appropriate.
- Reinstall the surface.
- Commission the new service or utility.
- Access to existing fire hydrants would be maintained until newly constructed fire hydrants are operational.

6.6 Track infrastructure

6.6.1 Civil engineering works

The main civil engineering works would typically be carried out in linear segments, with the exception of works at road intersections, which would be constructed separately due to traffic staging requirements. Indicative construction activities that would occur during track works would include the following:

- Site clearance including removal or relocation of trees (where required), where tree roots would likely be traversed by the works zone or may impact on utility relocations.
- Carry out service/utility relocation and protection works.
- Earthworks.
- Saw-cutting of existing road pavement and excavation for the light rail services; installation of light rail services conduits; backfilling of trenches; and construction of pits for the light rail services.
- Temporary reinstatement of affected areas, as required.
- Removal of existing road pavement and subgrade (where required) for the light rail tracks; preparation of track base and for binding layer; placement of reinforcement steel (where required).
- Excavation and compaction, where required.
- Concrete pumping and/or pouring.

An automated baseplate placing machine or slipform construction technique may be adopted for the construction of the track barriers and kerbs in place of manual work to maximise productivity and minimise traffic disruptions during construction. However, different construction methodologies may be adopted within public areas, wherever possible to minimise impacts on the community (such as noise and vibration).
Subgrade works (e.g. excavation of existing material and backfilling with engineered general and structural fill) would be required along the majority of the alignment with the exception of where the proposed track is founded on an adequate subgrade. The subgrade works would be required to provide a suitable foundation for the track slab.

A description of the general construction methodology and staging that would be carried out to manage potential traffic, transport and access impacts is provided in section 6.14.

6.6.2 Earthworks

A total of approximately 176,000 cubic metres of material would be excavated during construction works, as summarised in Table 6.3. Fill material would generally be required for backfilling excavations, subgrade works for sections of the alignment not underlain by existing road pavements and retaining wall construction. The estimated excavated material and fill requirements for the project are also summarised in Table 6.3.

**Table 6.3 Estimated volume of excavated material and fill required for the project**

<table>
<thead>
<tr>
<th>PRECINCT</th>
<th>APPROXIMATE VOLUME OF MATERIAL TO BE EXCAVATED (CUBIC METRES)</th>
<th>APPROXIMATE VOLUME OF MATERIAL REQUIRED FOR FILL (CUBIC METRES)</th>
<th>EARTHWORK BALANCE (CUBIC METRES)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Westmead precinct</td>
<td>34,000</td>
<td>19,000</td>
<td>15,000</td>
</tr>
<tr>
<td>Parramatta North precinct</td>
<td>33,000</td>
<td>19,000</td>
<td>14,000</td>
</tr>
<tr>
<td>Parramatta CBD precinct</td>
<td>38,000</td>
<td>22,000</td>
<td>16,000</td>
</tr>
<tr>
<td>Rosehill and Camellia precinct</td>
<td>28,000</td>
<td>16,000</td>
<td>12,000</td>
</tr>
<tr>
<td>Carlingford precinct</td>
<td>23,000</td>
<td>50,000</td>
<td>-27,000</td>
</tr>
<tr>
<td>Stabling and Maintenance Facility</td>
<td>20,000</td>
<td>90,000</td>
<td>-70,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>176,000</strong></td>
<td><strong>216,000</strong></td>
<td><strong>-40,000</strong></td>
</tr>
</tbody>
</table>

Where feasible, the excavated material would be used to meet the fill material needs for the project. However, this may be impractical if the excavated material is unsuitable for the purposes of structural fill. In this case, fill would need to be imported, and excavated material exported for reuse on other sites or for treatment or disposal. Disposal would be a last resort.

It is estimated that, in the worst case scenario, up to 176,000 cubic metres of excavated material would require disposal (i.e. off-site disposal of all excavated material). For the best case scenario, all fill material would be sourced from on-site, with an additional 40,000 cubic metres of fill material required to be imported to site.

As outlined in Chapter 16, a comprehensive list of sustainable initiatives was developed for the project, with the aim of maximising the sustainability outcomes during the planning, construction and operational phases of the project. One of these sustainability initiatives strives to minimise waste generation and disposal throughout the project lifecycle and maximise recycling of construction and demolition waste. Overall, the project would seek to achieve the following with respect to waste management:

- A diversion rate for construction waste from landfill of at least 90 per cent of waste by volume, with a target of 95 per cent of waste by volume (this may not be achievable given the amount of contamination in the area).
Reuse of 100 per cent of paving and other reusable materials or facilitate reuse of such materials (these targets may not be possible, given the amount of contamination in the area).

6.6.3 Ballast recycling

Ballast from the T6 Carlingford Line would be reused for the designated light rail corridor, where suitable.

A qualitative in-situ risk assessment would be carried out to determine the extent of preliminary in-situ sampling required – the higher the result of the risk assessment, the more preliminary samples would be taken. Samples would be tested for contamination and the results would be assessed against an established criterion to determine whether the ballast is suitable for recycling. Ballast (and associated soil) that is below the criteria thresholds would be transported to the ballast recycling facility located within the Sandown Line where the ballast and associated soils would be screened, crushed, treated and stockpiled for further validation. Stockpiled materials would be sampled and tested to ensure that the material meets the criteria specified in the Resource Recovery Exemption issued by the Environment Protection Authority (EPA) and is suitable for reuse on site or by a third party.

It is assumed that about 50 per cent of the old ballast would be reused. New ballast would be delivered to replace the lost 50 per cent plus additional ballast as required for the track duplication. It is estimated that about 16,000 tonnes (1.6 cubic metres per tonne) of ballast would be removed, 8,000 tonnes recycled with an additional 18,000 tonnes of new imported ballast.

All materials that do not meet the criteria and are deemed unsuitable for reuse due to contamination or asbestos would be transported to an authorised waste disposal facility in accordance with the NSW EPA Waste Classification Guidelines.

6.6.4 Rail installation works

Generally, rail installation would progress in linear sections with disruption at any one point lasting less than a month. The nature of the project means that the rails may be either installed together or each line may be installed separately. Therefore, more than one pass of the installation works at any one location may be required depending on the requirements identified during the detailed construction planning. This would be determined by the contractor(s) once appointed. Typically the rail installation within the road corridor would entail the following activities:

- Rail laying, welding and track finishing (installation of a topping slab, asphalt in-fill or paver in-fill).
- Installation of rail boot in embedded track form (where applicable).
- Rail systems installation.
- Permanent reinstatement of affected areas, including installation of road line markings.
- Systems integration, testing and commissioning.

One or more segments of track could be constructed simultaneously, depending on the construction methodology adopted; for example an automated baseplate placing machine or slipform machine (a machine used to form and pour concrete) may be used to lay the track slab and base plates, pending applicable traffic restrictions and/or the accessibility of the work sites.

The construction methodology for the rail installation within ballasted areas (e.g. T6 Carlingford Line and Sandown Line) would typically be as follows:

- Removal of existing rail infrastructure.

- Widening of the rail formation to accommodate twin tracks. This would require:
  - Removal of rail corridor drainage and installation of new track drainage (where required).
  - Removal of vegetation on embankments where likely to be impacted by the widening activities.
- Widening of cuttings (where required).
- Construction of new embankments with imported fill material.
  » Placement of a capping layer over the formation.
  » Rail laying, welding and track finishing (placement and tampering of recycled ballast if suitable).
  » Permanent reinstatement of affected areas and landscaping.
  » System integration, testing and commissioning.

### 6.6.5 Overhead wiring and poles, and street lighting

Pole foundations for new overhead wiring, and street lighting would be constructed during the main works (i.e. carried out during the excavation of footpaths for utility relocations) or during track works. Construction activities would vary from pole to pole; however, would typically involve:

  » Relocation/protection of utilities, where required.
  » Saw-cutting of existing pavement and excavation of footing.
  » Placement of pre-fabricated reinforcement cage, base plate and other reinforcement structures.
  » Concrete pouring.
  » Offsite fabrication of overhead wiring post and delivery to the work site.
  » Fit-out of overhead wiring poles.
  » Erection of poles.
  » Stringing overhead wires, installation of droppers and wiring terminations.

### 6.6.6 Road pavement works

The road network would be modified in numerous locations (particularly around intersections) to accommodate the track infrastructure. These works are required to ensure the road surface ties into the new track and the grade is sufficient to provide suitable drainage. These works would involve milling the road surface and laying new asphalt.

These works would generally be completed during intersection or road closure periods which may be for a specific extended duration or night time and weekends pending traffic and access considerations. Works would be carried out in consultation with Roads and Maritime Services, Sydney Coordination Office, and City of Parramatta Council and in accordance with the relevant standards and specifications. Typical activities associated with road network works would include:

  » Establishment of safe work environments and traffic controls.
  » Demolition of existing kerb, gutters and median strips (where required).
  » Milling and excavation of existing road surface to the formation level.
  » Removal and replacement of any unsuitable road base materials.
  » Compaction of road base.
  » Excavation and installation of new drainage to tie in to the existing stormwater and installation of new stormwater pits (where required).
  » Utility crossovers (where required).
  » Construction of a new kerb and gutter.
  » Laying of new asphalt road surface.
  » Installation of new traffic lights and induction loops (where required).
  » Installation of signage and line marking.
In some areas, the profile of existing carriageways may be modified to tie into the light rail alignment. This would require the existing asphalt carriageway to be milled and a new surface laid to the relevant grade.

6.7 Light rail stops and interchanges

Light rail stops would be constructed concurrently with the track infrastructure works or may be constructed separately, with works at each stop commencing progressively after the completion of the adjacent linear segment of track infrastructure. Stop construction is likely to consist of prefabricated materials and on-site concrete pours. This work is anticipated to require up to three months of construction at each location, depending on the size and finish specified. Indicative construction activities during the establishment of light rail stops would vary between locations; however, would generally include the following:

» Removal/relocation of trees and vegetation (where required), where tree roots would likely be traversed by the works zone or may impact on utility relocations.
» Service/utility relocation and protection works.
» Installation of light rail services and conduits.
» Establishment of localised traffic controls.
» Saw-cutting, removal and excavation of existing pavement.
» Formwork.
» Piling, if required.
» Construction of slab and footings.
» Concrete pouring.
» Installation of services, including communications and electrical.
» Installation of prefabricated stop canopy, signage, seating, tactile indicators and paving.
» Finishing works, landscaping and urban design works.

Construction of structures with potential to be vandalised would be carried out as late as possible within the program.

6.8 Bridge and culvert works

As outlined in section 5.9, works on a number of bridges along the alignment would be required to support the project. The general construction methodology is described below with further details provided for Parramatta North Bridge, James Ruse Drive Bridge and Parramatta River Bridge due to the complex nature of the construction works associated with these bridges.

6.8.1 General bridge works

To reduce the duration of construction works required onsite, where possible, elements of the bridges, such as concrete support beams, would be precast offsite. Typically bridge construction works would involve the following activities:

» Establishment of the work site, traffic controls, temporary hoardings and laydown areas.
» Removal/relocation of trees and vegetation (where required).
» Construction of site access for plant and materials.
» Establishment of erosion and sedimentation controls.
» Site preparation and levelling activities for site compounds.
» Piling pad construction for piling works.
» Installation of piled foundations.
» Demolition of existing abutments (where required).
» Construction of formwork, steel reinforcement and cast concrete for headstocks.
» Construction of new abutments (where required).
» Mobilise crane and install precast beams or culverts.
» Installation of drainage behind abutments.
» Casting of the deck slab and embed rails.
» Casting of edge barriers and install handrails.
» Landscaping and restoration of disturbed areas.

6.8.2 Parramatta North Bridge
A new bridge is to be constructed adjacent and to the south of the existing bridge over Parramatta River within Cumberland Hospital. This section outlines an indicative construction methodology; the final construction methodology would be determined during detailed construction planning.

Due to the steepness of the banks at this location, levelling works would be required to stabilise the work site. This would involve the construction of a gabion retaining wall down slope and would then be infilled to create a level surface, lined with geofabric and stabilised with blue metal. Erosion and sediment controls would be established around the work site boundary to prevent off-site sedimentation including the construction of a bund around the work site and vegetated swale drain.

Construction of the bridge would be likely to mainly occur from the western side of the river. The barge platform may also be used to construct certain elements of the bridge, such as the headstocks. A central pier would be constructed within Parramatta River to support the deck slab. This would involve the construction of a temporary causeway within Parramatta River upon which a crane would be mounted to construct new piling for the central pier. A crane would be used to install a precast concrete form onto the piles. This would be dewatered and cast in-situ to form the new central pier. Traffic control measures would be implemented throughout construction. Precast beams would be installed during the weekend to minimise potential traffic impacts. Emergency and pedestrian access would be maintained on the existing bridge.

Following the construction of the bridge, the work sites and site access would be rehabilitated and landscaped. The site levels would be returned to pre-construction condition.

6.8.3 James Ruse Drive Bridge
A new grade separated bridge would be constructed over James Ruse Drive Bridge. This section outlines an indicative construction methodology; the final construction methodology would be determined during detailed construction planning.

The bridge would span from Grand Avenue North (West) to Grand Avenue North (East) and allow for the potential future widening of James Ruse Drive. The bridge would comprise seven piers and two abutments with one pier located within the median strip of James Ruse Drive. Road widening would be required along both the western and eastern sides of James Ruse Drive to provide additional space for the construction of the pier in the median strip. These works would need to be carried out at least six months prior to the commencement of construction on the bridge. These works would impact on adjacent commercial properties and require property boundary and access adjustments. Works on the sections of the bridge crossing James Ruse Drive would be carried out during night times and at weekends to minimise impacts to traffic.
6.8.4 Parramatta River Bridge

The Parramatta River Bridge would include a cantilevered structure on the western side providing an active transport path. This section outlines an indicative construction methodology; the final construction methodology would be determined during detailed construction planning.

The cantilevered structure would be craned into place and would be constructed of precast materials. A site compound would be constructed on either side of the bridge. The site is slightly sloped and site preparation works would involve the construction of a retaining wall down slope and then infilling the site to create a level surface. The site would be lined with geofabric and stabilised with blue metal. Erosion and sediment controls would be established around the work site boundary to prevent off-site sedimentation including the construction of a bund around the work site and vegetated swale drain.

The existing bridge abutments would be demolished and piling works would be carried out from both sides of the river. Abutment headstock would be constructed on each side of the river and precast beams would be lifted into place by crane. The deck slab would then be formed and concrete poured. Finally, precast modular sections would be lifted into place to create the finished bridge structure.

6.8.5 Culvert extensions

A number of minor culverts or utilities along the project alignment may require strengthening or lengthening. These would be identified during detailed design and an appropriate methodology would be established. This may involve protecting utilities within bridging structures or concrete encasement.

6.9 Retaining walls

Retaining walls, required along the T6 Carlingford Line, may be constructed through utilisation of gabions or crib walls or other alternatives where a more natural appearance of the retaining wall is required (as the retaining walls beneath the Parramatta River Bridge are located adjacent to the Western Sydney University Heritage Walk).

Construction activities associated with these retaining walls would vary between locations; however, would typically involve:

» Tree removal/relocation.
» Utility relocations.
» Excavation of construction footprint.
» Preparation of base and blinding slab.
» Pour concrete footings for placement of retaining wall panels.
» Construction of retaining wall structure, placement, and compaction with fill material.
» Progressive survey conformance check and inspection.
» Progressively backfilling and compaction of free draining aggregate, geotextile and subsurface drainage system behind.
» Construction of a concrete dish drain on top of the wall to divert any surface stormwater flows.

Retaining walls along proposed light rail stops would need to be aesthetically acceptable to the proposed streetscape and, therefore, would be more labour intensive to construct (as the retaining walls require some type of façade).
Construction activities associated with these retaining walls would vary between locations; however, would typically involve:

- Saw cutting and removal of existing pavement.
- Utility relocations.
- Tree removal and relocation.
- Excavation and removal of existing pavement.
- Preparation of base and bindings.
- Construction of concrete footings.
- Formwork, if adopting in-situ concrete construction for the retaining wall.
- Reinforcement and concrete placement if adopting in-situ concrete construction for the retaining wall or placement of concrete pre-cast retaining wall panels.
- Progressively backfill and compaction of free draining aggregate, geotextile and subsurface drainage system behind.
- Progressive survey conformance check and inspection.
- Placement of concrete dish drain on top of the wall to divert any surface stormwater flows.
- Placement of façade, subject to final design.

6.10 Stabling and maintenance facility

Subsurface remediation works to make the stabling and maintenance facility suitable for development would be carried out at the site prior to works as part of this project (refer to section 6.15.3) and would be subject to a separate planning approval process. These works are required to satisfy Transport for NSW’s legal and regulatory obligations and would occur regardless of the status of the Parramatta Light Rail project. The objective of the subsurface remediation works is to prevent the offsite migration of contaminated groundwater.

For this project, construction activities associated with the stabling and maintenance facility would typically comprise:

- Demolition of existing structures (where required).
- Utilities relocation, protection and modification.
- Earthworks including embankment fill and installation of site drainage.
- Installation of a vapour mitigation system.
- Establishment of site roads and open spaces.
- Detailed excavation for buildings in embankment fill.
- Construction of foundations.
- Construction of new utilities to supply the site (where required).
- Drainage works.
- Construction of water supply tanks.
- Construction of retaining walls (where required).
- Construction of buildings and water treatment facilities.
- Formwork, track work and the construction of footpaths (for staff access) and foundations for railway systems (e.g. overhead wiring structures and signalling equipment).
- Installation of rail systems (e.g. power distribution, overhead wiring and signalling) and lighting.
Installation of maintenance equipment.

Landscaping.

Building fit-out, including installation and connection of electricity/communications, water and sewer systems.

The buildings could comprise a steel frame with a metal roof and either metal cladding or precast concrete panel walls.

Earthworks on site would involve the construction of raised platform approximately two metres in height using clean fill material, as a foundation upon which buildings and structures would be constructed. The purpose of raising the level of the site would be to provide a buffer of clean material above contaminated subsurface layers and to reduce the potential for interaction of contaminated material with clean material during construction. The fill material would also accommodate any infrastructure required to manage vapours from the subsurface layers.

Construction of the stabling and maintenance facility is anticipated to take approximately 18-24 months to complete and would only commence once the separate remediation works have been complete.

6.11 Substations and associated works

Substations would generally comprise prefabricated structures, with the manufacture and fit-out of each substation occurring off-site. On-site works would typically comprise excavation, foundation preparation and construction, and the installation of conduits and other in-situ works (i.e. electrical works) prior to the installation of the prefabricated substation building and security fencing surrounding the site.

Construction activities would typically include:

- Establishment of the work site, temporary hoardings, construction pad and laydown area including any erosion and sediment controls required in accordance with the Blue Book and any additional drainage and bunding requirements to protect local stormwater.

- Construction of foundations, footings, conduits and other in-situ works.

- Installation of earthing and lighting systems.

- Delivery and installation of prefabricated substations/transformers.

- Installation of electrical components including wiring fit-out.

- Installation of high voltage cables between substations and the location cabinets situated at each light rail stop, as well as to existing Ausgrid substations within the network.

- The supply, installation and termination of low voltage power and control cabling between equipment.

- Backfill around substation with concrete, pavers, or other materials depending on finished surface.

- Construction of security fencing and any landscaping works.

- Post construction testing and commissioning of substations.

There is potential for the site to be contaminated due to its past use (refer to section 6.15.3).
6.12 Construction sites

6.12.1 Construction zone

The construction site boundary for the project is shown in Figure 6.2a to Figure 6.2h. Generally, construction works would take place within existing road reserves, with the exception of works:

- Associated with the Westmead terminus on the corner of Railway Parade and Hawkesbury Road.
- Within the Cumberland Hospital Precinct (west) adjacent to and south of Bridge Road and the crossing over Parramatta River.
- Between Parramatta River and Factory Street within Cumberland Hospital Precinct (east).
- Within Prince Alfred Square.
- Within a western boundary of Robin Thomas Reserve.
- Within the nature reserve between George Street and Noller Parade.
- Between Tramway Avenue and Grand Avenue North including the crossing of Clay Cliff Creek and James Ruse Drive.
- Within the Sandown Line.
- The stabling and maintenance facility.
- Within land acquired as part of this project (refer to Figure 5.26 in Chapter 5).
- Within the T6 Carlingford Line corridor.

Some substations, utility, services and drainage works may also require construction access and work to be carried out outside of existing road reserves, which could include public areas and acquired private properties. Construction compounds would be established outside of the existing road reserves.

6.12.2 Primary construction compounds

6.12.2.1 Location and key features

Construction compounds are enclosed areas, not open to the public used to support construction works in nearby areas. Construction compounds would generally accommodate offices, lunchrooms, toilet, first aid room, security and laydown area. Construction hours for the specific compounds are outlined in Table 6.4. Where possible noisy works and deliveries would be restricted to standard construction hours to minimise impacts on adjacent sensitive receivers. Hoarding would be erected around the site to reduce noise impacts to nearby sensitive receivers.

The proposed locations for the primary construction compounds are shown in Figure 6.2a to Figure 6.2h and described in Table 6.4. These sites were selected as primary construction compounds due to the linear nature of the project and the limited land available to accommodate such construction facilities.
Figure 6.2a | Construction compounds and disturbance footprint
Figure 6.2b | Construction compounds and disturbance footprint
Figure 6.2c | Construction compounds and disturbance footprint
Figure 6.2d | Construction compounds and disturbance footprint
Figure 6.2e | Construction compounds and disturbance footprint
Figure 6.2f | Construction compounds and disturbance footprint
Figure 6.2g | Construction compounds and disturbance footprint
Figure 6.2h | Construction compounds and disturbance footprint
To minimise impacts from the construction compounds, the following site factors were considered during the selection of viable construction compound locations:

- Location on relatively level ground of sufficient size to accommodate the required facilities.
- Accessible for construction traffic and deliveries.
- Close to key construction activities (such as bridge works and stop locations) to minimise transport of materials and equipment.
- On public land to avoid impacts on private land uses/property.
- On sites where acquisition of private property is required for the project alignment.
- Located away from (or able to be managed in such a way so as to not significantly impact on) heritage items, native vegetation, waterways, and areas prone to flooding.
- Ability to manage public safety and access around the construction compound.
- Undeveloped nature of the site (i.e. parks) to minimise impacts on existing structures, services and utilities.

The number and locations of construction compounds may change during detailed design. Any new additional construction compound would be subject to consistency with the planning approval.

Following completion of construction any residual land not required for operational purposes would be returned to at least its former condition with the final use and any replacement structures subject to the relevant planning requirements as applicable to the land. This final land use would be identified in consultation with key stakeholders such as City of Parramatta Council.

Opportunities for the redevelopment of the residual land would be identified subject to meeting the applicable planning requirements. Future land uses for residual land is discussed on a precinct by precinct basis in sections 11.7.3 (Westmead), 12.7.3 (North Parramatta), 13.7.3 (Paramatta CBD), 14.7.3 (Rosehill and Camellia) and 15.7.3 (Carlingford).

Table 6.4 Proposed primary construction compounds

<table>
<thead>
<tr>
<th>COMPOUND</th>
<th>GENERAL LOCATION AND DESCRIPTION</th>
</tr>
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<tbody>
<tr>
<td>Westmead</td>
<td>The construction compound would be located on the corner of Railway Parade and Hawkesbury Road to the north of Westmead Station. The compound would support construction activities proposed to be carried out between Westmead Railway Station and the Cumberland Hospital Precinct. The construction compound would operate on a 24/7 basis. Access to the compound would be from Hawkesbury Road. The compound would be located at the site of the proposed Westmead terminus for the project and would require the demolition of several commercial properties.</td>
</tr>
<tr>
<td>Hawkesbury Road</td>
<td>The compound would be located on the corner of Hawkesbury Road and Hainsworth Street at the site of the Wesley Apartments. The compound would support construction activities proposed to be carried out between Westmead Station and the Cumberland Hospital Precinct and would be accessed from Hawkesbury Road. The construction compound would operate during standard construction hours to minimise noise impacts to the adjacent residential receivers.</td>
</tr>
<tr>
<td>COMPOUND</td>
<td>GENERAL LOCATION AND DESCRIPTION</td>
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<tr>
<td>Cumberland Hospital</td>
<td>The compound would be located within Cumberland Hospital Precinct (west) between the Willow and Jarrah cottages and the Boronia Unit which would be demolished and later form part of the operational footprint. The compound would support construction activities proposed to be carried out within the Westmead precinct and also to support construction of the Parramatta North Bridge and would operate on a 24/7 basis. The site layout would be configured so as to avoid the need to remove any of the trees within the site; however there is potential that some trees may require trimming to provide clearance for construction plant, equipment and laydown areas.</td>
</tr>
<tr>
<td>Parramatta North precinct</td>
<td>The compound would be located within the Cumberland Hospital Precinct and is part of the area transferred to UrbanGrowth NSW for the construction of the Parramatta North Urban Transformation. The site is in a cleared area on the eastern bank of Parramatta River near the Parramatta River Bridge at Westmead. The compound would support works associated with the construction of the project generally and in particular, construction of Parramatta North Bridge and would operate on a 24/7 basis. Capping material would be placed on top of the existing topography to establish a flat site. The use of the compound would require the clearing of a community vegetable garden. Access to the compound would be from the existing Cumberland Hospital (east) Precinct access roads. During works on the Parramatta North Bridge, emergency vehicle access would be maintained at all times (refer section 6.14.8).</td>
</tr>
<tr>
<td>Factory Street</td>
<td>The compound would be located on the corner of Factory Street and Church Street. The site of the compound currently contains an apartment building which would be demolished and a substation would be constructed at the site. The compound would support construction activities within the Parramatta North precinct and would operate on a 24/7 basis. Limited construction parking would be provided on-site. Access to and from the compound would be via Church Street.</td>
</tr>
<tr>
<td>Fennell Street</td>
<td>The compound would be located on the corner of Fennell Street and Church Street in the area primarily acting as an at-grade car park and would also include several of the adjacent commercial properties fronting on to Church Street. The compound would support construction activities within the Parramatta North precinct and would operate on a 24/7 basis. Access to and from the compound would be via Church Street.</td>
</tr>
<tr>
<td>Ross Street</td>
<td>The compound would be located on the corner of Ross Street and Church Street in the site that currently comprises the Royal Oaks Hotel which would be demolished and eventually form part of the operational footprint for the light rail. The compound would support construction activities within the Parramatta North precinct and would operate on a 24/7 basis. Access to and from the compound would be via Church Street.</td>
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<tr>
<td>COMPOUND</td>
<td>GENERAL LOCATION AND DESCRIPTION</td>
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<tr>
<td>Parramatta CBD precinct</td>
<td>The compound would be located within a vacant lot accessible from O’Connell Street and on the western side of Parramatta River, directly adjacent to the foreshore. This compound would be the primary compound to support the off-alignment road works required to minimise traffic impacts during construction and operation of the project. The compound would operate on a 24/7 basis. Access to and from the compound would be via O’Connell Street.</td>
</tr>
<tr>
<td>O’Connell Street</td>
<td>The existing Endeavour Energy substation located at 1A Barrack Lane would be acquired to construct a substation for the project. Until the construction of the substation, the site would be used for the storage of small materials and provision of staff facilities. Following completion of the main activities within the Parramatta CBD, a substation would be constructed at this site. Barrack Lane is a one-way street accessible from George Street with traffic exiting on to Macquarie Street. No construction parking would be provided at the compound.</td>
</tr>
<tr>
<td>Barrack Lane</td>
<td>The compound would be located at 129–133 Alfred Street, Parramatta, and occupies land that ultimately would contain light rail infrastructure. Until required for the construction of light rail infrastructure, it would support construction activities within Parramatta CBD as well as the bridge crossing over Clay Cliff Creek and James Ruse Drive and would operate on a 24/7 basis. Some construction parking would be provided at this site. Vehicles accessing and leaving the compound would do so along Hassall Street. A secondary access route would be along George Street.</td>
</tr>
<tr>
<td>Rosehill and Camellia precinct</td>
<td>The compound would be located on the southern side of Parramatta River adjacent to the T6 Carlingford Line. The site is currently used as a maintenance site for Sydney Trains and utility providers. The site would be used to support works associated with modifications to the Parramatta River Bridge and would operate on a 24/7 basis. A retaining wall would be constructed downslope and capping material would be placed on top of the existing topography to establish a flat site. The site would be lined with geofabric material and stabilised with blue metal. The site would include a pad mount and crane. Construction vehicles would access the site via an access road than runs parallel and to the west of the T6 Carlingford Line. Vehicles would cross beneath the rail alignment through the James Hardie underpass to access the compound.</td>
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## General Location and Description

<table>
<thead>
<tr>
<th>Compound</th>
<th>General Location and Description</th>
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</thead>
<tbody>
<tr>
<td><strong>Carlingford precinct</strong></td>
<td>The compound would be located on the northern side of Parramatta River adjacent to the T6 Carlingford Line and within Western Sydney University Parramatta campus. The site would be used to support works associated with modifications to the Parramatta River Bridge and would operate on a 24/7 basis. A retaining wall would be constructed downslope and capping material would be placed on top of the existing topography to establish a flat site. The site would be lined with geofabric material and stabilised with blue metal. The site would include a pad mount and crane. Vehicles would access the site from Railway Street off Victoria Road, and through the Western Sydney University Campus.</td>
</tr>
<tr>
<td><strong>Parramatta River Bridge North</strong></td>
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</tr>
<tr>
<td><strong>Vineyard Creek</strong></td>
<td>The compound would be located within a grassed area and bordered by Railway Street, Vineyard Creek and the T6 Carlingford Line near Rydalmere Station. The construction compound would be required to support modifications to the rail bridge over Vineyard Creek and more generally for works within the Carlingford precinct. The compound would operate during standard construction hours to minimise noise impacts to the adjacent residential properties. A retaining wall would be constructed downslope and capping material would be placed on top of the existing topography to establish a flat site. The site would be lined with geofabric material and stabilised. The site layout would be configured so as to avoid the need to remove any of the trees within the site; however, there is potential that some trees may require trimming to provide clearance for construction plant, equipment and laydown areas. Vehicles would access the site from Railway Street off Victoria Road, via the Western Sydney University Campus.</td>
</tr>
<tr>
<td><strong>Rydalmere Station (west)</strong></td>
<td>The compound would be located within an existing Sydney Trains maintenance compound located off Victoria Road and adjacent to the west of the T6 Carlingford Line near Rydalmere Station. The construction compound would be required to support construction of the new rail bridge over Vineyard Creek and more generally for works within the Carlingford precinct. The compound would operate during standard construction hours to minimise noise impacts to the adjacent residential properties. Access to the site would be off Victoria Road and along an unnamed and unsealed private road.</td>
</tr>
<tr>
<td><strong>Rydalmere Station (east)</strong></td>
<td>The compound would be located within the existing Rydalmere commuter car park located off Victoria Road and adjacent to the east of the T6 Carlingford Line near Rydalmere Station. The construction compound would be the main compound supporting modifications to the rail bridge over Vineyard Creek and more generally for works within the Carlingford precinct. The compound would operate during standard construction hours to minimise noise impacts to the adjacent residential properties. Access to and from the compound would be via Brodie Street.</td>
</tr>
<tr>
<td>COMPOUND</td>
<td>GENERAL LOCATION AND DESCRIPTION</td>
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</tbody>
</table>
| Dundas Station            | The compound would be located in an existing Sydney Trains maintenance compound and Dundas Station commuter car park. The compound would support construction activities within the Carlingford precinct.  
                          | The compound would operate during standard construction hours to reduce noise impacts to nearby sensitive receivers.  
                          | Vehicles would access the compound via an existing access gate on the corner of Dudley Street and Calder Road and exit through the commuter car park onto Station Street.                                                                                               |
| Kissing Point Road        | The compound would be within Vineyard Creek Reserve located off Kissing Point Road near the bridge. This compound would support the duplication of the Kissing Point Road Bridge and general construction works within the Carlingford precinct.  
                          | The compound would generally operate during standard construction hours however would operate out of standard hours during night work periods associated with the Kissing Point Bridge duplication.  
                          | Capping material would be placed on top of the existing topography to establish a flat site. The site layout would be configured so as to avoid the need to remove any of the trees within the site; however there is potential that some trees may require trimming to provide clearance for construction plant, equipment and laydown areas.  
                          | Access to and from the site would be via Kissing Point Road (eastbound).                                                                                                                                                           |
| Adderton Road compound    | The compound would be located in an existing Sydney Trains maintenance compound located in the rail corridor off Adderton Road. The compound would support general construction activities within the Carlingford precinct and would operate during standard construction hours.  
                          | The existing surface of the compound is hardstand and would not require any modification or excavation.  
                          | Vehicles would access the compound via Adderton Road.                                                                                                                                                                              |
| Telopea Station           | The compound would be located within the at-grade commuter car park located adjacent to Telopea Station. This compound would support construction activities within the Carlingford precinct and would operate during standard construction hours.  
                          | The existing surface of the compound is hardstand and would not require any modification or excavation. Access to the compound would be via the existing drive way located on Sturt Street.                                                 |
| Carlingford Station       | The compound would be located within an open space area north of Carlingford Station on land owned by RailCorp. The compound is located within the curtilage of the heritage listed Carlingford Produce Store however would not impact on the fabric of the building. The compound would support construction activities within the Carlingford precinct and would operate during standard construction hours.  
                          | Access to the compound would be from Pennant Hills Road and through the Carlingford Station commuter car park or via Boundary Road.                                                                                               |
6.12.3 Substation work sites

Smaller work sites would be required for each of the proposed substations (refer to Figure 6.2a to Figure 6.2h). The size of these work sites would be considerably smaller that the main work sites described in section 6.12.2. Work sites for proposed above ground substations would generally be approximately 250 square metres in size (assuming a one metre offset to the site boundary) and would accommodate laydown for the prefabricated substation and a large mobile crane.

6.12.4 Potential for selecting additional construction sites

Although every endeavour has been made to identify all lands required for construction, the construction contractor(s) may require additional construction sites and/or compounds to those detailed above. Alternative or additional sites would be assessed against the following performance criteria:

» Works comply with all relevant mitigation measures as outlined in the CEMP as required under the conditions of the approval.
» Does not increase daytime or night time maximum noise levels or average noise predictions identified within the Environmental Impact Statement.
» Not require native vegetation clearing beyond that already required for the project.
» Not have any more than a minor impact on heritage items beyond those already required for the project.
» Not unreasonably affect the land use of adjacent properties.

6.12.5 Stockpiling

Stockpiling of construction materials and spoil would generally occur within proposed construction compounds (as shown in Figure 6.2a to Figure 6.2h) as well as throughout the construction work site where the alignment is wide enough to accommodate a stockpile. These areas would be used to store equipment and small quantities of spoil and materials for day-to-day use as well as facilities and ablutions for use by construction personnel.

All stockpiled materials would be stored in accordance with the ‘Blue Book’ Managing Urban Stormwater: Soils and Construction (Landcom 2004) and kept away from waterways and stormwater drainage structures to avoid sediment entering surrounding waterways. All fuels, chemicals and hazardous liquids would be stored within an impervious bunded area in accordance with Australian Standards and NSW Environment Protection Authority guidelines.

6.13 Construction traffic generation

Construction traffic would comprise vehicles transporting equipment, materials and spoil, as well as light vehicles. Minor volumes of materials are expected to be excavated for utility relocations/protection works, or for the track slab. Larger numbers of heavy vehicle movements would likely occur during the main civil construction works when heavy vehicles are required to transport spoil, concrete, equipment, tracks, overhead wiring etc.

Average and peak daily heavy vehicle movements anticipated to occur within each precinct during the construction of the project are outlined in Table 6.5. These truck movements have been estimated based on the average number of truck movements per day and the individual peak number of heavy vehicle movements for any activity throughout the works. The truck movements stated in Table 6.5 are indicative only and may change as a result of detailed construction planning.

Generally, the peak level of truck movements are anticipated to be associated with concrete pours, which would typically be of short duration (extending over one to four shifts, nominally over one to four days, depending on whether day or night work is proposed).
6.14 Construction traffic, transport and access management strategies

The project would require construction works to be carried out within or adjacent to major arterial/sub-arterial and local roads in the Westmead, North Parramatta, Parramatta CBD, Rosehill and Camellia and Carlingford precincts. The following sections provide an outline of the broad traffic, transport and access management strategies that would be adopted during the construction across the entire project. Details of specific construction traffic, transport and access management measures are discussed on a precinct by precinct basis in sections 11.3.3 (Westmead), 12.3.3 (North Parramatta), 13.3.3 (Parramatta CBD), 14.3.3 (Rosehill and Camellia) and 15.3.3 (Carlingford).

6.14.1 Intersection works

Disruption to current intersection movements would generally be kept to a minimum (to maintain network operations) through the adoption of the following principles:

- Partial or full closures of major intersections would not be carried out during peak traffic periods (works would generally be scheduled for quieter traffic periods such as at night or on weekends).
- Intersection closures would be staged in consultation with Roads and Maritime Services, the Sydney Coordination Office and the Traffic Management Centre (TMC) to minimise network impacts.
- Major closures of intersections could be scheduled to occur at times of the year with reduced traffic demand (e.g., school holidays) or on weekends.
- The days and times for proposed intersection works would be qualified and assessed/approved by the TMC.

### Table 6.5 Indicative average and peak daily heavy vehicle movements estimated during the construction of the project

<table>
<thead>
<tr>
<th>PRECINCT</th>
<th>AVERAGE DAILY HEAVY VEHICLE MOVEMENTS¹</th>
<th>MAXIMUM DAILY HEAVY VEHICLE MOVEMENTS²</th>
<th>MAXIMUM HOURLY HEAVY VEHICLE MOVEMENTS³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Westmead</td>
<td>27</td>
<td>137</td>
<td>12</td>
</tr>
<tr>
<td>North Parramatta</td>
<td>31</td>
<td>269</td>
<td>24</td>
</tr>
<tr>
<td>Parramatta CBD</td>
<td>29</td>
<td>77</td>
<td>7</td>
</tr>
<tr>
<td>Rosehill and Camellia</td>
<td>20</td>
<td>227</td>
<td>21</td>
</tr>
<tr>
<td>Carlingford</td>
<td>39</td>
<td>136</td>
<td>12</td>
</tr>
<tr>
<td>Camellia Maintenance and Stabling Facility</td>
<td>96</td>
<td>103</td>
<td>9</td>
</tr>
</tbody>
</table>

(1) Average daily vehicle movements represent the total inbound and outbound truck movements (two-way) for the precinct (excluding testing and commissioning phase).

(2) Maximum average daily vehicle movements include the total inbound and outbound truck movements (two-way) for the precinct (including asphalt delivery, civil and drainage materials, concrete trucks, flatbeds for steel and rail, rigid tippers, truck and dogs and water carts).

(3) Maximum hour vehicle movements assumes the maximum average daily volumes are evenly distributed over weekday construction hours (7 am to 6 pm).
Advanced public notification of upcoming road closures would be provided, with alternative routes advertised.

A hierarchy of major and minor intersections would be established for the project for the purposes of determining appropriate closure treatments and interdependencies. Intersection works would be carried out in accordance with a road occupancy licence (ROL) approval identifying time and day restrictions. Works would be restricted to periods of low traffic volume, typically:

- Night works (9 pm to 5 am) — staged and full intersection closures.
- Weekend works (9 pm Friday to 5 am Monday) — staged and full intersection closures.

During these closures, pedestrian crossing movements would be managed by directing pedestrians around the intersection, to alternate footpaths or where permitted by the work, providing a path through the work site.

A description of construction works proposed at key road intersections is provided in sections 12.3.3 (Westmead), 13.3.3 (North Parramatta), 14.3.3 (Parramatta CBD), 15.3.3 (Rosehill and Camellia) and 16.3.3 (Carlingford).

### 6.14.2 Traffic signal modifications

Traffic signal modifications are likely to be required to facilitate the network management measures recommended to minimise and avoid traffic impacts. Management measures are described in Chapter 4 of Technical Paper 2 (Construction Traffic and Transport Technical Report). Traffic signal modifications are likely to include:

- Phase adjustments
- Temporary phasing to facilitate construction staging
- Kerb adjustments
- Geometry changes
- Turn bays

Any temporary or permanent works requiring reconstruction or adjustment to traffic signals would require prior approval of traffic signal design plans from the relevant road authority. Prior approval of the timing of intersection works may also be required from the TMC to determine appropriate times for works. The construction contractor(s) would be responsible for the preparation of traffic signal designs and obtaining prior approvals. Designs would comply with the Roads and Maritime Services manual, Traffic Signal Design and Specification SI/TCS/8 Installation and Reconstruction of Traffic Light Signals. Any works would be carried out by a Roads and Maritime Services accredited traffic signal contractor.

### 6.14.3 Road changes

Key road changes that would occur during the construction of the project would include the following:

- Hawkesbury Road and Hainsworth Street road modifications would be staged to minimise impacts to traffic. Access would be maintained along Hawkesbury Road however lanes would be closed throughout the construction period. Traffic along Hawkesbury Road would be restricted to one-way northbound with southbound traffic being directed along Park Avenue and Queens Road.

- Factory Street would become local-access-only and a cul-de-sac would be constructed at its eastern end to reduce traffic during the peak construction period.

- George Street (between O’Connell Street and Harris Street) would become a two-lane, two-way street.
» Church Street (between Factory Street and Lennox Bridge) would become local access only during construction works with traffic detouring along O’Connell Street.

» Church Street (between Lennox Bridge and Macquarie Street) would become construction and emergency access only in a southbound direction.

» Macquarie Street would become local access only during construction and be restricted to one lane travelling eastbound.

» George Street (between Purchase Street and Alfred Street) would become local access only during construction.

» Tramway Avenue (between Alfred Street and Arthur Street) would become local access only during construction.

» Temporary speed restrictions and lane restrictions would be established on James Ruse Drive during construction of the bridge crossing with a number of temporary full road closures required to lift support beams into place.

» Temporary speed and lane restrictions would be established on Kissing Point Road Bridge to allow the construction of the new bridge. Lane closures would be staged (inside lanes followed by outside lanes) over a period anticipated to be 18 months. A number of full road closures would also be required for installation of the precast bridge elements over the road. Traffic would be diverted via Silverwater Road, Victoria Road and James Ruse Drive. During this period limited local access would be maintained to Rippon Road, Bells Road, Leamington Road and Elder Road.

All traffic changes would be carried out in accordance with TMC approvals.

6.14.4 Bus operations

The construction of the project would require modifications to the existing bus network and Western Sydney University shuttle services at the following key locations:

» Westmead, along Hawkesbury Road

» North Parramatta Road along Church Street and O’Connell Street

» Parramatta along Macquarie Street

» The T6 Carlingford line.

The bus diversions proposed during the construction of the project would require off-corridor road works including changes to signage, parking restrictions, temporary bus stops and minor intersection reconfiguration.

6.14.4.1 Westmead

Bus operations in the Westmead precinct, in particular the buses that use Hawkesbury Road, would be affected by the construction activity. The North-west T-way buses would continue to operate in Darcy Road with the Darcy Road T-way station maintained as existing throughout the construction period. These buses would continue to Paramatta Interchange via Alexandra Avenue with a T-way stop on the south side of Westmead Station.

The North-west T-way routes (Route T60, T61, T62, T63, T64, T65, and T66) and Route 705 would not be affected by the construction of the project in Hawkesbury Road.

The bus routes that would be affected by construction activity in the Westmead Precinct include:

» Route 708 that operates to the Mayflower Retirement Village would be modified to operate from Darcy Road and Hawkesbury Road directly to Paramatta Interchange via Alexandra Avenue to no longer use Caroline Street, Park Avenue and Queens Road. The retirement village would be serviced by bus routes 711 and 818 via Park Avenue and Caroline Street.
» Route 711 that operates to the Children’s Hospital at Westmead en route to Parramatta Interchange. This would be diverted in a one-way loop around Hawkesbury Road, Hainsworth Street, Park Avenue and Caroline Street and then head to Parramatta CBD via Alexandra Avenue.

» Route 818 that terminates at the Children’s Hospital at Westmead would be modified to operate on Hawkesbury Road, Hainsworth Street, Park Avenue and Caroline Street.

» Bus stops would be maintained during the construction period at Westmead Children’s Hospital and in Caroline Street only.

Route 711 would continue to Parramatta Interchange via Darcy Road, Alexandra Avenue and Park Parade after servicing the Westmead Children's Hospital in Hawkesbury Road. Both Route 711 and Route 818 that terminates at the Westmead Children’s Hospital would operate via a one-way loop along Hawkesbury Road, Hainsworth Street, Park Avenue, Caroline Street to service Westmead Children’s Hospital and the Mayflower Retirement Village in Caroline Street. This one-way loop through the Westmead precinct would require standard 12.5 metre buses to be managed with construction traffic controls. For the buses to safely make the right turns from Hainsworth Street into Park Avenue and from Park Avenue into Caroline Street, it is recommended that the sections of Hainsworth Street east of the light rail construction zone and Park Avenue north of Caroline Street be changed for one-way traffic only.

The terminating Route 818 would require a layover area. There is currently insufficient space available at the bus stop in Hawkesbury Road at the entrance of the Children’s Hospital at Westmead. Up to five car spaces of on-street parking on the north side of Hainsworth Street would be removed for a layover zone for up to two terminating buses.

### 6.14.4.2 Parramatta North

Bus operations in the Parramatta North precinct would be affected during construction of the project. Alternative options to using Church Street in North Parramatta include short term temporary diversions. These include:

» Windsor Road services via Board Street and Bamey Street to O’Connell Street would require routes 549, 600, 601, 603, 604, 606, 706 and M60 to be diverted via Board Street/Bamey Street to O’Connell Street and Victoria Road to operate all stops; however, the bus stops in O’Connell Street between Bamey Street and Victoria Road would be rationalised from six to three stops to improve efficiency.

» The Pennant Hills Road corridor routes M54 and 625 would be diverted via Albert Street to O’Connell Street and Victoria Road with bus stops rationalised in O’Connell Street.

» Route 609 would be diverted to O’Connell Street in both directions via Dunlop Street; stop sign traffic controls would be installed to give east-west bus movements priority.

» Routes 546 and 552 would remain as existing, but be managed through the construction zone south of Grose Street; an alternative one-way route via Sornell Street and Brickfield Street would be used when Church Street is not available.

The existing bus layover in Market Street would be maintained with active traffic control.

### 6.14.4.3 Parramatta

The operation of the Western Sydney University student shuttle bus services between the Parramatta and Parramatta CBD campus would be impacted during construction of the project, as the current bus stop on Macquarie Street would not be accessible.

During construction, the existing indented bay on Smith Street north of Darcy Street adjacent to the Sydney Water building would be used as the bus stop and terminus layover area for the shuttle bus. The return bus trip would be via Smith Street, Wilde Avenue to Victoria Road. This CBD stop has space for waiting customers on the footpath and shelter under the overhang of the Sydney Water
building. Consultation would be carried out with Western Sydney University regarding the adjustments to this shuttle service.

6.14.4.4 Carlingford

The T6 Carlingford Line train services would be discontinued at the start of the construction of the project between Camellia and Carlingford. A shuttle bus service would run between Carlingford and Parramatta, providing existing commuters on the Carlingford Line with connections to the T1 Western and T5 Cumberland Lines. The shuttle bus would operate every 10 minutes during peak periods and every 30 minutes in the off-peak periods and evenings. Additional buses would be added as required to meet peak demand. As outlined in Figure 6.5, the shuttle bus route would operate between Carlingford and Parramatta and would include stops near Rydalmere, Dundas and Telopea Stations. Buses would be low-floor and wheelchair accessible.
Figure 6.3 | Westmead precinct bus operations during construction of the project
Figure 6.4 | Parramatta North precinct bus operations during construction of the project
Figure 6.5 | Route of the shuttle bus replacing the T6 Carlingford Line
6.14.5 Pedestrian traffic management

For the majority of construction works, existing pedestrian movements running parallel to the project alignment would be maintained along the footpaths. Pedestrian movements crossing the project alignment would generally be maintained at existing pedestrian crossing facilities either at signals or controlled by traffic controllers.

Where the installation of overhead wiring foundations and service relocations encroach on footpaths, the footpaths would be temporarily narrowed past the work site or pedestrians would be diverted to adjacent footpaths via safe crossing facilities with appropriate barriers and signs. Footpaths adjacent to work sites with high volumes of construction vehicle movements would require traffic controllers to manage the conflict between construction vehicles and pedestrians.

Where work sites have an impact on footpaths, consideration would be given to the requirements of all pedestrians and especially users with specific requirements (e.g. those with mobility limitations). Disability Discrimination Act 1992 (DDA) requirements would be adopted (e.g. with drop kerbs, etc. provided at crossings). Footpath widths would allow two-way pedestrian traffic, with sufficient space provided to accommodate prams and wheelchairs. Where high numbers of users with specific requirements utilise a footpath, special provision and design consideration would be carried out to minimise impacts to these pedestrians.

6.14.6 Cycle routes

Where existing cycle routes or facilities are occupied by the construction work sites, alternate routes would be identified. Alternative major cycle route changes that are currently anticipated to be required during the construction of the project include the following:

» Hawkesbury Road cycle path (between Railway Parade and Queens Road) would be temporarily impacted during construction.

» Harris Street cycle path (between Macquarie Street and George Street) would be temporarily impacted during construction.

» James Ruse Drive cycle path would be temporarily impacted during construction of the light rail bridge.

Any proposed alternate cycle route would be reviewed by the relevant roads authority, prior to their establishment. Existing cycle paths located within the construction corridor, but not occupied by the required work site, would be maintained during construction unless temporary diversions are required during the works.

6.14.7 On-street parking

On-street parking and loading zones along the project corridor would be affected during construction to provide sufficient work site width and to maximise the number of traffic lanes available. These changes would apply from the commencement of construction in any area, and would be permanent (in certain locations).

Loading zones, disabled parking, taxi ranks and service vehicle zones impacted by the project would be relocated, where possible, to the permanent location proposed for these users in adjacent side streets.

Transport for NSW would continue to work with the key stakeholders involved in the management and operation of the road network and management of kerbside activity to implement a number of mitigation measures. These are outlined in sections 11.3, 12.3, 13.3, 14.3, and 15.3 of the Environmental Impact Statement. The City of Parramatta Council will be a key stakeholder in the implementation of any changes to the function and management of on-street kerbside activity within the area of influence of the project. The purpose of further consultation and design would be to ensure appropriate and satisfactory measures are implemented which promote better utilisation and efficiency of use for kerbside space, while considering the access requirements of local...
residents, businesses, sporting, health and education use and all other land uses along and in the vicinity of the corridors.

6.14.8 Emergency access

Access for emergency vehicles would be maintained at all construction sites and emergency services would be advised of all planned changes to traffic arrangements prior to applying the changes. Advice would include information about upcoming traffic switches, anticipated delays to traffic, extended times of work, locations of road possession or any likely major disruptions.

Measures to facilitate the movement of emergency vehicles through work sites would be outlined in the work site specific traffic management plans. These measures may include the establishment of clearways adjacent to work sites and/or the installation of road plates.

During short periods when major construction and loading/unloading activities are underway, it may not be possible to allow emergency vehicles to traverse the full block length. Access to an emergency within the block would be maintained at an identified access point and diversion routes would be agreed with the emergency services prior to the commencing the major construction and loading/unloading activities. The construction contractor(s) would consult with emergency services (such as fire, police and ambulance) during the preparation of the site specific traffic management plans, to obtain any specific requirements for any of the buildings adjacent to the project alignment in preparing the site specific traffic management plans. An Emergency Management Plan would coordinate these measures and provide a framework for input to the individual work site traffic management plans.

Access to Westmead Hospital and the Children’s Hospital at Westmead would be maintained at all stages of construction. The northbound lane approaching the Children’s Hospital at Westmead would be open to traffic at all times (for hospital and local traffic only).

Access within Cumberland Hospital, particularly access to the bridge over Parramatta River, would be maintained at all times during the construction of the project with a new Parramatta North Bridge to be constructed adjacent to the existing bridge on the south side.

Church Street (between Lennox Bridge and Macquarie Street) would be closed to all traffic, during construction works. Intersections crossing Church Street at Phillip Street, Victoria Road and George Street would generally be maintained, except during intersection construction works, during which appropriate traffic management controls and diversions would be implemented.

6.14.9 Emergency evacuation procedures for buildings

It is anticipated that emergency evacuation procedures for buildings located along the project alignment may need to be amended to account for the project construction work site and compounds. This would particularly be the case for buildings which utilise public open spaces affected by the project as emergency evacuation marshalling areas. Transport for NSW would consult with building owners/managers along the project alignment to assist with the redesign of emergency evacuation procedures for affected buildings.

Emergency evacuation requirements would need to be agreed with emergency service providers (fire brigade). Depending on the stage of work this may require:

» Temporary road plates to permit crossing of the work zone.

» Assistance of traffic controllers in restricting public access to the street block and facilitating access for emergency service vehicles.

» Protocols for managing emergency response, which would need to be agreed with service providers prior to the start of work.

» Protocols to manage the evacuation of occupants adjacent to the work site, which would need to be agreed with the building owners and service providers prior to the start of work.
6.14.10 Property and utility access

Access would be maintained along the project corridor to minimise the impact on local residents and businesses, and to maintain access to utilities. However, due to the closure of some approach alignments, diversions to properties on or adjacent to the project corridor would result in some increased travel distances. The area most affected due to the closure of key corridors would be the Parramatta CBD (due to the closure of Church Street and Macquarie Street). For these precincts, access maps have been produced to detail the effect of these alternate routes. These precinct maps are provided in Appendix A of Technical Paper 1 (Construction Traffic and Transport Management Plan).

Further discussion on measures that would be adopted to maintain access to local businesses and residences along the project corridor are described on a precinct by precinct basis in sections 11.3.3 (Westmead), 12.3.3 (North Parramatta), 13.3.3 (Parramatta CBD), 14.3.3 (Rosehill and Camellia) and 15.3.3 (Carlingford).

6.14.11 Midblock works

Midblock cross-sections along the construction corridor dictate the number of traffic lanes that could be kept open to traffic during the construction program. Access would be maintained to local land uses, including residential, employment and commercial uses. Traffic lanes provided adjacent to construction work sites would be in accordance with Roads and Maritime Services' Traffic Control at Work Site Manual Version 4.0 and Roads and Maritime Services' D&C G10 Traffic Management. All safety barriers adjacent to traffic lanes would be in accordance with Australian Standard 1742 Manual of Uniform Traffic Control Devices, the RMS Supplements to Australian Standards and other Roads and Maritime Service complementary materials.

6.14.12 Special event management

The Roads and Maritime Services’ special event management guidelines process identifies four classes of special events:

» Class 1: is an event that impacts major traffic and transport systems and there is significant disruption to the non-event community. (For example, an event that affects a principal transport route in Parramatta, or one that reduces the capacity of the main highway through a country town.)

» Class 2: is an event that impacts local traffic and transport systems and there is low scale disruption to the non-event community. (For example, an event that blocks off a main street town or shopping centre but does not impact a principal transport route or a 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 vehicle.)

Wherever possible, agreement would be sought with event organisers to avoid Class 1 and 2 events occurring concurrently, where such events are identified to have a cumulative impact on travel demand around the project construction corridors.

The traffic management requirements of special events may require adjustment to times of operation and routes used by haulage or delivery operations as well as varying approved ROL conditions for the construction. The ROL approval would identify time and day restrictions, where potential conflicts are known at the time of submission.

The construction contractor(s) would be responsible for incorporating known special events into the construction program and detailed responses and contingencies in the construction traffic management plan, subject to further inputs from other stakeholders (such as The City of Parramatta Council, State Emergency Services, the Sydney Coordination Office and Roads and Maritime...
Services). The construction contractor(s) would work with event organisers to identify the possibility of relocating planned events, if possible.

6.15 Other construction elements

6.15.1 Demolition

It is anticipated that construction of the project would require the demolition of a number of buildings located within the construction disturbance footprint. Some demolition would occur in the enabling works phases before substantial construction begins. This would allow the timely mobilisation of sites designated to be used as construction compounds during main construction works prior to the construction of their specific final uses.

Typically, access and egress to and from the site during the demolition would use existing driveways; however, alternative site access may be required. Indicative heavy vehicle movements associated with the demolition phase are described on a precinct by precinct basis in sections 11.3.3 (Westmead), 12.3.3 (North Parramatta), 13.3.3 (Parramatta CBD), 14.3.3 (Rosehill and Camellia) and 15.3.3 (Carlingford).

Demolition would be carried out by a licensed demolition contractor and in stages 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, made safe and redundant.
- 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.

A hazardous materials analysis would be carried out prior to stripping and demolition of the structure. Any hazardous materials 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 practicable and sent to a waste facility with recycling capabilities.

Other structures that would be demolished include paving, kerbs, utility and drainage pits, culverts and bridge decking.

Construction contractors would be required to meet the requirements of the Construction Environmental Management Plan (refer to Chapter 17).

6.15.2 Spoil removal

Estimated volumes of excavated materials are outlined in section 6.6.2.

Construction haulage routes for heavy vehicles accessing construction compounds have been developed based on the following principles:

- Heavy vehicles generally should access the work sites via the shortest route possible from the arterial road network.
- The construction corridor should be used as much as possible for haulage to minimise impact on surrounding road network.

Spoil volumes would be generally small. Indicative construction spoil haulage routes are provided on a precinct by precinct basis in Figure 6.6 and Figure 6.7.

Haulage routes would be refined in consultation with relevant stakeholders and as site-specific Traffic Management Plans are developed. Any additional haulage routes required during the
construction phase would require approval from Transport for NSW and the relevant road authority prior to use. All haulage routes and protocols would be communicated in detail to construction personnel during inductions, specifying travel times during various periods throughout the day.

Layover areas will be selected for storing vehicles arriving at spoil removal sites to manage the arrival and departure rates at work sites. It is not envisaged that there will be heavy vehicle storage provided in the Parramatta CBD to minimise the risk of conflict between construction vehicles and pedestrians in high pedestrian areas.
Figure 6.6 | Proposed inbound construction haulage routes
Figure 6.7 | Proposed outbound construction haulage routes
6.15.3 Remediation

6.15.3.1 Stabling and maintenance facility
As indicated in section 6.10, subsurface remediation works are proposed at 6 Grand Avenue, Rosehill as a separate project and would be completed prior to the commencement of construction of the stabling and maintenance facility at Camellia. These remediation works would be subject to a separate environmental impact assessment under Part 5 of the Environmental Planning and Assessment Act 1979 (EP&A Act). The aim of these subsurface remediation works is to render the site suitable for commercial/industrial land use, and mitigate off-site migration of contamination from the site.

6.15.3.2 Other remediation works
Contamination testing would be carried out to determine any remediation activities for sites identified as having a high risk of contamination. Further detail is provided in section 10.7.

6.15.4 Plant and equipment
Table 6.6 provides an indicative list of construction plant and equipment that may be required during key construction scenarios.

<table>
<thead>
<tr>
<th>PLANT/EQUIPMENT</th>
<th>CONSTRUCTION SCENARIO</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>TRACK WORKS</td>
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<tr>
<td>Rigid tippers</td>
<td>Yes</td>
</tr>
<tr>
<td>Saw</td>
<td>Yes</td>
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<tr>
<td>Suction truck</td>
<td>Yes</td>
</tr>
<tr>
<td>Truck and dog</td>
<td>Yes</td>
</tr>
<tr>
<td>Concrete agitator</td>
<td>Yes</td>
</tr>
<tr>
<td>Concrete pump</td>
<td>Yes</td>
</tr>
<tr>
<td>Bob cat</td>
<td>Yes</td>
</tr>
<tr>
<td>Profiler</td>
<td>Yes</td>
</tr>
<tr>
<td>Roller</td>
<td>Yes</td>
</tr>
<tr>
<td>Watercart</td>
<td>Yes</td>
</tr>
<tr>
<td>Piling rig</td>
<td>Yes</td>
</tr>
<tr>
<td>Grader</td>
<td>Yes</td>
</tr>
</tbody>
</table>
## Plant & Equipment

<table>
<thead>
<tr>
<th>Plant/Equipment</th>
<th>Construction Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compactor</td>
<td>Yes</td>
</tr>
<tr>
<td>Dozer</td>
<td>Yes</td>
</tr>
<tr>
<td>Excavator</td>
<td>Yes</td>
</tr>
<tr>
<td>Hydraulic hammer</td>
<td>Yes</td>
</tr>
<tr>
<td>Crane</td>
<td>Yes</td>
</tr>
<tr>
<td>Backhoe</td>
<td>Yes</td>
</tr>
<tr>
<td>Automated baseplate placing machine</td>
<td>Yes</td>
</tr>
<tr>
<td>Welder</td>
<td>Yes</td>
</tr>
<tr>
<td>Paver</td>
<td>Yes</td>
</tr>
<tr>
<td>Bitumen sprayer</td>
<td>Yes</td>
</tr>
<tr>
<td>Suction sweeper</td>
<td>Yes</td>
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<tr>
<td>Pneumatic jackhammer</td>
<td>Yes</td>
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<tr>
<td>Kerbing machine</td>
<td>Yes</td>
</tr>
<tr>
<td>Elevated working platform</td>
<td>Yes</td>
</tr>
<tr>
<td>Generator</td>
<td>Yes</td>
</tr>
<tr>
<td>Barge</td>
<td>Yes</td>
</tr>
<tr>
<td>Tug boat</td>
<td>Yes</td>
</tr>
<tr>
<td>Screen and crusher</td>
<td>Yes</td>
</tr>
<tr>
<td>Road plane</td>
<td>Yes</td>
</tr>
</tbody>
</table>
6.15.5 Resources and materials

Construction resources and materials required for the project would be determined during the detailed design and procurement phases of the project. These materials would likely include the following:

» Steel rails, structural steel and steel reinforcement, and prefabricated steel furniture and signage
» Diesel
» Petrol
» Lubricating oil
» Premix concrete
» Road sub-base and road base
» Timber/plywood
» Rock gabions
» Asphalt and bitumen
» Bentonite
» Water
» Concrete, sand and cement
» Precast concrete pipes and conduits
» Paving stones
» PVC conduit
» Paint
» Sleepers and ballast
» Structural fill (where existing subgrade material is not suitable).

6.15.6 Utilities and power supply

Utilities such as power and water would be supplied to each of the construction compounds. Generally, these utilities are located close to the sites (such as the adjacent footpath). In addition, sewer and communications services would be provided to the stabling and maintenance facility in Camellia, the O’Connell Street compound and the Fennell Street compound.

6.15.7 Demobilisation, rehabilitation and landscaping

At the end of construction, the contractor(s) would demobilise all construction equipment from the construction sites. Where relevant, sites that were occupied temporarily and do not form part of the operational footprint, such as temporary construction compound sites, would be rehabilitated at least to its former condition.

As part of the operational readiness phase, the contractor would progressively deliver the track infrastructure and light rail stops as described in Chapter 5 – Project description – operation. Typically, this would involve the progressive removal of construction equipment, site sheds and other temporary construction site elements.

Landscaping and finishing works would be carried out at permanent operational sites as described in Chapter 5 – Project description – Infrastructure and operation and Part D of the Environmental Impact Statement (within the precinct specific landscape character and visual amenity).
6.15.8 Heritage investigations, protection and archival recordings

Additional heritage investigations, protection work and archival recordings (as required) may be carried out prior to substantial construction to minimise delays and provide unrestricted access to the sites from the start of substantial construction.

6.15.9 Residual land

Following completion of construction any residual land not required for operational purposes would be returned to at least its former condition with the final use and any replacement structures subject to the relevant planning requirements as applicable to the land. This final land use would be identified in consultation with key stakeholders such as City of Parramatta Council.

6.15.10 Construction workforce

It is anticipated that the peak construction workforce across the project would be in the order of 500 full-time equivalent positions. These would be deployed across the whole project as required. For example, peak workforce for the Macquarie Street works, including subcontractors, is anticipated to be around 200 personnel.

6.15.11 Construction workforce parking

Worker parking provisions for light vehicles within, or near to, construction compounds would be provided across the project. Areas would be assigned for worker parking, which would be regularly reinforced through project inductions and toolbox talks.

The construction workforce would also be encouraged to use public transport (where feasible) to further reduce the impact of construction parking on surrounding areas, particularly for construction works within the Parramatta CBD. It is intended that workers could be transported from the above sites to their work sites using minibuses so as to minimise parking requirements for the project, as well as to reduce impacts on the local traffic conditions. A traffic management plan would be prepared to provide further details on car parking arrangements and minimise impacts on the surrounding network during construction of the project.

6.16 Construction hours

As the project would be constructed in sections through busy urban areas, construction works have the potential to disrupt traffic at a number of intersections throughout the study area. To minimise disruption to traffic and for safety reasons, it is anticipated that construction works would be required outside of standard construction hours. For example, within Parramatta CBD, works may need to take place outside of standard construction hours, particularly at busy intersections. Outside of Parramatta CBD, works would be carried out between 7 am and 11 pm, however, there would generally be more flexibility to restrict construction works outside of the CBD to the daytime and occasionally evening periods.

Where reasonable and feasible, preference would be given to scheduling construction works within the standard construction hours of 7 am to 6 pm Monday–Friday and 8 am to 1 pm on Saturdays (particularly those activities generating high noise and/or vibration levels). Any deliveries or service vehicles would need to be planned to occur at night or in the morning and in accordance with the contractor’s traffic management schedules.
The type of works that would be carried out outside of peak traffic periods (i.e. between 10 am and 3 pm and between 7 pm and 11 pm) include:

» Construction of the James Ruse Drive Bridge.

» Construction of a new bridge over Kissing Point Road and modifications to the existing rail bridge over Kissing Point Road to support the active transport link.

» Construction of track infrastructure at busy intersections, such as:
  - Macquarie Street and Church Street
  - Macquarie Street and Smith Street
  - Harris Street and George Street
  - Church Street and George Street
  - Church Street and Phillip Street
  - Church Street and Pennant Hills Road
  - Church Street and Victoria Road
  - Factory Street and Church Street
  - Factory Street and O'Connell Street
  - Hawkesbury Road and Darcy Road.

» Certain utility adjustments may be restricted to nights depending on the asset owner's requirements.

» Off-corridor works along George Street and O’Connell Street.

» Bridge works at Parramatta River, Camellia to avoid impacts on ferry operations.
7 Approach to the impact assessment and environmental risk analysis

This chapter provides an overview of the impact assessment approach carried out for this Environmental Impact Statement. This includes an explanation of the regional and precinct-based assessment approach, environmental risks identified and a summary of the specialist technical assessment methodologies.

7.1 Assessment of regional and local impacts

The alignment of the Parramatta Light Rail project would cross a number of distinctive areas/regions as it traverses between Westmead and Camellia and between Camellia and Carlingford. Accordingly, it would have a broad range of potential impacts on the environment ranging from direct and indirect regional effects (i.e. transport network changes and wider economic and land use impacts and benefits) through to very direct and local effects (such as noise impacts, changes to access and parking etc.)

As noted in section 1.6, this Environmental Impact Statement provides an assessment of both regional based impacts as well as local impacts.

The regional based assessment considers regional level impacts on the environment, including indirect impacts on regional planning and land use, traffic and transport and cumulative impacts. There are also some other environmental impacts (such as biodiversity, water and flooding, contamination, air quality, etc.) that are best described on a regional or whole-of-project basis. Regional based issues are addressed in Chapters 8 to 10.

For the local based assessment, a precinct approach was used on the basis that:

» The alignment for the project passes through five distinctive local areas (precincts), each of which has been determined based on these areas having similar characteristics (e.g. similar land uses etc.).

» The assessment enables presentation of all relevant environmental impacts for each precinct in one chapter of the Environmental Impact Statement to make it more readily relatable to the local communities potentially impacted, rather than those communities having to read through chapters that may be of little or no relevance to their local area of concern.

» It provides an opportunity to address and mitigate impacts within each precinct, so that specific mitigation is applied at the location where it is most relevant/needed.

Figure 1.3 (Chapter 1 – Introduction) showed the approximate extent of the five local precincts. The boundaries between and surrounding these precincts are indicative only and as such, are deliberately shown as broad areas. In some places, the impacts may also cross precinct boundaries, depending on the issue considered. The precinct-based assessment also provides a more tailored approach to addressing specific community and stakeholder issues and concerns.

Further details regarding the extent of each of the precincts are summarised in Table 7.1, along with the relevant chapters which assess the potential impacts associated with each of these precincts.
### Table 7.1 Impact assessment - Precinct areas

<table>
<thead>
<tr>
<th>AREA</th>
<th>GEOGRAPHIC DESCRIPTION</th>
<th>CHARACTER</th>
<th>RELEVANT EIS CHAPTER(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Westmead precinct</td>
<td>Between the Westmead terminus stop and the Parramatta River crossing west of the Cumberland Hospital site.</td>
<td>Primarily residential (low and medium density) with some commercial and retail premises. Includes major trip generators such as the Westmead health precinct, Western Sydney University (Westmead campus) and for interchange with Westmead Station and T-way buses.</td>
<td>Chapter 11 - Local impacts: Westmead Precinct</td>
</tr>
<tr>
<td>North Parramatta precinct</td>
<td>Between the Parramatta River crossing west of the Cumberland Hospital site and Victoria Road, Parramatta.</td>
<td>Combination of residential (low and medium density) at the northern end and comprising largely retail and commercial uses south of Pennant Hills Road intersection with Church Street. Also includes the future major trip generator of the Parramatta North Urban Transformation Area (UrbanGrowth NSW) and proposed future Western Sydney Stadium.</td>
<td>Chapter 12 - Local impacts: North Parramatta Precinct</td>
</tr>
<tr>
<td>Parramatta CBD precinct</td>
<td>Between Victoria Road, Parramatta and Purchase Street (east of Robin Thomas Reserve).</td>
<td>Primarily retail and commercial within the Parramatta CBD. Some parkland and open space (Robin Thomas Reserve). Includes major trip generators such as ‘Eat Street’ restaurants, commercial offices, retail spaces and for interchange at Parramatta Station.</td>
<td>Chapter 13 - Local impacts: Parramatta CBD Precinct</td>
</tr>
<tr>
<td>Rosehill and Camellia precinct</td>
<td>Between Purchase Street, the stabling and maintenance facility at Camellia and Parramatta River, Rydalmere (along the Carlingford branch line).</td>
<td>Suburban residential area (typically low and medium density) within the Rosehill area and industrial premises, typically to the east of James Ruse Drive and Rosehill Gardens Racecourse.</td>
<td>Chapter 14 - Local impacts: Rosehill and Camellia Precinct</td>
</tr>
<tr>
<td>Carlingford precinct</td>
<td>Within the existing T6 Carlingford Line corridor, north of Parramatta River, Rydalmere.</td>
<td>Suburban residential area (typically low and medium density) along the existing T6 Carlingford Line corridor. Small areas of retail and commercial premises generally surrounding each existing train station location. Future high density development currently being developed at Carlingford and proposed at Telopea.</td>
<td>Chapter 15 - Local impacts: Carlingford Precinct</td>
</tr>
</tbody>
</table>
7.2 Secretary environmental assessment requirements

The Secretary’s environmental assessment requirements (SEARs) for the project were issued by the Department of Planning and Environment on 19 April 2017, with revised SEARs issued on 21 July 2017 (refer to Appendix A). The project SEARs were reviewed in detail to confirm the impact assessment approach and the scope of key and non-key issues for assessment were included in this Environmental Impact Statement.

A checklist reflecting where the consolidated SEARs has been addressed throughout this Environmental Impact Statement is provided at Appendix B.

7.3 Environmental risk analysis

Environmental risk analysis, carried out at the commencement of project planning, is used to identify potentially significant environmental effects associated with the project. Evaluating a project’s construction and operating characteristics, and the baseline environment, helps in deriving potential issues and further impact assessment needs.

For the project, an environmental risk analysis was used to define key and non-key environmental, social and economic issues for assessment as part of the Environmental Impact Statement. It also helped to define mitigation measures for the project to assist in mitigating potential risks. This environmental risk analysis consisted of the following key processes:

» A preliminary environmental risk analysis was carried out for the purposes of scoping the Environmental Impact Statement and preliminary environmental assessment as part of the Parramatta Light Rail State Significant Infrastructure Application Report (Transport for NSW 2017).

» The preliminary analysis was updated using technical specialist input, once the Environmental Impact Statement specialist studies had commenced. The analysis was further updated once the Environmental Impact Statement studies were more developed and mitigation measures had been partially defined.

» Finally, a residual risk analysis was completed to confirm potential residual impacts after application of proposed management and mitigation measures. Key findings of the residual risk analysis are summarised in Chapter 18 – Environmental risk analysis.

7.4 Approach to the technical impact assessment

To assess the potential environmental impacts associated with the project, a number of technical specialist assessments were carried out. A summary of each of the technical impact assessment approaches/methodologies has been included in Table 7.2 below.

Technical impact assessments for each of the key environmental issues associated with this Environmental Impact Statement are provided in the supporting technical specialist papers, provided as Technical Papers 1 to 15 (refer to Volumes 2 to 7). These technical papers provide a more comprehensive description of the assessment approach including detailed methodologies, relevant legislation and guidelines that the assessment has been carried out in accordance with, potential impacts at local and regional scales as appropriate, and mitigation and management measures to avoid or minimise impacts.
### Table 7.2 Summary of technical impact assessment approaches

<table>
<thead>
<tr>
<th>ISSUE</th>
<th>SUMMARY OF IMPACT ASSESSMENT APPROACH/METHODOLOGY</th>
<th>REGIONAL AND/OR PRECINCT-BASED APPROACH</th>
<th>FURTHER DETAILS ON METHODOLOGY</th>
</tr>
</thead>
</table>
| Traffic, transport and accessibility | A construction traffic and transport impact assessment was prepared to document construction impacts of the proposal at both the regional network and precinct level. This included:  
» Detailed modelling of the impact of the construction scenario on the wider network during the morning peak (7 am to 9 am) and afternoon peak (4 pm to 6 pm) time period, using a traffic forecast year of 2016.  
» Assessment of both regional and precinct level construction impacts including impacts on:  
  • Local traffic, pedestrian, cycle and emergency vehicle access (including access to the Westmead Hospital Precinct)  
  • The number, frequency and size of construction related vehicles  
  • Construction worker parking  
  • Construction access routes  
  • Access constraints and impacts on existing or planned public and community transport and drop off zones, pedestrians and cyclists.  
» Preparation of a framework for alternative public transport arrangements during the period between the close of T6 Carlingford Line and the commencement of light rail operations.  
» Identification of mitigation measures to minimise any reduction in network performance and journey times for all road users, including travel demand management measures, to ensure demand is better matched to the temporarily reduced network capacity. | Both regional (network) and precinct-based | For construction impacts, refer to Technical Paper 2–Construction Traffic and Transport Impact Assessment in Volume 2 |
### Traffic, transport and accessibility (continued)

An operational traffic and transport assessment report was prepared to document operational impacts of the proposal at both the regional network and precinct level. This included:

- The detailed modelling of the impact of the project on the wider network included modelling of the morning peak (7 am to 9 am) and afternoon peak (4 pm to 6 pm) time period, using a traffic forecast year of 2026.
- The modelling framework adopted for the traffic assessment included:
  - Analysis and assessment of the existing traffic performance of the existing road network near the project alignment and at key intersections along the corridor including a level of service analysis for road and active transport users and pedestrians.
  - Evaluation of the impact of the project and associated road network changes (including wider transport interactions such as local and regional roads, active transport, public and freight transport).
  - Identification of further improvements if required, through evaluation of the traffic performance under future traffic scenarios.
- Traffic management changes as a direct consequence of the project and their impacts, including any potential impacts on surrounding precincts.
- The modelling tools and techniques adopted for the project as part of the construction and operation assessments included:
  - Mesoscopic – AIMSUN to assess the impact of the project on the broader transport network
  - Analytical – SIDRA Intersection to assess the intersections in isolation and identify the preferred intersection arrangements
  - Strategic – EMME including Sydney Strategic Transport Model (STM) and Public Transport Project Model (PTPM) to develop the forecast travel demand increases associated with land use changes and the project.

### Summary of Impact Assessment Approach/Methodology

<table>
<thead>
<tr>
<th>ISSUE</th>
<th>SUMMARY OF IMPACT ASSESSMENT APPROACH/METHODOLOGY</th>
<th>REGIONAL AND/OR PRECINCT-BASED APPROACH</th>
<th>FURTHER DETAILS ON METHODOLOGY</th>
</tr>
</thead>
</table>
| Traffic, transport and accessibility (continued) | An operational traffic and transport assessment report was prepared to document operational impacts of the proposal at both the regional network and precinct level. This included:  
  - The detailed modelling of the impact of the project on the wider network included modelling of the morning peak (7 am to 9 am) and afternoon peak (4 pm to 6 pm) time period, using a traffic forecast year of 2026.  
  - The modelling framework adopted for the traffic assessment included:  
    - Analysis and assessment of the existing traffic performance of the existing road network near the project alignment and at key intersections along the corridor including a level of service analysis for road and active transport users and pedestrians.  
    - Evaluation of the impact of the project and associated road network changes (including wider transport interactions such as local and regional roads, active transport, public and freight transport).  
    - Identification of further improvements if required, through evaluation of the traffic performance under future traffic scenarios.  
  - Traffic management changes as a direct consequence of the project and their impacts, including any potential impacts on surrounding precincts.  
  - The modelling tools and techniques adopted for the project as part of the construction and operation assessments included:  
    - Mesoscopic – AIMSUN to assess the impact of the project on the broader transport network  
    - Analytical – SIDRA Intersection to assess the intersections in isolation and identify the preferred intersection arrangements  
    - Strategic – EMME including Sydney Strategic Transport Model (STM) and Public Transport Project Model (PTPM) to develop the forecast travel demand increases associated with land use changes and the project. | Both regional (network) and precinct-based | For operational impacts, refer to Technical Paper 3 – Operational Traffic and Transport Impact Assessment in Volume 2 |
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<th>ISSUE</th>
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<th>FURTHER DETAILS ON METHODOLOGY</th>
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</table>
| Biodiversity  | A biodiversity assessment was prepared to address impacts during construction and operation in accordance with the Framework for Biodiversity Assessment, including:  
- A desk-based search of previous assessments, relevant databases and historical records to identify threatened flora and fauna species, populations and ecological communities; Commonwealth listed migratory species; or critical habitat recorded previously or predicted to occur in the vicinity of the study area.  
- Daylight and nocturnal site surveys by qualified ecologists to assess the nature, location and condition of fauna and vegetation habitats (including ground-truthing existing vegetation mapping) with a focus on threatened species, populations and ecological communities in October 2016 and December 2016.  
- Condition assessment of identified vegetation communities and fauna habitat assessments to assess the likelihood of threatened species of animal occurring within the study area.  
- Consideration of the potential impacts of the project on the ecological value identified including assessment of landscape features, native vegetation impacts, impacts on threatened species and populations, consideration of matters of national environmental significance.  
- Consideration of the potential for the project to be classified as a Key Threatening Process in accordance with the listings in the Threatened Species Conservation Act 1997, Fisheries Management Act 1994 and Environmental Protection and Biodiversity Conservation Act 2000 (EPBC Act 200).  
- Recommendations in regard to management and mitigation of impacts, including identification of required ecosystem credits to offset potential impacts.  
- An aquatic ecology technical report was prepared, including:  
  - Site visits of key locations with relevance to aquatic ecological impacts.  
  - Determining the aquatic ecological components (species, populations and ecological communities/habitats) present in the defined study area protected under current legislation, policies and guidelines. | Regional | Refer section 2 (biodiversity) of Technical Paper 4 – Biodiversity Assessment Report in Volume 3 Section 3 (aquatic ecology) (Appendix G of the Biodiversity Assessment Report) |
### Summary of Impact Assessment Approach/Methdoology

<table>
<thead>
<tr>
<th>Issue</th>
<th>Summary of Impact Assessment Approach/Methdoology</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>• Assessing the likelihood of occurrence of ecological components in the project study area.</td>
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<td></td>
<td>• Identifying impact pathways and assessing the risks of the project to relevant aquatic ecological components.</td>
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<td></td>
<td>• Identifying relevant mitigation measures that avoid, minimise or reduce potential impacts of the project on aquatic ecology and biodiversity.</td>
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<tr>
<td>Aboriginal heritage</td>
<td>• An Aboriginal cultural heritage assessment was prepared using the following general methodology:</td>
</tr>
<tr>
<td></td>
<td>• Carrying out background research and primary investigations, including ethnohistorical, landscape/environmental, archaeological and cultural, to identify Aboriginal cultural heritage places and values within the study area.</td>
</tr>
<tr>
<td></td>
<td>• Consulting with Aboriginal stakeholders through the Aboriginal heritage assessment process.</td>
</tr>
<tr>
<td></td>
<td>• Identification and assessment of identified Aboriginal archaeological and cultural heritage places and values within the study area including an assessment of significance prepared in accordance with the NSW Office of Environment and Heritage (OEH) requirements and guidelines relating to the assessment of Aboriginal heritage in NSW. Guidelines included: Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW (OEH 2010a); Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW (OEH 2011); and Aboriginal cultural heritage consultation requirements for proponents 2010 (OEH 2010b).</td>
</tr>
<tr>
<td></td>
<td>• Assessment of actual or likely harm to those Aboriginal objects or Aboriginal places from the proposed activities of the project.</td>
</tr>
<tr>
<td></td>
<td>• Identification of practical management and measures that may be taken to protect and conserve those Aboriginal objects or Aboriginal places. Any practical measures that may be taken to avoid or mitigate any actual or likely harm to those Aboriginal objects or Aboriginal places.</td>
</tr>
<tr>
<td></td>
<td>Regional</td>
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<td></td>
<td>Refer section 1 of Technical Paper 5 – Aboriginal Cultural Heritage Assessment in Volume 3</td>
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<tr>
<td>ISSUE</td>
<td>SUMMARY OF IMPACT ASSESSMENT APPROACH/METHODOLOGY</td>
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</table>
| Hydrology, flooding and water quality | An assessment of likely and potential impacts of the project on the surface water quality during construction and operation was prepared through:  
• Review of existing literature relating to the project, available water quality data and existing conditions using available non-project literature to obtain background information on catchment history and land use to aid in interpreting the existing conditions.  
• Assessment of the impact of construction activities on water quality with reference to the ANZECC/ARMCANZ (2000) water quality guidelines with regard to the nominated environmental values.  
• Assessment of any increases in pollutant loads as a result of the project.  
• Assessment of opportunities to provide water quality treatment measures for the project. | Regional | Refer section 3 of Technical Paper 6 – Water quality Impact Assessment in Volume 4 (hydrology and surface water) |
| | An additional assessment was carried out to assess the impacts of the project on flood behaviours during construction and operation through:  
• A review of existing hydraulic models, available flood and drainage information and previous flood studies, including the City of Parramatta Council’s Draft Parramatta CBD Floodplain Risk Management Plan.  
• Development of a baseline model to identify overland flow behaviour within the catchment and identify existing flood depths and levels, hydraulic categorisation and flood hazards (including consideration of climate change impacts).  
• Incorporation of the changes to the ground profile associated with the project were incorporated into the developed model to assess changes in flood behaviour.  
• Assessment of construction phase impacts and analysis of potential operational impacts including identification of:  
  − Post-project flood depths and levels | Regional | Refer section 2 of Technical Paper 7 – Flooding Impact Assessment in Volume 4 (flooding) |
## Approach to the impact assessment and environmental risk analysis

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<th>ISSUE</th>
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</thead>
</table>
| Groundwater                                                         | - Afflux levels (change in existing peak flood level)  
- Impact on the velocity of potential floodwaters  
- Changes to hydraulic categorisation  
- Change in flood hazards.  
  • Identification of performance requirements and mitigation measures. | Regional                                 | Refer section 3 of Technical Paper 6 – Water Quality Impact Assessment in Volume 4 |
| Soils, geology and contamination                                    | » Assessment of likely and potential impacts of the project on groundwater quality and levels during construction and operation through:  
  • Review of Department of Primary Industries (DPI) Water’s groundwater database and existing geotechnical studies.  
  • Identification of groundwater dependent ecosystems (GDEs).  
  • Identification of existing groundwater users and extraction volumes/entitlements and licensing.  
  • Assessment of potential impacts on groundwater quality, GDEs and local groundwater users with identification of mitigation measures. | Regional                                 | Refer to Technical Paper 8 – Contaminated Land Assessment in Volume 4 (contamination) |

For assessment of soils and geology impacts, a desktop assessment was carried out using available mapping and background studies. Appropriate management and mitigation measures were then proposed, where appropriate.

For assessment of contamination impacts, a contaminated land technical paper was carried out to assess the likelihood of contaminated material within the project footprint and potential contamination risks and impacts. This assessment included:

- A review of contamination assessments previously carried out near the project including consideration of prior land uses.
- Review of publicly available information (Environmental Protection Authority (EPA) records, aerial photos, etc.).
### Summary of Impact Assessment Approach/Methodology

**Regional and/or Precinct-based Approach**

<table>
<thead>
<tr>
<th>Issue</th>
<th>Summary of Impact Assessment Approach/Methodology</th>
</tr>
</thead>
</table>
| Air Quality | Identification of the potential impacts of the project to disturb contaminated areas and the potential human health risks and/or ecological risks.  
              | Identification and assessment of areas of environmental concern with the potential to impact on the project.   
              | Identification of management and mitigation measures proposed, where appropriate, including recommendation for additional investigations and/or management strategies.  
              | An air quality assessment was carried out, including:  
              | • A desktop review of the background air quality environment based on 2013 to 2016 data sourced from OEH air quality monitoring stations at Chullora and Prospect (the closest stations to the project).  
              | • A desktop review of long-term meteorological conditions (including prevailing wind and temperature trends) based on data sourced from Bureau of Meteorology (BoM).  
              | • A desktop review of Commonwealth Department of the Environment’s National Pollutant Inventory data to identify any projects or facilities that may be contributing to local air quality conditions.  
              | • The identification of air quality sensitive receivers with the potential to be adversely affected by the project.  
              | • A review of construction and operational aspects of the project with the potential to generate air pollutant emissions (including dust and exhaust emissions).  
              | • A qualitative assessment of potential air quality impacts at surrounding sensitive receivers. This assessment was carried out by comparing the locations of construction and operational air pollutant emission sources and nearby receivers with prevailing weather and ambient air quality conditions.  
              | • The identification of mitigation measures to address potential air quality impacts.  
              | Regional/whole of project                                                                                   |

*Refer to section 2 of Technical Paper 9 – Air Quality Impact Assessment in Volume 4.*
### ISSUE

**Built and non-Aboriginal heritage**

» A built and non-Aboriginal heritage assessment was prepared using the following general methodology:

- Review of statutory heritage lists, including the State Heritage Register, heritage schedules on local and regional environmental plans, State agency Section 170 heritage and conservation registers, the National Heritage List, Commonwealth Heritage List and the World Heritage List.

- Review of relevant previous heritage reports and archaeological assessments previously prepared for relevant items and areas along the project alignment.

- Site inspections of the project alignment to inspect listed heritage items and potential archaeological sites.

- Desktop research and historical research to inform the impact assessment, including review of relevant conservation management plans and plans of management.

- Consultation with heritage advisors at local councils and State agencies regarding items on their heritage registers, where required.


- Assessments of historical archaeological potential and heritage impact based on relevant guidelines.

- Recommendations in regard to management and mitigation of impacts.
### Approach to the impact assessment and environmental risk analysis

#### Parramatta Light Rail | Stage 1 – Westmead to Carlingford via Camellia

#### Environmental Impact Statement

<table>
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<tr>
<th>ISSUE</th>
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<th>FURTHER DETAILS ON METHODOLOGY</th>
</tr>
</thead>
</table>
| Urban design, landscape and visual amenity                             | - A precinct-based landscape and visual impact assessment was prepared, through:  
  - Review of the relevant planning context, including relevant policies, master plans and strategies for each precinct.  
  - Identification of the existing environmental conditions and landscape and visual sensitivity of key receptors along the alignment.  
  - Assessment of potential landscape impacts during construction and operation considering the sensitivity of the landscape, the magnitude of change proposed and assessment of overall impact on the landscape character of each precinct including the preparation of visual montages of the project operation.  
  - Assessment of the potential daytime visual impacts during construction and operation based on the level of visual modification created by the project and the sensitivity of the viewers including the preparation of visual montages of the project operation.  
  - Assessment of night time visual impact during construction and operation.  
  - Assignment of significance of impact levels to identified impacts.  
  - Identification of key urban design principles that consider NSW Government strategies and priority precincts, integration of the stops with the surrounding area, landscape, streetscape and community facilities and accessibility and connectivity requirements.  
| Noise and vibration                                                   | - A noise and vibration impact assessment was prepared, including:  
  - Ambient noise surveys to determine the existing noise environment surrounding the project, including determination of noise catchment areas.  
  - Identification of receptors, including health, research, education and small business receivers, along the alignment that would be potentially sensitive to noise and vibration changes/impacts (including consideration of future approved                                             | Precinct-based                        | Refer to Technical Paper 13 – Noise and Vibration Impact Assessment in Volume 12                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
### Summary of Impact Assessment Approach/Metho dology

- **Prediction of noise and vibration from the construction and operational phases of the light rail line**, including the stabling and maintenance facility at Camellia, stops and ancillary infrastructure (such as substations).
- **Assessment of potential noise and vibration impacts in accordance with relevant legislation and guidelines**, including:
  - Interim Construction Noise Guideline (ICNG) (Department of Environment and Climate Change, 2009) for construction noise.
  - Rail Infrastructure Noise Guideline (RING) (NSW EPA, 2013) for operational noise from the light rail line.
  - NSW Industrial Noise Policy (INP) (NSW EPA, 2000) for noise from the stabling and maintenance facility, stops and electrical substations.
  - NSW Road Noise Policy (RNP) for roads that are required to have a change in functional classification and which are anticipated to have a substantial increase in traffic volumes.
- **Identification of potential improvement to existing noise environments as a result of the project**, including identification of an out of hours work protocol framework.
- **Recommendation of management and mitigation measures to reduce and control potential impacts where noise and vibration levels are predicted to be above the assessment criteria** *(based on guidance provided in the Transport for NSW Construction Noise Strategy)*.
### Approach to the impact assessment and environmental risk analysis

#### Parramatta Light Rail | Stage 1 – Westmead to Carlingford via Camellia

#### Environmental Impact Statement

<table>
<thead>
<tr>
<th>ISSUE</th>
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<th>REGIONAL AND/OR PRECINCT-BASED APPROACH</th>
<th>FURTHER DETAILS ON METHODOLOGY</th>
</tr>
</thead>
</table>
| Trees          | A precinct-based arboricultural impact assessment was prepared, including:  
  - A stage one visual tree assessment in accordance with the method formulated by Mattheck and Breloer (1994).  
  - A tree retention assessment carried out in accordance with the IACA Significance of a Tree, Assessment Rating System.  
  - A pruning assessment prepared in accordance with the Australian Standard, AS 4373-2007, Pruning of Amenity Trees.  
  - Impact assessment of the project against potential encroachment into existing tree protection zones (TPZs) and structural root zones (SRZs) including classification of either high or low impacts.  
  - Development of management and mitigation measures during the design and construction phase based on the requirements under AS 4970-2009, Protection of trees on development sites and encroachment impacts. | Precinct-based                          | No technical paper                   |
| Property and land use | A review of existing land use was carried out using information including existing geographic information system (GIS) land use data/mapping, aerial photography and ground-truthing of existing land use along the project alignment.  
  Background studies were also reviewed to identify potential future developments including:  
  - Zoning information from the Parramatta Local Environmental Plan (LEP).  
  - Outcomes of consultation with major landholders regarding their plans for future development (e.g. Parramatta North Urban Transformation Area).  
  - A search of the Department of Planning and Environment’s major projects database (carried out in February 2017).  
  - High level planning strategies, local planning strategies and other available master plans. | Both regional and precinct-based          | No technical paper                   |
## Potential impacts on land use

Potential impacts of the project on land use were identified with consideration of the following issues:

- Direct construction and operational impacts on land and water uses and utilities within the project impact area and in areas of proposed land acquisition.
- Indirect construction and operational impacts (positive and negative) on land and water uses and utilities, including potential land use integration issues, impacts on land use amenity including impacts on adjacent land uses, potential opportunities and/or benefits for urban renewal/development.

### Business and economic impacts

The business and economic assessment included:

- A review of relevant available research and background information of common business impacts and lessons learned from previous transport infrastructure projects.
- A profile of the precincts’ existing employment characteristics and businesses that may be influenced by the project. Note that the assessment expands the Parramatta Light Rail precincts for potential sensitive business receivers to be identified. These expanded precincts are referred to as local business precincts.
- Consultation with businesses within the project area was carried out to determine community and business values and concerns including a ‘snapshot’ survey of about 131 businesses located along the project alignment.
- A review of issues and comments raised through the consultation and communications programs carried out to date.
- Identification of the likely changes/impacts that may occur as a result of the project were scoped and example business locations that may be affected by the project.
- An assessment of the significance of an impact during construction and operation.
- The identification of plans and strategies for monitoring and managing the impacts during both construction and operational stages.

<table>
<thead>
<tr>
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</tr>
</thead>
</table>
| Social impacts and community facilities | A social impact assessment was carried out to identify and evaluate key social issues that could potentially arise during the construction and operation of the project. The socio-economic assessment drew upon various specialist studies including the economic impact, property and land use, traffic, noise, air quality, visual and other assessments to provide an integrated approach. This assessment followed the standard procedure for a socio-economic assessment, including:  
• Scoping of impact issues and identification of affected communities and stakeholders.  
• Describing the existing socio-economic environment using both quantitative demographic data and qualitative information about the affected communities.  
• Identifying and assessing potential socio-economic impacts, both positive and negative, using information from stakeholders and the community.  
• Developing measures to manage or mitigate the project’s potential impacts and maximise potential benefits. | Both regional and precinct-based | Refer section 2 of Technical Paper 15 – Social Impact Assessment in Volume 7 |
| Cumulative impacts | Potential cumulative impacts of the project and other major developments in the vicinity were assessed through:  
• Consultation with stakeholders such as UrbanGrowth NSW, City of Parramatta Council and Department of Planning and Environment.  
• A search of Department of Planning and Environment’s major project’s register in February 2017.  
• Review of public environmental assessments and major facility master plans where available, and liaison with project proponents such as NSW Roads and Maritime Services regarding potential cumulative impacts with the proposed bus changes in the Parramatta CBD.  
• Qualitative assessment of cumulative impacts. | Regional | No technical paper |
## Greenhouse gas and energy

A quantitative greenhouse gas emissions assessment was carried out for the project. This assessment comprised:

- An inventory of likely greenhouse gas emissions for the project including construction phase emissions and annual operational emissions for major greenhouse gases attributable to specific components of the project, with total emissions expressed in tonnes of carbon dioxide equivalent (t CO$_{2\text{e}}$).
- Scope 1 and 2 emissions were calculated for construction, operation and maintenance of the project. Scope 3 emissions from materials used during the project’s construction were also calculated and included in the carbon footprint for the project.
- Activities considered to be material and therefore incorporated in the footprint calculations included stationary energy use, mobile energy use, fugitive emissions, waste disposal and treatment, wastewater treatment, land use changed/vegetation clearing and materials.
- Application of Transport for NSW’s Carbon Estimation and Reporting Tool to calculate the project’s construction carbon footprint including estimation of quantities and types of materials to be used in order to calculate embodied energy emissions for the project.
- A high-level investigation of greenhouse gas abatement opportunities, including a description of the intended measures to avoid and/or minimise greenhouse gas emissions.
- Basic qualitative assessment of the potential benefits of using electric-powered light rail vehicles in terms of greenhouse gas emissions and energy intensity.
### Climate change adaptation

A climate change risk assessment (in consideration of Transport for NSW’s Climate Risk Assessment Guidelines) was carried out as part of the design of the project to assess potential future climate risks to both the physical project (track, light rail vehicles (LRVs), stops, etc.) in addition to project operations and customer experience. The assessment:

- Assessed the potential vulnerabilities to be considered in the design and construction process of the project and associated ancillary infrastructure.
- Recommended management and mitigation measures to incorporate into the project design to mitigate climate risks through each phase of project delivery and operation.

### Hazards and risks

A Preliminary Hazard Assessment was prepared in accordance with HIPAP 6 – Hazard Analysis. The assessment included:

- Identification of all potential hazards and incident scenarios.
- Analysis of the consequences of the incidents on people.
- Analysis of the likelihood (frequency) of such events occurring.
- Quantification of the resultant risk levels (individual risk and societal risk).
- Comparison of the risk levels with established risk criteria and identification of opportunities for risk reduction.

A desktop assessment of potential electromagnetic interference impacts was also carried out, including:

- Identification of potentially sensitive equipment.
- Potential measures to ensure the project does not affect the operation of identified sensitive equipment with regard to electromagnetic fields.
**Approach to the impact assessment and environmental risk analysis**

<table>
<thead>
<tr>
<th>ISSUE</th>
<th>SUMMARY OF IMPACT ASSESSMENT APPROACH/METHODOLOGY</th>
<th>REGIONAL AND/OR PRECINCT-BASED APPROACH</th>
<th>FURTHER DETAILS ON METHODOLOGY</th>
</tr>
</thead>
</table>
| Waste and resource use | » A desktop assessment was carried out to assess the potential impacts of the project on waste, energy and resource use. The desktop assessment comprised:  
  • A review of likely resource and materials that would be required during construction and operation of the project, including energy requirements.  
  • A review of the likely waste streams during construction and operation, including wastewater, spoil and demolition materials.  
  • Identification of the potential environmental impacts associated with the generation (and subsequent disposal) of waste materials, with consideration of:  
    - Waste minimisation and re-use potential  
    - The level of hazard associated with the types of waste generated  
    - The capacity of disposal facilities to receive the volumes of waste generated by the project.  
  • Identification of targets for the beneficial re-use of solid wastes, wastewater and other construction wastes in accordance with the project’s sustainability strategy (refer to Chapter 16 – Project sustainability).  
  • Identification of management strategies to adequately address waste during construction and operation. | Regional                                            | No technical paper                     |
| Utilities and services | » Preliminary information on the location of existing services and utilities was reviewed through consultation with key utility and service providers.  
  » Identification of works likely to be required to protect or relocate affected services were identified.  
  » Where required, appropriate environmental management measures for these works were developed to minimise impacts on the receiving environment. | Regional                                            | No technical paper                     |
Part C:
Regional environmental impact assessment
Regional planning, transport and economic impacts

This chapter provides an overview of the existing regional character and environment of the wider project area as well as the key regional environmental impacts that are best described on a 'whole-of-project' basis. This chapter focuses on the key regional planning, transport and economic issues associated with the project. Other regional impacts of the project are discussed in Chapter 10.

Local impacts of the project on traffic, transport, land use, property and businesses are addressed for each precinct in Chapters 11 to 15 of this Environmental Impact Statement.

8.1 Purpose and approach

The main impacts that would occur from implementation of the project beyond the immediate vicinity of the project would relate to changes in traffic routes, volumes and composition, changes to land uses and associated socio-economic impacts. As the area affected would vary depending on the issue, a common study area has not been defined for regional impacts. However, for the purposes of this study it includes at least the Greater Parramatta Region – an area typically east to west from Westmead to Camellia and north to south from Parramatta Station to James Ruse Drive in North Parramatta.

8.2 Regional traffic, transport and accessibility

The project presents an opportunity to provide an important public transport link between the major development areas of Westmead Health Precinct, Parramatta North, Parramatta CBD, Camellia, Rydalmere and Telopea. This would promote growth and investment in these growth areas and elsewhere along its alignment. To achieve such benefits the project will need to integrate with the existing road network and other existing transport modes including the active transport network through the reallocation of road space from other road users. A balance would need to be achieved between providing a high quality and high frequency light rail service and a reduction in road network capacity.

This chapter is based on the following technical papers:

» The Traffic and Transport Existing Conditions Report prepared by GTA (Technical Paper 1, Volume 2 of this Environmental Impact Statement). This report outlines the existing traffic and transport environment of the study area and surrounding region.

» The Construction Traffic and Transport Impact Assessment prepared by GTA (Technical Paper 2, Volume 2 of this Environmental Impact Statement). This report outlines the potential impacts and management responses during construction of the project.

8.2.1 Existing environment

8.2.1.1 Characteristics and constraints of the existing transport network

The project travels through a diverse area with varying traffic, transport and accessibility characteristics, constraints and opportunities. An overview of the key features and constraints associated with the existing regional transport network is provided in the following sections.

A detailed description of the existing transport network is provided on a precinct by precinct basis in section 11.3 (Westmead), 12.3 (Parramatta North), 13.3 (Parramatta CBD), 14.3 (Rosehill and Camellia) and 12.5 (Carlingford).

Key features of the existing regional transport network

The existing regional transport network comprises of key transport corridors that link the study area with the Greater Sydney Metropolitan Area. Several state and regional roads in the study area combine to provide an inner and outer ring road system around the Parramatta CBD as depicted in Figure 8.1. The inner ring road provides a circulation route around the Parramatta CBD to provide access to the CBD. It includes a combination of Victoria Road to the north, MacArthur Street / Harris Street to the east, Parkes Street / Great Western Highway to the south and O’Connell Street / Pitt Street to the west.

The outer ring road provides a diversion route around Parramatta CBD reducing the need for vehicles to travel through the CBD for origins and destinations outside the CBD. The outer ring road includes a combination of James Ruse Drive to the north and east, the Cumberland Highway to the north and west and the M4 Western Motorway to the south.

The inner and outer ring roads form the key approach and departure routes for the Parramatta CBD and study area, and are shown on Figure 8.2 and Figure 8.3 respectively.
Regional planning, transport and economic impacts

Figure 8.1 Existing State and regional road network
Figure 8.2  Parramatta CBD key approach routes
Bus network

Key bus infrastructure in the project area comprises of:

» Key interchanges at:
  • Parramatta with access via Argyle Street, Church Street to the south, Smith Street/Wilde Avenue to the north and Station Street to Parkes Street to the east.
  • Hospital T-way station at Westmead.

» The Liverpool-Parramatta T-way and the North-west T-way via Argyle Street into Parramatta CBD.

» Bus lanes used by Metrobus and T-way routes and local bus services along the main corridors into Parramatta CBD, such as:
  • Church Street north of Victoria Road and south of the Great Western Highway.
  • Victoria Road east of Wilde Avenue and Wilde Avenue, Smith Street and Station Street in Parramatta CBD.
  • Park Parade connecting to the North-West T-way at Westmead.
Bus layover areas:
- Along the north side of Argyle Street between Pitt Street and Church Street.
- In Charles Street north of Parkes Street (northbound direction and east side of street).
- In Market Street west of Church Street on the south side of Prince Alfred Square.
- Off-street of Station Street immediately south of Darcy Street.

The Greater Parramatta to the Olympic Peninsula (GPOP) priority growth area bus network is shown on Figure 8.4.

The Parramatta Interchange in Argyle Street adjacent to the Parramatta Railway Station is the key focal point for the bus network in Western Sydney, with eight bus stands in an integrated public transport facility with underground connections to Parramatta Station, Westfield Parramatta shopping centre and the future Parramatta Square.

The existing bus network in the study area has around 57 timetabled public bus routes servicing the study area and the broader Western Sydney region. Around 90 per cent of the bus routes in the study area operate within, to or through Parramatta CBD which shows the importance of Parramatta as a key transport interchange point between connecting buses and trains. This concentration of bus services creates an operations issue with the limited capacity of the bus stands and the access streets for buses. The highest number of AM peak services exists in Church Street north of Victoria Road and in Church Street south of the Great Western Highway with 33 buses per hour in the AM peak direction (inbound) at both locations.

Figure 8.4 The GPOP priority growth area bus network
Dedicated school buses operate throughout the study area with direct services to public and private schools, and are predominately located in the Westmead, Parramatta CBD and Carlingford precincts.

Four shuttle bus services also operate in the study area, including the free Parramatta CBD shuttle bus service, the late night Parramatta bus service, the Western Sydney University shuttle bus service and the Parramatta Leagues Club shuttle bus.

Rail network

The study area is serviced by heavy rail with the following lines:

- **T1 Western Line** - connecting Clyde, Granville, Harris Park and Parramatta Stations onto Blacktown, Richmond and Emu Plains Stations.
- **T5 Cumberland Line** - connecting Campbelltown to Schofields Stations via Liverpool, Parramatta and Blacktown Stations.
- **T6 Carlingford Line** - A heavy rail line, connecting Carlingford to Clyde Stations via Telopea, Dundas, Rydalmere, Camellia and Rosehill Stations. The AM peak service frequency is every 30 minutes with one train operating through to Sydney CBD and hourly services with a cross-platform transfer at Clyde Station at all other times.
- **Blue Mountains Line** that stops at Parramatta station.
- **NSW TrainLink** with trains to Dubbo.

These railway lines, in the context of the GPOP priority growth area is provided in Figure 8.5.

A number of stations within the study area are serviced by connecting bus routes to provide connections beyond the study area. Westmead, Parramatta, Rydalmere and Carlingford stations are serviced by a greater number of bus routes compared to other stations in the study area.

Further detail is provided on a precinct by precinct basis in section 11.3 (Westmead), section 12.3 (Parramatta North), section 13.3 (Parramatta CBD), section 14.3 (Rosehill and Camellia) and section 12.5 (Carlingford).

Ferry network

Parramatta is served by the F3 Parramatta River ferry route that operates between Parramatta and Circular Quay with mostly hourly services operating between 6:30 am and 7 pm on weekdays and 7:30 am and 7:30 pm on weekends. Ferry operations are affected by the tidal conditions on the western end of the Parramatta River, in particular west of Rydalmere Wharf. Natural low tides result in bus services often replacing more than 100 ferry services per month between Rydalmere and Parramatta.

The ferry wharves in the study area are located at:

- **Parramatta Wharf** in Phillip Street and Charles Street, Parramatta CBD
- **Rydalmere Wharf** which is 1.9 kilometres east of James Ruse Drive in Rydalmere with access from John Street

The F3 Parramatta River ferry service is much slower than alternative transport modes for travel between Parramatta and Sydney CBD with a weekday off-peak travel time of 86 minutes versus 31 minutes on the T1 Western Line train from Parramatta to Town Hall stations and 66 minutes on the M52 bus routes from Smith Street, Parramatta to Park Street, Sydney via the Victoria Road bus corridor.
Pedestrian network

The pedestrian infrastructure in the study area is generally well established. Parramatta Park provides a key east-west link between Westmead and the Parramatta CBD to the west. A combination of Church Street, O’Connell Street, Marsden Street and MacArthur Street / Harris Street provides north-south pedestrian connections across Parramatta River to the north of Parramatta CBD and under the existing heavy rail line to the south.

A combination of footpaths and pedestrian and cyclist shared paths are provided along both sides of the Parramatta River, as part of the regional walking and cyclist connection, which are typically used for recreational activities.

The surrounding outer ring road generally acts as a barrier for pedestrian with limited at-grade pedestrian crossings provided. Grade separated pedestrian facilities are provided in key locations along the outer ring road to accommodate pedestrian desire lines generated by key adjacent land uses including at Western Sydney University (Parramatta) campus in Rydalmere and Rosehill Gardens Racecourse.

Within the Carlingford precinct, pedestrian facilities are limited along the T6 Carlingford Line. Each station has dedicated pedestrian facilities to connect the train stations with the suburb. Pedestrian facilities are mostly provided in the form of footpaths and pedestrian crossings. A few dedicated pedestrian links exist including a link between Dundas station and a bus stop on Kissing Point Road and links between Carlingford station and the surrounding residential streets.
Cyclist network

The study area is generally well serviced with east-west and north-south cycling routes via Parramatta Park and along the Parramatta River. Key cycling provisions are provided in the following locations although noting that some have been flagged by City of Parramatta Council as requiring improvements:

- Darcy Road in Westmead separated cycle path
- Parramatta Park cycle loop
- O’Connell Street shared path
- Parramatta River shared paths
- Argyle Street shared path.

Within the Carlingford precinct, cyclist facilities are limited along the T6 Carlingford Line, using the existing road network.

The City of Parramatta Council has prepared a draft Parramatta Bike Plan 2017 – 2037 outlining a 20 year plan for the Parramatta LGA. The plan lays out a set of routes that would transform the safety and attractiveness of cycling in the Parramatta LGA.

Existing travel demand

Travel to/from the study area

The ABS Census Journey to Work data 2011 is regarded as the most robust picture of existing travel patterns to and from zones in Sydney. The smallest geographical area for which data is available is a Travel Zone (TZ). The ABS Census Journey to Work data was reviewed to understand the existing mode share distribution for trips to and from work for each of the precinct study areas.

The 2011 Journey to Work statistics are based on around 27,600 residents and around 77,600 people who live and work in the selected travel zones respectively. The study area has significant employment density, with the number of employees almost ten times greater than the number of residents. The distribution of employees and residents for each of the precincts is provided in Table 8.1.

<table>
<thead>
<tr>
<th>PRECINCT</th>
<th>NUMBER OF EMPLOYED RESIDENTS</th>
<th>PER CENT OF TOTAL EMPLOYED RESIDENTS</th>
<th>NUMBER OF EMPLOYEES</th>
<th>PER CENT OF TOTAL EMPLOYEES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Westmead</td>
<td>5,916</td>
<td>21%</td>
<td>14,868</td>
<td>19%</td>
</tr>
<tr>
<td>Parramatta North</td>
<td>9,346</td>
<td>34%</td>
<td>7,676</td>
<td>10%</td>
</tr>
<tr>
<td>Parramatta CBD</td>
<td>4,461</td>
<td>16%</td>
<td>39,799</td>
<td>51%</td>
</tr>
<tr>
<td>Rosehill and Camellia</td>
<td>1,015</td>
<td>4%</td>
<td>5,306</td>
<td>7%</td>
</tr>
<tr>
<td>Carlingford</td>
<td>6,843</td>
<td>25%</td>
<td>9,942</td>
<td>13%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>27,581</strong></td>
<td><strong>100%</strong></td>
<td><strong>77,591</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

The mode share for the journey to work trips of these residents and employees (excluding mode not stated and worked from home) are shown in Figure 8.6. Private vehicles are the primary travel mode for the area accounting for 70 per cent of trips for employees of the area and nearly 60 per cent of trips for residents who live in the project area (including vehicle driver and vehicle passenger). Public transport is used for 25 per cent of employees of the area and more than 30 per cent of people who work in the project area.
Within each precinct:

» Employees of the Parramatta CBD precinct use public transport around 40 per cent of trips to work. Employees of the Westmead, Parramatta North, Rosehill and Camellia and Carlingford precincts mostly use the private vehicle.

» Residents in the Carlingford precinct have the greatest use of private vehicle at 75 per cent of journeys to work, while residents of the Parramatta CBD precinct (around 42 per cent), and to a lesser extent, Westmead precinct (36 per cent) are more inclined to use public transport. From five to 10 per cent of the residents of the Westmead, Parramatta North, Parramatta CBD and Rosehill and Camellia precincts walk to work.

The top five origins and destinations based on the number of trips for residents and employees of the study area are summarised in Table 8.2. Approximately 14,400 journey to work trips occur to or from the Parramatta region in each peak period. Furthermore, about 13,100 residents of the north-west Sydney region travel to the regional area for work and 4,330 residents of the regional area travel to the Sydney CBD for work.

Table 8.2  Key origins and destinations

<table>
<thead>
<tr>
<th>RANK</th>
<th>ORIGINS FOR EMPLOYEES OF THE STUDY AREA</th>
<th>NUMBER OF TRIPS</th>
<th>KEY WORK DESTINATIONS FOR RESIDENTS</th>
<th>NUMBER OF TRIPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Parramatta</td>
<td>9,338</td>
<td>Parramatta</td>
<td>5,065</td>
</tr>
<tr>
<td>2</td>
<td>Blacktown</td>
<td>5,083</td>
<td>Sydney Inner City</td>
<td>4,330</td>
</tr>
<tr>
<td>3</td>
<td>Merrylands – Guildford</td>
<td>4,977</td>
<td>Ryde – Hunters Hill</td>
<td>1,967</td>
</tr>
<tr>
<td>4</td>
<td>Baulkham Hills</td>
<td>4,832</td>
<td>Carlingford</td>
<td>1,244</td>
</tr>
<tr>
<td>5</td>
<td>Penrith</td>
<td>3,189</td>
<td>Auburn</td>
<td>1,297</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>40% of all trips</strong></td>
<td><strong>27,419</strong></td>
<td><strong>56% of all trips</strong></td>
<td><strong>13,903</strong></td>
</tr>
</tbody>
</table>

Source: Parramatta Light Rail Existing Environment Report (GTA, 2017a)
Travel to/from the Parramatta CBD

The NSW Long Term Transport Master Plan acknowledges Parramatta as the major economic centre of Western Sydney, accommodating more than 100,000 jobs. Private vehicles are the primary mode of transport with public transport used for 15 per cent of all trips to Parramatta and 40 per cent during the peak periods.

On an average weekday, around 26 per cent of commuters travel to and from Parramatta CBD use public transport, with work trips to Parramatta having origins from across the Sydney region, as shown in NSW Long Term Transport Master Plan (NSW Government 2012)(refer Figure 8.7). Based on the travel demand analysis used to prepare the NSW Long Term Transport Masterplan (NSW Government 2012), this public transport mode share to and from Parramatta CBD is expected to increase by six per cent to around 32 per cent by 2031 without any significant improvements to the existing public transport system and without the project.

The 10 to 50-minute travel time isochrones for public transport and private vehicle access to Parramatta CBD are shown in Figure 8.8 and Figure 8.9 respectively. The isochrones indicate a wider travel catchment for private vehicle travel, as well as travel time increases for most public transport trips when compared to private vehicle trips.

Source: NSW Long Term Transport Master Plan (NSW Government 2012)

Figure 8.7 Current work trip catchment for Parramatta CBD
Regional planning, transport and economic impacts

Parramatta Light Rail | Stage 1 – Westmead to Carlingford via Camellia
Environmental Impact Statement

Figure 8.8  Parramatta CBD public transport access travel time

Figure 8.9  Parramatta CBD private vehicle access travel time
Future transport challenges

The key challenges identified for the Parramatta regional transport network (as identified in the NSW Long Term Transport Master Plan) include:

» Peak period congestion around the Parramatta city centre affects bus services and local amenity.

» Barriers to movement, including Parramatta River, Parramatta Park, major arterial roads and rail lines need to be traversed to provide better connectivity and to minimise congestion arising from movements being funnelled into a limited number of crossings.

» The need for stronger transport connections to other parts of GPOP priority growth area and Greater Sydney to support business and economic activity.

» The need for additional road and public transport infrastructure to manage travel times.

Another key challenge for Parramatta is the city centre is serviced by only one railway station and one major bus interchange that are both reaching capacity limits for the number of trains and buses in the peak periods.

For bus operations, most bus routes have terminating services at Parramatta Interchange. This creates a significant problem with insufficient space for conveniently-located layovers to be used by drivers on the terminating bus services at Parramatta Interchange is an issue that creates inefficiency for the bus network.

8.2.2 Impacts during construction

8.2.2.1 Construction vehicles and volumes

The total number of truck movements generated by the project was estimated based on the quantities of the total materials to be excavated, removed or imported to all precincts including the stabling and maintenance facility. The estimated heavy vehicle movements are provided in Table 8.3.

<table>
<thead>
<tr>
<th>PRECINCT</th>
<th>DAILY AVERAGE</th>
<th>PEAK DAILY AVERAGE</th>
<th>PEAK HOUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Westmead</td>
<td>27</td>
<td>137</td>
<td>12</td>
</tr>
<tr>
<td>Parramatta North</td>
<td>31</td>
<td>269</td>
<td>24</td>
</tr>
<tr>
<td>Parramatta CBD</td>
<td>29</td>
<td>77</td>
<td>7</td>
</tr>
<tr>
<td>Rosehill and Camellia</td>
<td>20</td>
<td>227</td>
<td>21</td>
</tr>
<tr>
<td>Carlingford</td>
<td>39</td>
<td>136</td>
<td>12</td>
</tr>
<tr>
<td>Stabling and Maintenance Facility</td>
<td>96</td>
<td>103</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>242</strong></td>
<td><strong>949</strong></td>
<td><strong>85</strong></td>
</tr>
</tbody>
</table>

(1) Average daily vehicle movements represent the total inbound and outbound truck movements (two-way) for the precinct (excluding testing phase).
(2) Peak average daily vehicle movements include the total inbound and outbound truck movements (two-way) for the precinct (including asphalt delivery, civil and drainage materials, concrete trucks, flatbeds for steel and rail, rigid tippers, truck and dogs and water carts).
(3) Peak hour vehicle movements assume the peak average daily volumes are evenly distributed over weekday construction hours (7am to 6pm).
Overall the total number of additional trucks would be small compared to the total truck volumes across the regional network. Issues with respect to access to construction sites are addressed for each precinct.

The total peak construction workforce is estimated to be around 500 personnel plus management. Assuming a vehicle occupancy rate of three people per vehicle for construction personnel, this equates to about 167 additional private vehicles across the regional road network. This increase would have a negligible impact on the regional road network.

8.2.2.2 Haulage routes during construction

Haulage routes during construction were determined using the following principles:

» Heavy vehicles generally access the worksites via the shortest route possible to arterial road network.
» The construction corridor would be used as much as possible for haulage to minimise impact on the surrounding road network.

Haulage routes would be refined in consultation with relevant stakeholders and as site-specific Traffic Management Plans are developed. Any additional haulage routes required during the construction phase need approval from Transport for NSW and the relevant road authority prior to use. All haulage routes and protocols would be communicated in detail to construction personnel during project inductions, specifying travel times during various periods throughout the day.

Layover areas would be selected for storing vehicles arriving at spoil removal sites to manage the arrival and departure rates at work sites. Heavy vehicles would not likely be stored in Parramatta CBD to minimise the risk of conflict between construction vehicles and pedestrians in high pedestrian areas.

8.2.2.3 Intersection performance

The operation of road intersections along the project alignment would vary during construction. The analysis indicates that most of the intersections potentially affected by the project would continue to operate through the construction period at a level of service comparable to existing conditions. As some traffic would take entirely different routes, a number of intersections along Macquarie and Church Streets would operate at an improved level of service in both the morning and afternoon peak periods compared to current operations.

The exceptions would be:

» The Macquarie Street/ Harris Streets signalised intersection, where there would be a marginal decline in the AM peak period, but the operation would still considered good.
» The intersection of Church Street/ Factory Street where the service level during the morning peak would decline from B to C.
» The intersections of Macquarie Street/ O’Connell Street, George Street/ Charles Street and Church Street/ Phillip Street would deteriorate marginally from B to C in the PM Peak.

Further details regarding the intersection performance during construction is provided in section 4.11 of Technical Paper 2 – Construction Traffic and Transport Impact Assessment, and is discussed in the precinct chapters in this Environmental Impact Statement.

8.2.2.4 Pedestrians

The project would be located in some road sections of high pedestrian activity, particularly in the Westmead and the Parramatta CBD precincts. The construction staging and methodology would be developed to minimise impact on footpath widths and crossing facilities to maintain existing pedestrian capacity, amenity and safety. Existing pedestrian movements would be maintained along footpaths and crossings, facilitated by traffic controllers where required.
Regional planning, transport and economic impacts

All pedestrians, including vulnerable users, would be considered in the design development in accordance with legislative requirements (for example, kerb ramps at crossings, maintaining minimum footpath widths).

All worksites would consider pedestrian access and safety as follows:

- During general constructions hours implement traffic controllers at intersections to monitor pedestrian movements and respond to potential incidents at crossing locations.
- At night to maintain pedestrian safety, consideration would be given to maintaining traffic controllers or placing security personnel during hours of operation of surrounding businesses such as restaurants and entertainment premises in agreement with NSW Police and City of Parramatta Council.
- Site boundaries and hoardings to have sufficient lighting.
- Fencing, hoarding, screens and barriers placed to provide maximum sight lines for pedestrians, minimise blind spots and alcoses to maximise pedestrian security.
- Consider installation or relocation of CCTVs where blind spots and alcoves cannot be avoided.
- Develop emergency evacuation procedures and protocols with emergency services, which may require:
  - temporary road plates to facilitate crossing of work zone
  - traffic controllers to restrict public access to emergency area and enable access for emergency vehicles
  - management of occupants of building located near the worksite, in agreement with building owners.

Installation of overhead wiring and poles would require closure of footpaths. In these situations, pedestrians would be diverted to alternative footpaths via safe crossing facilities under the control of traffic controllers with appropriate signage, fencing and barriers.

Traffic controllers would be required to manage site accesses to minimise potential conflicts between pedestrians and construction vehicles where they are required to cross footpaths.

8.2.2.5 Cyclists

The regional cycleway network exists with the Parramatta River cycleway providing an east-west cycle route through the study area connecting Westmead, Parramatta CBD, Rydalmere on the northern side of the Parramatta River to Ermington.

Where cycle routes and cycleways are impacted by construction worksites, alternate routes would be identified and implemented through appropriate signage and in consultation with bicycle user groups and the relevant road authority.

8.2.2.6 Trains – T6 Carlingford Line

Existing train services between Carlingford and Clyde stations would be discontinued commencing with the construction of the project. This would result in the closure of the following stations:

- Carlingford Station
- Telopea Station
- Dundas Station
- Rydalmere Station
- Camellia Station
- Rosehill Station
- Clyde Station.
Following closure of the T6 Carlingford Line, replacement bus services would operate every 10 minutes in the peak and interpeak periods on weekdays, and every 30 minutes in the off-peak and evenings. The 10 minute interpeak service is proposed instead of the existing hourly services to mitigate the loss of convenience to train customers. Supplemental buses would be added as required to meet peak loads. The buses used would be low-floor and wheelchair accessible, but they would not accept motorised scooters as on the trains.

The shuttle bus for the existing train customers would be less comfortable than the existing trains and would not replicate the future light rail experience to Parramatta. An additional journey time increase of 1-7 minutes (depending on origin station) would be likely (based on the January 2017 timetable) for rail replacement bus services during construction for the AM peak.

8.2.2.7 Buses

Key impacts on bus routes during construction would include:

» Route 711 would continue to Parramatta Interchange via Darcy Road, Alexandra Avenue and Park Parade after servicing The Children’s Hospital at Westmead in Hawkesbury Road. Both Route 711 and Route 818 that terminates at the The Children’s Hospital at Westmead would operate via a one-way loop along Hawkesbury Road, Hainsworth Street, Park Avenue, Caroline Street to service The Children’s Hospital at Westmead and the Mayflower Retirement Village in Caroline Street. This one-way loop through the Westmead precinct would require standard 12.5 metre buses to be managed with construction traffic controls. For the buses to safely make the right turns from Hainsworth Street into Park Avenue and from Park Avenue into Caroline Street, it is recommended that the sections of Hainsworth Street east of the light rail construction zone and Park Avenue north of Caroline Street be changed for one-way traffic only. Alternatively, if Caroline Street at Hawkesbury Road is closed for the construction of the Westmead Hospital light rail stop, the one-way loop could operate via Park Avenue to Railway Parade back to Hawkesbury Road. Bus stops would be maintained during the construction period at The Children’s Hospital at Westmead and in Caroline Street only.

» Since the terminating Route 818 at the Westmead Children’s Hospital would require a layover area, insufficient space would be available at the bus stop (TSN 214515) in Hawkesbury Road at the entrance of The Children’s Hospital at Westmead. The on-street parking on the northside of Hainsworth Street east of the light rail construction zone is proposed to be removed for a layover zone for up to two terminating buses. This may require up to five car spaces to be removed.

» Route 708 (with two trips per day on weekdays) would no longer service the Mayflower Retirement Village via Caroline Street, Park Avenue and Queens Road. Instead, the re-routed Route 711 would provide a high level of service with a new bus stop in Caroline Street at the Mayflower Retirement Village.

» Northwest T-way buses would continue to operate in Darcy Road with the Darcy Road T-way station maintained and operating as existing throughout the construction period. These buses would continue to Paramatta Interchange via Alexandra Avenue with a T-way stop on the south side of Westmead Station. The North-west T-way routes (Routes T60, T61, T62, T63, T64, T65 and T66) and Route 705 would not be affected by the PLR construction in Hawkesbury Road.

» Diversion of all buses that currently travel along Church Street between Bamey Street and Victoria Road to O’Connell Street which is the parallel through street west of Church Street. All Church Street north buses would be diverted to use O’Connell Street via Bamey Street/Board Street with the general traffic.

» For the Windsor Road corridor, this includes Routes 549, 600, 601, 603, 706 and M60. They would operate southbound via Bamey Street, O’Connell Street to Victoria Road and continue as existing into Wilde Avenue and Smith Street to terminate at Paramatta Interchange. In the northbound direction, these services would operate along Victoria Road, O’Connell Street and Board Street into Church Street to continue to the Windsor Road corridor.
Route 609 would be rerouted in the southbound direction via Dunlop Street, O’Connell Street and Victoria Road to Wilde Avenue. The westbound crossing of Church Street at Dunlop Street would be managed with very little traffic in Church Street south of Dunlop Street resulting from the closure of Church Street south of Factory Street for the construction activity. In the northbound direction, Route 609 buses would operate via Victoria Road, O’Connell Street, Albert Street, Pennant Hills Road and left into Castle Street to continue the existing route. This would be a longer route in both directions.

Bus routes that currently use Pennant Hills Road (Routes 625 and M54) would operate via Albert Street to O’Connell Street in both directions.

Route 900 (free shuttle bus) would be discontinued prior to the commencement of construction. The Windsor Road and Pennant Hills Road bus services would be diverted via Victoria Road to O’Connell Street to service bus stops on O’Connell Street south of Grose Street. This would provide frequent bus services between Paramatta Interchange and O’Connell Street (south of Grose Street).

The operation of the Western Sydney University student shuttle bus services between Rydalmere and Paramatta CBD campus would be impacted by project construction activity, as Macquarie Street would not be available for the bus stop and operation of the service. It is proposed that the existing indented bay in Smith Street immediately north of Darcy Street at the Sydney Water building is used as the bus stop and terminus layover area for the shuttle bus. The return bus trip would be via Smith Street, Wilde Avenue to Victoria Road. This CBD stop has space for waiting customers on the footpath and shelter under the overhang of the Sydney Water building. Further work would be undertaken with Western Sydney University to confirm these arrangements.

8.2.2.8 Parking

The project would result in the progressive loss of parking spaces – with around 870 spaces potentially affected during construction. Around 150 to 200 would be potentially relocated. The process of managing impacts on car parking along the corridor is identified in Figure 8.10.

All accessible parking spaces (compliant with the Commonwealth Disability Discrimination Act 1992) and loading zones would be (where practicable) be relocated to the adjacent side streets. Loss of other parking spaces during construction including loading bays would be addressed on a progressive basis and in accordance with the parking mitigation approach identified above in consultation with City of Parramatta Council. Further details on parking impacts including impacts on loading bays as it would relate to permanent loss are addressed in Section 8.1.5.
8.2.2.9 Impacts on special events

**Rosehill Gardens Racecourse**

During construction rail services would be discontinued on the T6 Carlingford Line at Clyde and Rosehill Stations including the existing through train services from Central Station to Rosehill Station. On major event days, special shuttle bus services would be provided between Parramatta Station and Rosehill Gardens by the ATC for its patrons.

**Parramatta Park**

Road traffic, pedestrian and cyclists can access Parramatta Park from Park Avenue. Access to Park Avenue from Railway Parade and Queens Road would remain available during construction.

The Parramatta Park Trust is planning to modify access arrangements to the park. Transport for NSW would consult with stakeholders to ensure access is maintained once the access to Parramatta Park is modified.
8.2.2.10 Mitigation measures

Transport for NSW has and would continue to work closely with Roads and Maritime Services and the City of Parramatta Council to optimise the local and regional road network during construction. Given the progressive nature of construction this would require an iterative and dynamic approach – which would be appropriately managed through the progressive submission and updating of detailed construction management plans.

Further detail is provided in section 11.3 (Westmead), section 12.3 (Paramatta North), section 13.3 (Paramatta CBD), section 14.3 (Rosehill and Camellia) and section 12.5 (Carlingford), Chapter 17 – Outcomes, environmental management and mitigation, and the Construction Traffic and Transport Management Report (Technical Paper 3, Volume 2 of this Environmental Impact Statement.

8.2.3 Future road network principles

To optimise the transport network performance, the following future road network principles were developed for the project in consultation with Roads and Maritime and City of Parramatta Council and have been adopted in the design of the project and the future road network:

» Maintain capacity and functionality of the state roads interfacing with the project (including the bus T-way).

» Maintain local area access on local and regional roads and minimise reduction to traffic capacity.

» Limit right turns or U-turns across the project alignment at signalised intersections.

» Minimise the number of signalised intersections along the project alignment to maintain an efficient light rail service and minimise impact on road network operation.

» Position light rail stops near signalised intersections with marked foot crossings (signalised), such that pedestrian access to and from one end of the stop can be achieved via the same marked foot crossing. Crossings would be appropriately staggered to maximise safety and allow for operational requirements for intersections.

» Provide a trafficable surface in on-street environments to allow access for emergency and/or general traffic if directed by emergency services or during approved road closures (noting the design would discourage this for everyday traffic movements).

» Limit contra-flow traffic and light rail movements (traffic lanes should accommodate the same direction of travel as the adjacent light rail) to limit associated road safety risks.

» Road safety audits to be completed throughout design development and implementation of the project.

8.2.4 Impacts during operation – regional road network

8.2.4.1 Broad road network changes

The regional road network beyond the study area west of Westmead, north of North Parramatta and Carlingford and east of Parramatta CBD would continue as major road corridors for traffic movement to and around Parramatta CBD and the study area. The outer ring road would have a key role for bypass traffic and freight around the study area.

Light rail customers would be attracted away from private vehicles, reducing the potential negative impacts of congestion. These include road user travel times and reliability, vehicle operating costs, pollution, noise and safety.

The project is forecast to attract 25,000 cars off the road by 2041, resulting in 188,000 fewer car kilometres each day. This is expected to benefit road users as a result of increased speeds and reduced vehicle operating costs.
8.2.4.2 Interfaces with the existing State and regional road network

The project would interface with the existing State and regional road network at the following locations:

» Hawkesbury Road / Darcy Road (including T-way)
» Factory Street / O’Connell Street
» Church Street / Pennant Hills Road/Albert Street
» Church Street / Victoria Road
» Harris Street / Macarthur Street/George Street
» James Ruse Drive / Grand Avenue North.

A portion of the project alignment is also located along the part of Church Street that is classified as a State road (north of Victoria Road) and has dedicated bus lanes.

To reduce impacts at these key interfaces, the future road network strategy for the project has incorporated the following features:

» Grade separation at James Ruse Drive to eliminate conflicts with the State road network.
» Diversion of traffic away from Church Street to O’Connell Street and other alternative access arrangements in the Parramatta CBD.
» Local area access improvements or intersection modifications to provide alternative access to local areas impacted by the project alignment.

These features are discussed further in this section.

James Ruse Drive grade separation

A new bridge is proposed to allow for a grade separated crossing of James Ruse Drive. The bridge ensures that the light rail alignment does not interfere with current and future traffic flow along James Ruse Drive, which is a key north-south component of the Parramatta regional ring road.

Alternative Parramatta CBD access

Alternative Parramatta CBD approach and departure routes are identified in Figure 8.11 and Figure 8.12. The proposed alternative access arrangements include:

» O’Connell Street would be upgraded (two lanes in each direction), to accommodate a portion of the north-south traffic diverted away from Church Street.
» Bamey Street and Board Street would be upgraded to carry traffic between Church Street and O’Connell Street. Bamey Street would predominately accommodate inbound traffic from Church Street, while Board Street would accommodate outbound traffic to Church Street.
» In the Parramatta CBD, the project light rail alignment integrates with existing and future CBD land uses and transport facilities along Church Street and Macquarie Street.
» No general traffic lanes would be provided in Church Street between Lennox Bridge and Macquarie Street and a single traffic lane would be maintained along Macquarie Street (except between Howood Place and the Parramatta Square private property vehicle access). To avoid contra-flow light rail and traffic conditions, Macquarie Street traffic (west of Marsden Street) would be converted to eastbound.
» To maintain westbound local area access within the Parramatta CBD, George Street would be modified to be two-way. As such, George Street would accommodate majority of the traffic diverted away from Macquarie Street.
Figure 8.11 Alternative Parramatta CBD approach roads
Local area access improvements

Localised intersection modifications and supporting local area access arrangements would be required to accommodate the project and reduce its impact at locations along the light rail alignment. Key intersection modifications would occur at Hawkesbury Road and Harris Street and MacArthur Street.

The proposed changes to the local road network for each precinct and an assessment of their impacts on future network performance are included in section 11.3 (Westmead), section 12.3 (Paramatta North), section 13.3 (Paramatta CBD), section 14.3 (Rosehill and Camellia) and section 12.5 (Carlingford).
8.2.5  Impacts during operation – public and active transport

8.2.5.1  Interfaces with other transport modes

The project would interface with other transport modes including trains, buses, ferries, cycling and walking networks. Key public and active transport mode interfaces with the project would include:

» Trains – at Westmead and Parramatta.

» Buses – at Parramatta Interchange, the North-West T-way at Darcy Road, North Parramatta at Factory Street (Windsor Road bus services), Fennell Street stop (Pennant Hills Road bus services), Carlingford stop, Telopea stop, Dundas stop and Rydalmere stop.

» Ferry – Parramatta Wharf.

» Kiss and ride and park and ride – Rydalmere, Dundas, Telopea and Carlingford stops.

» Proposed Metro West.

Key public and active transport interfaces with the project are identified in Figure 8.13.

Access to light rail stops would be designed to follow a mode hierarchy that promotes and supports efficient and sustainable access. These priorities would follow the hierarchy of importance of connecting transport modes identified below:

» Priority 1: Pedestrian movements

» Priority 2: Bicycle movements

» Priority 3: Other public transport modes, such as buses and trains

» Priority 4: Taxis

» Priority 5: Kiss and ride (passenger drop-off and pick-up)

» Priority 6: Park and ride.
8.2.5.2 Pedestrians

Ranked highest in the mode hierarchy, pedestrian access to light rail stops would be facilitated with priority. All access to light rail stops includes an element of walking, either as a sole access mode (for example, walk-up from trip origin), or as part of a wider access interchange (for example, walking from the bus stop to the light rail stop).

While different light rail stops would have different and specific requirements based on functionality, location and patronage, a series of overarching pedestrian access principles are valid for all light rail stops. These principles describe the standards and requirements for pedestrian access to all light rail stops to ensure a consistent approach and design across the entire network:

- Every light rail stop would have dedicated, easy, safe and convenient pedestrian access.
- Every platform would have dedicated pedestrian access from at least one end.
- Dedicated pedestrian access includes a signalised marked foot crossing facility where platforms require crossing more than one traffic lane for access.

**Figure 8.13 Key public and active transport mode interfaces**
Regional planning, transport and economic impacts

- A desired maximum walking distance between a platform end and a marked foot crossing (signalised) of 50 metres.
- Paths leading to/from all platforms would be a maximum of 2.5 metres wide.
- The implementation of kerb ramps that are level with the road.
- Adequate lighting for all platforms and pedestrian paths.

8.2.5.3 Bicycles

The regional cycleway network exists with the Parramatta River cycleway providing an east-west cycle route through the PLR study area connecting Westmead, Parramatta CBD, Rydalmere on the northern side of the Parramatta River to Ermington.

Bicycle parking would be located as close as feasible to the stop access, and be an integral aspect of the overall stop design.

8.2.5.4 Buses

Regional bus network planning would integrate the project with broader needs of GPOP priority growth area.

Initial work undertaken by Transport for NSW identifies the following focus areas for the bus network:

- Maintaining existing rapid routes within the study area (T80, T65, M52, M60, M54, M91), as outlined in Sydney’s Bus Future.
- Maintaining the existing Suburban route within the study area (Route 525), as outlined in Sydney’s Bus Future. Potential changes to this route exist for future light rail stages.
- Reviewing the local bus routes within the study area. This review would include:
  - Introducing new routes to meet existing and future customer travel patterns.
  - Modifying services that access the Parramatta CBD to balance demand and customer travel patterns with effective operations, particularly during peak periods.
  - Truncating some services to better integrate with the project and the broader transport network.
  - Changing routes to avoid identified road network constraints.
  - Discontinuing some routes with alternate travel options in place.
  - Considering opportunities for on demand services in the study area.

Further work will be undertaken by Transport for NSW to confirm the preferred approach for the bus network. Opportunities exist for some of these changes to be introduced in the short term, aligned with demand, customer travel patterns or the construction phase of the project.

In addition, some minor changes to bus stop infrastructure and locations would be required to avoid proposed light rail infrastructure. The final design of these changes would be determined during detailed design.

The proposed changes to the bus network for the project would have the following potential issues:

- Bus routes or bus stops to be permanently removed or relocated to support the project would be subject to further analysis and consider stakeholder feedback. These include locations at Westmead and Parramatta North.
- Capacity and operations at bus layover areas and termini may be limited. Further investigations would be required to confirm the ability for buses to turnaround and layover at these terminus locations.
Reduced crowding from attracting light rail customers from buses is expected to be offset by additional bus customers attracted as a result of rationalisation and improvements to bus services. This is expected to result in a net increase of up to 260 bus trips per hour (2041, one-hour AM peak), or 1,600 per day. Even so, the project would reduce hours spent at the highest levels of crowding. It is forecast that there would be 480 fewer hours spent at greater than 250 per cent of seated capacity in the 2041 one-hour AM peak.

8.2.5.5 Trains – Heavy rail network

The project is forecast to attract up to approximately 5,000 passengers per hour off heavy rail (between the 6 am – 9 am peak) or 15,000 per day by 2041. This would reduce crowding for remaining heavy rail passengers and improve passenger comfort.

8.2.5.6 Trains – T6 Carlingford Line

The light rail alignment would utilise the heavy rail corridor between Carlingford and Camellia, converting the existing single track to a double-track light rail alignment.

Existing train services on the T6 Carlingford Line would be replaced by more frequent light rail services (eight per hour) linking with Parramatta CBD, Paramatta North and Westmead. The existing railway stations at Carlingford, Telopea, Dundas, Rydalmere and Camellia would be converted to light rail stops.

Rosehill Station would be decommissioned, and the section of the T6 Carlingford Line between Grand Avenue and Clyde Station would be converted for other uses to be determined. This would impact 200 passengers per day using Rosehill Station. Alternative public transport options would be provided at the Tramway Avenue and Camellia light rail stops for customers that currently use the Rosehill Railway Station for special event access or commuting to and from the residential area west of James Ruse Drive. Customers from Rosehill, west of James Ruse Drive could walk to the Tramway Avenue light rail stop via Arthur Street and across Hassall Street or to walk to the existing Route M92 bus stops in James Ruse Drive. Customers attending events at the Rosehill Gardens Racecourse could access the northern end of the racecourse and entertainment venue from the Camellia light rail stop via the pedestrian crossing of Grand Avenue.

The existing railway level crossing on Parramatta Road would be closed. This would lessen road capacity constraints on Parramatta Road.

At Clyde Station, train services or stopping patterns unrelated to the T6 Carlingford Line are not proposed to be altered as part of the project.

Journey time comparison

There are currently 1,310 passengers during the 3.5 hour AM peak (6–9:30am), or 3,760 per day, using the T6 Carlingford Line. This is level of patronage is relatively low, compared to 59,680 passengers per day using Parramatta Station or 15,680 at Westmead Station. The T6 Carlingford Line has the lowest customer satisfaction ratings on the Sydney heavy rail network because it is infrequent (two services per hour in each direction) and requires customers to transfer at Clyde to access services to the Sydney or Parramatta CBDs.

Some eight per cent of T6 Carlingford Line passengers travel to other stations within the T6 Carlingford Line. Of those that travel to Clyde, ticketing data revealed that 85 per cent travel east (29 per cent to Sydney CBD). Only 15 per cent of those customers boarding stations along the T6 Carlingford Line head west of Clyde, including to Parramatta CBD.
A journey time comparison was undertaken for commuter trips to arrive at Wynyard at about 8:30am. A summary of the travel times from the T6 Carlingford Line stations to Wynyard Station in the AM peak hour are provided in Table 8.4 for the following scenarios:

» Via the existing T6 Carlingford Line train services

» Via light rail to Parramatta Square and the T1 Western Line train to Wynyard Station.

The AM peak journey times from the T6 Carlingford Line stations to Wynyard Station in the AM peak hour were calculated on existing train timetables and the indicative light rail running times from Carlingford, and included the cross-platform transfer of nine minutes for the 8:24 am arrival at Wynyard and a five minute from light rail to a T1 Western Line train for the 8:33 am at Wynyard. For all stations, the travel times for the light rail and train journeys are the same or one to two minutes faster than the existing T6 Carlingford Line train to Clyde to transfer to the T1 Western Line trains.

Table 8.4  T6 Carlingford Line/light rail journey time comparison

<table>
<thead>
<tr>
<th>STATION</th>
<th>EXISTING T6 CARLINGFORD LINE TO WYNYARD STATION (JANUARY 2017 TIMETABLE)</th>
<th>LIGHT RAIL TO PARRAMATTA SQUARE AND T1 WESTERN LINE TO WYNYARD STATION (AM PEAK)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carlingford</td>
<td>55 minutes with a 9 minute cross-platform transfer at Clyde to the T1 Western Line with 7 intermediate stops to Wynyard Station</td>
<td>55 minutes by light rail to Parramatta Square and train Wynyard station via the T1 Western Line stopping at Strathfield, Redfern and Central Stations (same as existing train service)</td>
</tr>
<tr>
<td>Telopea</td>
<td>53 minutes with a 9 minute cross-platform transfer at Clyde to the T1 Western Line with 7 intermediate stops to Wynyard Station</td>
<td>52 minutes by light rail to Parramatta Square and train Wynyard station via the T1 Western Line stopping at Strathfield, Redfern and Central Stations (1 minutes less than the existing train service)</td>
</tr>
<tr>
<td>Dundas</td>
<td>50 minutes with a 9 minute cross-platform transfer at Clyde to the T1 Western Line with 7 intermediate stops to Wynyard Station</td>
<td>49 minutes by light rail to Parramatta Square and train Wynyard station via the T1 Western Line stopping at Strathfield, Redfern and Central Stations (1 minute less than the existing train service)</td>
</tr>
<tr>
<td>Rydalmere</td>
<td>48 minutes with a 9 minute cross-platform transfer at Clyde to the T1 Western Line with 7 intermediate stops to Wynyard Station</td>
<td>47 minutes by light rail to Parramatta Square and train Wynyard station via the T1 Western Line stopping at Strathfield, Redfern and Central Stations (1 minute less than the existing train service)</td>
</tr>
<tr>
<td>Camellia</td>
<td>47 minutes with a 9 minute cross-platform transfer at Clyde to the T1 Western Line with 7 intermediate stops to Wynyard Station</td>
<td>45 minutes by light rail to Parramatta Square and train Wynyard station via the T1 Western Line stopping at Strathfield, Redfern and Central Stations (2 minutes less than the existing train service)</td>
</tr>
<tr>
<td>Rosehill</td>
<td>45 minutes with a 9 minute cross-platform transfer at Clyde to the T1 Western Line with 7 intermediate stops to Wynyard Station</td>
<td>43 minutes by light rail to Parramatta Square and train Wynyard station via the T1 Western Line stopping at Strathfield, Redfern and Central Stations (2 minutes less than the existing train service)</td>
</tr>
</tbody>
</table>
8.2.5.7  Ferries
Parramatta Wharf (F3) ferry services to the City via Parramatta River would be accessible from Prince Alfred Square and Harris Street stops. Harris Street Stop would have the shortest walking distance (500 metres) to the ferry wharf, via Argus Lane, George Street and Charles Street. Prince Alfred Square Stop may offer a shorter journey time for customers approaching the Parramatta CBD from the north/west.

8.2.5.8  Taxis
Taxi zones would generally not be provided at the light rail stops, but rather as part of existing facilities to address requirements of nearby land uses and demand generators, such as retail or commercial land uses. A number of existing taxi zones would be integrated with the project to provide convenient customer access to the light rail stops.

8.2.5.9  Kiss and ride
The results of strategic demand modelling for likely demand for kiss and ride access at project light rail stops are shown in Table 8.5 below. The greatest demand for kiss and ride access during the AM peak hour in 2026 would be at the Dundas, Telopea and Carlingford stops, reflecting the anticipated growth in residences around these stops.

The location and extent of Kiss and Ride facilities at each of the light rail stops would depend on the configuration of the local road network and the availability of space. Opportunities for designating kerbside spaces as peak-period No Parking (designated kiss and ride) zones would be considered. These would be linked to the pedestrian network accessing the light rail stops.

Table 8.5  Kiss and Ride demand modelling results (AM peak hour, 2026)

<table>
<thead>
<tr>
<th>STOP NAME</th>
<th>KISS AND RIDE DEMAND (VEHICLES)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Westmead Station</td>
<td>20</td>
</tr>
<tr>
<td>Westmead Hospital</td>
<td>0</td>
</tr>
<tr>
<td>Westmead Children's Hospital</td>
<td>0</td>
</tr>
<tr>
<td>Cumberland Hospital</td>
<td>40</td>
</tr>
<tr>
<td>Factory Street</td>
<td>35</td>
</tr>
<tr>
<td>Fennell Street</td>
<td>5</td>
</tr>
<tr>
<td>Prince Alfred Square</td>
<td>10</td>
</tr>
<tr>
<td>Eat Street</td>
<td>0</td>
</tr>
<tr>
<td>Parramatta Square</td>
<td>5</td>
</tr>
<tr>
<td>Harris Street</td>
<td>10</td>
</tr>
<tr>
<td>Tramway Avenue</td>
<td>30</td>
</tr>
<tr>
<td>Camellia</td>
<td>20</td>
</tr>
<tr>
<td>Rydalmere</td>
<td>35</td>
</tr>
<tr>
<td>Dundas</td>
<td>45</td>
</tr>
<tr>
<td>Telopea</td>
<td>55</td>
</tr>
<tr>
<td>Carlingford</td>
<td>70</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>380</strong></td>
</tr>
</tbody>
</table>
8.2.5.10 Park and ride

Typically, Park and Ride facilities would be provided where significant demand from residential land uses outside the walking catchment access the public transport network. The nature, function and structure of light rail generally serve to limit Park and Ride access and cater more to public transport interchange as well as walking or cycling access.

Dedicated Park and Ride spaces for light rail customers would not be provided in Westmead, Parramatta CBD or in North Parramatta. Existing parking spaces at the light rail stops on the T6 Carlingford Line would be maintained, except for the Carlingford terminus. Provision of Park and Ride spaces at Carlingford would need to be investigated to cater to future demand. Strategic modelling (refer to Table 8.6) undertaken for the project indicates the Park and Ride demand in 2026 at Dundas, Telopea and Carlingford.

Accessible parking spaces would not generally be provided as part of the project. Where existing Sydney Trains commuter car parks are provided (Rydalmere, Dundas and Telopea), these would be retained.

<table>
<thead>
<tr>
<th>STOP NAME</th>
<th>PARK AND RIDE DEMAND (VEHICLES)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rydalmere</td>
<td>20</td>
</tr>
<tr>
<td>Dundas</td>
<td>20</td>
</tr>
<tr>
<td>Telopea</td>
<td>20</td>
</tr>
<tr>
<td>Carlingford</td>
<td>50</td>
</tr>
</tbody>
</table>

8.2.6 Impacts during operation – parking

The project would provide additional public transport capacity. However, some on-street car parking spaces would be lost to accommodate the project.

While car parking has a role within the transport system, in this instance, the overarching aim would be to optimise the use of available road space for access to adjacent land uses and to achieve efficient use of road space along the light rail alignment and the surrounding network. To achieve this, parking would need to be permanently removed in a number of instances.

Accessible parking spaces (compliant with the Commonwealth Disability Discrimination Act 1992) and loading zones would be (where practicable) relocated to the adjacent side streets to permanent locations during construction. Other kerbside parking along the alignment could be relocated to adjacent side streets.

Other parking management strategies – such as residential permit schemes and paid parking – would be considered to mitigate parking impacts created by the project. The project could have a number of transport impacts including:

- Light rail creates a mode shift away from private car travel, reducing car parking demands.
- Light rail increases commuter parking demands along the alignment, rather than at station locations, creating greater intrusion into local streets.

Accordingly, any introduction of residential permits and paid parking would be delayed until post light rail implementation such that the outcomes of the above transport impacts can be better understood.
On-alignment parking

Where the light rail line runs along a road, all on-street car parking along that road would be removed as part of the introduction of the project. A total of 500 on-street spaces would be directly impacted by the project as a result of their location on the alignment. Of these spaces some 135 would be relocated into adjacent streets (applying the mitigation approach described in section 8.2.3 above), while the remaining 365 spaces would be either accommodated within existing parking areas on surrounding streets or would be lost resulting in the need for mode shift during peak times. A summary of anticipated parking losses by precinct is provided in Table 8.7.

Table 8.7 Parking impact summary (along project alignment)

<table>
<thead>
<tr>
<th>PRECINCT</th>
<th>EXISTING ON-ALIGNMENT SUPPLY</th>
<th>PARKING MITIGATION RELOCATED SPACES</th>
<th>PARKING MITIGATION LOST DISPLACED SPACES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Westmead</td>
<td>72</td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td>Paramatta North</td>
<td>47</td>
<td>0</td>
<td>47</td>
</tr>
<tr>
<td>Paramatta CBD</td>
<td>224</td>
<td>25</td>
<td>199</td>
</tr>
<tr>
<td>Rosehill and Camellia</td>
<td>157</td>
<td>74</td>
<td>83</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>500</strong></td>
<td><strong>135</strong></td>
<td><strong>365</strong></td>
</tr>
</tbody>
</table>

Off alignment parking

A total of 363 spaces would be impacted by the project due to off corridor works. Of these spaces some 33 would be relocated into adjacent streets (applying the mitigation approach described earlier), while the remaining 330 spaces would either accommodated within existing parking areas on surrounding streets or would be lost resulting in the need for mode shift during peak times. A summary by precinct is provided within Table 8.8.

Table 8.8 Parking impact summary (along roads impacted by off-corridor works)

<table>
<thead>
<tr>
<th>PRECINCT</th>
<th>EXISTING SUPPLY ALONG OFF CORRIDOR WORKS</th>
<th>PARKING MITIGATION RELOCATED SPACES</th>
<th>PARKING MITIGATION LOST DISPLACED SPACES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Westmead</td>
<td>5</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>Paramatta North</td>
<td>180</td>
<td>-</td>
<td>180</td>
</tr>
<tr>
<td>Paramatta CBD</td>
<td>178</td>
<td>28</td>
<td>150</td>
</tr>
<tr>
<td>Rosehill and Camellia</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>363</strong></td>
<td><strong>33</strong></td>
<td><strong>330</strong></td>
</tr>
</tbody>
</table>

Commercial vehicle parking

The mitigation strategy for car parking has sought to replace as a maximum the existing supply of loading bay parking. It is however recognised that commercial vehicle parking can at times occur within both designated loading bay spaces and within short term parking spaces.

As such additional car parking surveys have been undertaken specifically within North Paramatta and Paramatta CBD to understand the demand for commercial vehicle parking within both designated loading bay spaces and within short term parking spaces. These surveys were
undertaken on Tuesday 4 April 2017 and Wednesday 5 April 2017 between the times of 7am and 6pm. The surveys indicated comparable results between the two days.

The survey results were summarised into parking demands of loading vehicles within both designated loading bay spaces and general parking spaces. The survey found that although designated loading bay spaces were well utilised along most streets, loading spaces were rarely fully occupied across the entire course of the day. Also, loading zones were occupied more highly during periods when general car parking would be lesser. The typical availability of loading bay spaces indicates that sufficient loading bay parking is currently provided.

The survey results of the utilisation of non-designated loading spaces by loading vehicles along the proposed light rail alignment at the peak time identified some 25 loading vehicles are parked within non-loading parking spaces within George Street. Lesser, however notable, demands exist within other streets including Macquarie Street and Church Street.

While vacancies exist within designated loading spaces, the demands of loading vehicles in other general spaces would not be able to be accommodated within the designated loading bays. On this basis, the displacement of general parking spaces as a result of the project is likely to have an impact on loading activity and result in some displacement of loading vehicles into surrounding streets.

Consideration could therefore be given to increasing the provision of loading bays within North Parramatta and Parramatta CBD. Alternatively a separate holistic loading strategy for the CBD could be considered to achieve greater efficiency in the use of on-street loading facilities.

8.2.7 Special events

The project would service the various event venues along the alignment, including various sporting and entertainment venues that are located in close proximity to the proposed alignment. The key venues/precincts that were considered as part of the operational study included Parramatta Park (including the future Western Sydney Stadium) and Rosehill Gardens Racecourse (including the Valvoline Raceway). A broad level annual timetable for events at each venue was developed, and the travel patterns of patrons (both now and in the future) associated with identified events at each venue were considered.

8.2.7.1 Parramatta Park

Parramatta Park covers over 85 hectares of land and includes the domain lands of Mays Hill, Old Kings Oval, the Parramatta Memorial Swimming Centre and extensive areas along the Parramatta River. Vehicular access to Parramatta Park is provided in two key locations:

» The primary access is located on the south-east corner where Pitt Street intersects with Macquarie Street in Parramatta CBD.

» The secondary access to the west of the park is via Park Avenue/Queens Road that links to Westmead.

Other vehicle access points for restricted vehicles, and pedestrian and cyclist access, are located at:

» Tudor Gatehouse at O’Connell Street/George Street

» The War Memorial Swimming Pool car park driveway access

» O’Connell Street/Victoria Road.

Vehicle circulation within Parramatta Park is available by a shared one-way vehicle (30 kilometres per hour speed limit), bicycle and pedestrian loop road which operates in a clockwise direction (pedestrian two-way). To improve the walking and cycling within Parramatta Park, modifications would be implemented by Parramatta Park Trust that would see the removal of cars from much of the existing internal road and improved pedestrian and bicycle.
These events generally peak during the summer months, and generally do not coincide with the rugby league events. However, many other events occur within Parramatta Park and its surrounds that attract small crowd sizes (i.e. 5,000 people or less).

**Western Sydney Stadium**

Many community events and festivals are held in Parramatta Park throughout the year. However, the predominant special events attractor for Parramatta Park is likely to be the Western Sydney Stadium.

The Western Sydney Stadium is part of the $1.6 billion Rebuilding the Stadia Network Strategy announced by the NSW Government in 2015, to improve sporting and major event infrastructure across the state. The stadium would involve a new 30,000-seat stadium to replace the former Parramatta Stadium which had a capacity of approximately 20,700 patrons.

Vehicular access to the Western Sydney Stadium would be maintained via the existing access points to O’Connell Street along the eastern boundary of the site. The concept proposal includes a series of measures to improve pedestrian accessibility:

- Improving pedestrian connectivity from surrounding transport and the Parramatta CBD.
- Implementing two primary pedestrian entry and exit points to the stadium.
- Creating public plaza and forecourt areas to mingle before events.
- Way finding signage around the stadium.

The traffic planning for the stadium would need to consider the traffic network changes due to the project, in particular the higher through traffic volumes expected on O’Connell Street as a result of diversions from Church Street.

The Western Sydney Stadium is due to open in 2019 (subject to planning approval) and would accommodate a range of sports events, including rugby league, football, and rugby union, as well as other events such as concerts, markets and fairs. It is projected to host approximately 45 matches per year, including 30 NRL games (10 games each for three teams), as well as up to 12 Western Sydney Wanderers games and potentially three other separate events (e.g. concert).

Infrastructure NSW expects that only 25 per cent of NRL matches hosted by Western Sydney Stadium would be at full capacity. Therefore, the maximum crowd of 30,000 patrons could be expected for up to 20 games per year. All other events would therefore likely experience lower crowd volumes. This does not include any potential concert that may be able to cater for additional patrons on the ground surface area.

**Parramatta Leagues Club**

Although located to the north of Parramatta Stadium (and outside the Parramatta Park boundary), the redevelopment of the Parramatta Leagues Club has recently been approved, and would include a new pool, gym and leisure centre, as well as a new above ground car park comprising of approximately 530 additional car parking spaces.

**Parramatta Park access summary**

A review of the Western Sydney Stadium Transport Access Plan identified the following:

- The ‘Game Day Approach’ walking route originates from Parramatta Railway Station, north on Church Street, across Prince Alfred Square and along Victoria Road to Western Sydney Stadium.
- The ‘Wanderers March’ walking routes originate both from the west and east of Parramatta Park before entering Parramatta Park via Victoria Road.
- There are also several ‘Parkland Approach’ pedestrian walking routes that either travel through Parramatta Park or along the Parramatta River in both directions.
A ‘Vehicular Ring Road’ identifies a car based travel route to Parramatta Park (working clockwise), with Parkes Street/Great Western Highway westbound, Pitt Street northbound, Macquarie Street eastbound, O’Connell Street northbound and Victoria Road eastbound.

There are several local streets (particularly north-east of Parramatta Park) that currently contain 4P on-street car parking restrictions, thus allowing alternate car parking opportunities for patrons who currently choose to drive to/from Parramatta Park.

**Impacts of special events on light rail**

Light rail vehicles would have the capacity to carry a safe maximum of 200 people per vehicle during Special Events. However, given Parramatta Square stop is located approximately 300 metres north of Parramatta Transport Interchange, customers exiting the train network at Parramatta are more likely to continue walking north on Church Street and through Prince Alfred Park to Parramatta Park rather than transfer to and wait for the light rail to transport them to this location.

Based on the above, the project presents an alternative mode of transport for events, connecting Parramatta Park and the Western Sydney Stadium via the Prince Alfred Park stop with the Parramatta Transport Interchange and other stops along the project corridor.

The Parramatta Square stop is located approximately 300 metres north of the Parramatta Transport Interchange. Event attendees using heavy rail and buses interchanging at the Interchange would likely continue to walk to and from these events. Some event attendees would also likely continue to walk between the events and Westmead Railway Station.

**Impacts of light rail on special events**

To facilitate light rail operations, Church Street between Victoria Road and Factory Street would be reduced to one traffic lane in each direction (currently two lanes in each direction). The reduced capacity on Church Street would increase the traffic demand in O’Connell Street. This has implications for busy traffic operations on Friday evenings and weekends that coincide with likely event periods at Parramatta Park and the Western Sydney Stadium.

In view of the above, it is recommended that Parramatta Park Trust (Parramatta Park) and Venues NSW (Western Sydney Stadium) consider the impact of the additional base traffic likely to be experienced on O’Connell Street when developing detailed event traffic management plans. Pedestrian flows during special events must be managed to avoid pedestrians spilling onto O’Connell Street. These traffic management plans would need to ensure that pedestrians exit Parramatta Park from appropriate locations (i.e. fencing installed along the boundary of the road interface). It is also recommended that an event day parking management plan be prepared to manage the flow of vehicles entering and exiting Parramatta Park.

### 8.2.7.2 Rosehill Gardens Racecourse

Rosehill Gardens Racecourse is located in Rosehill and is operated by the Australian Turf Club (ATC). Rosehill Gardens Racecourse has two vehicle access gates, one pedestrian overpass over James Ruse Drive, and a railway station (operated during raceday events) that provide access to this venue.

The racecourse has been designed so that vehicles entering via Gate 1 are able to access the members’ reserved on-site car parking areas (P1) to the north-east corner of the site. Vehicles entering via Gate 2 are primarily intended for the horse float areas, race day stalls and administration offices to the south of the site. Additional car parking is provided externally between the western boundary of the site and James Ruse Drive to four unreserved and public car parking areas (P1, P2, P3 and P4). Gate 3 is located to the west of racecourse for patron access via the Rosehill Railway Station on the T6 Carlingford line.

Information provided by ATC indicates that 209 non-race day and 28 race day events occurred at Rosehill Gardens Racecourse during 2016. The majority of large non-race day events at generate a
steady stream of sporadic arrivals and departures over the course of several days during the event. In 2016, 25 non-race day events of the total of 209 hosted at Rosehill Gardens attracted a crowd size exceeding 2,000 patrons. Having regard to the ATC data, only four annual non-race day events are likely to have an impact on the light rail, based on crowd size and duration.

Race day events typically have a duration of one day only (i.e. unlike most non-race day events). Accordingly, all arrivals and departures are likely during a concentrated period. The events that attracted a crowd size of greater than 10,000 patrons include the Golden Slipper, Derby Day and Schweppes Girls Day Out. 26 of the 28 non-race day events exceeded a crowd size of 2,000 patrons in 2016. As such, it is anticipated that a majority of race day events are likely to have an impact on the light rail (based on crowd size and duration).

ATC statistics show that cars, trains and buses make up approximately 80 per cent of travel mode for the Golden Slipper in 2016, with cars the dominant travel. Travel by heavy rail for the Golden Slipper event is far more popular at Rosehill Gardens than similar large events at Parramatta Park.

Valvoline Raceway

The Valvoline Raceway (formally known as Parramatta Speedway) is a dirt track racing venue capable of holding up to 10,000 patrons during events. The venue is located to the south of Rosehill Gardens Racecourse within the Granville Showgrounds (Parramatta Granville Sports Ground Reserve), with access via Wentworth Street.

Given its distance from the proposed light rail alignment and recognising that the majority of patrons are likely to continue to drive to the venue, this event is considered to have a negligible impact on light rail services and was not further assessed in the Special Events study for the project.

Existing access to Rosehill Gardens Racecourse

Various transport options exist for patrons attending race day and non-race day events and they are described as follows:

Train

» Under normal race day circumstances, the T6 Carlingford Line runs to a 60-minute service frequency between Clyde and Carlingford Stations, which includes Rosehill Station for access via Gate 3 for patrons.

» At non-race day events, ATC advises that patron arrivals/departures are generally sporadic and generally exhibit high car-based travel patterns. As such, no additional trains are provided with patrons to rely on the standard Carlingford services which operate hourly.

» For all standard race day events (which typically attract crowds of between 5,000 and 10,000 patrons), a train shuttle service operates between Clyde and Rosehill Stations only in addition to the regular T6 Carlingford Line trains between the commencement of the bump in until the completion of the bump out. This involves an additional four car train shuttling between Clyde and Rosehill Stations to provide patrons with three services per hour to Rosehill, including the regular hourly service to Carlingford.

» Additional services that operate from Central Railway Station direct to Rosehill Railway Station, thereby eliminating the need for a change at Clyde Railway Station are provided for the Golden Slipper race day event only (crowd of 25,000 patrons)

» Additional trains are provided for race day events at Rosehill Gardens, ranging between 17 to 19 per year, depending on the expected crowd numbers and event scheduling.
Car

» The members’ reserved on-site parking areas (P1) can be accessed via Gate 1 to the north of the site.

» Additional car parking is provided externally between the western boundary of the site and James Ruse Drive at four unreserved and public car parking areas (P2, P3, P4 and P5).

» Traffic control plans for race day events indicate that various treatments are installed to manage race periods, as well as assisting traffic entering and exiting the Rosehill Gardens Racecourse on event days.

Walking

» A pedestrian bridge (over the T6 railway track) provides pedestrian access to Gate 3 from the four unreserved and public car parking areas (P1, P2, P3 and P4) external to the western boundary of the site.

» A pedestrian bridge (disused horse bridge) provides a pedestrian connection between the western side of James Ruse Drive (at Oak Street) and the P2 car park.

Bus

» ATC runs a shuttle bus service for patrons to transport patrons on event race days.

» The return bus shuttle services (marked RACES) run from Parramatta Transport Interchange to Parramatta Wharf, to Rosehill Gardens Racecourse, as well as from Strathfield Railway Station to Rosehill Gardens Racecourse at 30 minute frequencies before and after events.

Impacts of special events

Once the project is opened, patrons attending events at Rosehill Gardens Racecourse can use the light rail services by interchanging at the Parramatta Square stop and alighting at the Camellia stop. Additional light rail services could be operated for events at Rosehill Gardens Racecourse than would likely generate additional patronage for the project via the Camellia stop that is only 300 metre north of Grand Avenue and the north entrance to Rosehill Gardens Racecourse. Further investigations are required with regards to any additional light rail services to be operated before and after major events at Rosehill Gardens Racecourse.

8.3 Regional land use outcomes

As discussed in Chapter 2 – Strategic context and need, substantial growth in jobs, dwelling and population in the GPOP priority growth area is expected, not only in the immediate to medium term, but also over the next 25 years. The GPOP priority growth area is anticipated to incorporate the following major regional land use and community investments:

» Some 30,000 to 50,000 additional jobs within the Westmead Health Precinct.

» A new campus for 10,000 additional students for Western Sydney University (Westmead campus).

» New Western Sydney Stadium and new Powerhouse Museum and Riverside Theatres Cultural Hub.

» Up to an additional 4,500 new dwellings as part of the Parramatta North Urban Transformation area (noting that the currently zoned land provides for approximately 3,000 dwellings with the potential for an additional 1,500 in the sites that have yet to be rezoned).

» A range of other development within Parramatta CBD, such as Parramatta Square and other developments facilitated by the City of Parramatta CBD planning proposal.

The current transport network is considered to provide limited choice and connectivity between the various precincts and hence there is a need to provide a reliable public transport service to meet future predicted growth. Without intervention with a new public transport system the limited
choice and connectivity would lead to increased car use causing further congestion. Together, the lack of connectivity and increased congestion is expected to negatively impact the city shaping and place-making vision for the GPOP priority growth area, leading to lower productivity and economic growth than would otherwise possible.

8.3.1 Regional land use plans and strategies

As detailed in Chapter 2 – Strategic context and need, regional land use development, within areas such as the GPOP priority growth area, are developed and managed through a hierarchy of strategic plans, policies and other guiding local development plans. These regional strategies are developed at a number of levels, including national, State, and local government, and provide for a range of purposes from overarching strategic planning principles to specific development controls for site-specific developments.

At the higher strategic level, the plans focus on identifying areas for the facilitation of economic growth and environmental and social outcomes, emphasising issues appropriate to this scale of future planning. At a more local level, policies and plans focus on providing the specific development controls and process that facilitates development of an urban area, including the scale form and function of land uses and the way in which these land uses interact.

The project is fully supportive of key NSW Government and Greater Sydney Commission strategic directions and objectives as set out in a number of regional strategies including the following:

» Towards Our Greater Sydney 2056 (draft)
» A Plan for Growing Sydney
» West Central District Plan (draft)
» Greater Parramatta and the Olympic Peninsula Vision
» NSW Long Term Transport Master Plan.

A summary of the relevant major land use strategic plans and policies that affect land use within the GPOP priority growth area is shown in Figure 8.14.
8.3.2 Existing land use, communities and facilities

The area surrounding the project contains a wide variety of land uses, including residential areas, employment areas, retail, educational centres, industrial, health precincts and major recreational destinations. The GPOP priority growth area already contains a blend of established large-scale, city shaping assets, making it well placed to further evolve into a vibrant modern city. These assets can be leveraged and connected to underpin the Central City and are comparable to the assets that already exist in the City of Sydney and include:

» Commercial:
  • Parramatta CBD
  • Sydney Markets.

» Health:
  • Westmead Hospital
  • The Children’s Hospital at Westmead.

» Parks:
  • Parramatta Park
  • Parramatta River
  • Bicentennial Park.

» Arts and culture:
  • The new Powerhouse Museum and Riverside Theatres Cultural Hub.
Regional planning, transport and economic impacts

8.3.3 Regional planning and land use implications of the project

Integrated planning of transport and land uses recognises that land use generates demand for travel while the available transport system can influence how land is used for a particular purpose. The ability to access housing, employment, retail outlets, education and other community services impacts on the quality of life of residents of a city. Effectively integrated land use patterns and transport systems make it possible to move people in ways that make the most of available economic and human resources.
The project would also result in a range of planning and land use implications at a regional level including the following benefits to the broader community and to the economy:

- Supporting the GPOP priority growth area vision.
- Providing a catalyst for investment and urban growth.
- Providing city shaping benefits.
- Place making benefits.

A summary of the potential regional planning and land use implications of the project (once operational) are discussed in the following sections. Further discussion of the potential local land use and property impacts associated with the project (including potential short-term impacts which may occur during construction) within each of the identified precincts are described in Chapters 11 to 15 of this Environmental Impact Statement.

8.3.3.1 Supporting the GPOP priority growth area vision

The GPOP priority growth area is expected to experience significant urban transformation over the next 10 to 20 years. Supporting the GPOP priority growth area vision would, in part, rely on property market interventions, including reviews of planning controls, priority precincts and transit oriented developments. The project has worked closely with key land use planning agencies such as Greater Sydney Commission, Department of Planning and Environment, the City of Parramatta and key local land use owners and developers such as the Department of Health (Westmead Hospital), UrbanGrowth NSW (Camellia) and Western Sydney University (Rydalmere), to ensure that land use outcomes are reflected in current and future planning instruments.

The project would support the GPOP priority growth area vision by providing a high frequency and high capacity public transport connection between places where people will live and work in the future, and in a way that would provide significant transport amenity to households and businesses.

8.3.3.2 Providing a catalyst for investment and urban growth

High frequency mass transit systems such as light rail are recognised globally as catalysts for transit oriented development in the walking catchments of new stops. Although there are many definitions of transit oriented development, the key elements are generally:

- Higher density urban developments located around high frequency mass transit stops.
- A diversity of land uses, including jobs, housing, shopping, recreation and education.
- Precinct designs that encourage and prioritise walking, cycling and public transport use.

An important secondary benefit of transit oriented development comes with the associated services and local infrastructure improvements that accompany new residential and commercial development, including:

- New and upgraded public domain, such as local parks, town squares and upgraded pedestrian and cycle path(s) through the wider precinct that contribute to local ‘place making’.
- New local shops and services that improve the convenience for new residents and existing communities, reducing the need to travel by private vehicle.
- New and upgraded community facilities such as libraries, community centres, and restoration of local heritage items and environmental assets.
The project is estimated to directly contribute to the following key areas with respect to assisting with investment and growth within the GPOP priority growth area:

» Western precincts of the GPOP priority growth area – including about 32 per cent of the potential uplift in population and about seven per cent of the potential uplift in jobs by 2041, such as:
  - Significant investments in the Westmead Health Precinct and Parramatta CBD for growth in jobs and dwellings.
  - The Parramatta North Urban Transformation Area and major urban renewal programs at Camellia, Rydalmere and Telopea.
  - Redevelopment of the Western Sydney Stadium.
  - Proposed new Powerhouse Museum and Riverside Theatres Cultural Hub.

» Total GPOP priority growth area – including about 17 per cent of the potential uplift in population and about two per cent of the potential uplift in jobs by 2041.

There are also a number of characteristics of light rail as a transport mode, and specific elements of the project design, which are likely to act as a catalyst for accelerated or further investment over and above these forecasts. For example:

» Light rail is relatively permanent as a result of embedding tracks and constructing stops, and signals a longer-term commitment by the government in growing the area.

» The project includes a number of elements that would directly improve the public domain and create opportunities for further investment including pedestrian and cycle path, removal of cars from Church Street and Macquarie Street (enhancing Parramatta’s restaurant precinct as a vibrant pedestrian friendly environment), and a grade separated pedestrian crossing to the future Camellia town centre (refer to Figure 8.16).

» Light rail stops provide the opportunity to integrate with future town centres and public plazas at Parramatta Square, North Parramatta, Camellia, Telopea and Carlingford (refer to Figure 8.16).

» The project would provide the only direct public transport link between the Westmead and Cumberland health areas.

» The project would link either side of the Parramatta River and supports future expansion of the CBD.

In addition, a number of additional urban renewal and city shaping activities have already commenced within the GPOP priority growth area with significant private sector investment either planned or already occurring.

Figure 8.17 provides an overview of the project integration locations with planned investments and contribution to the public domain. The potential cumulative impact of these developments in conjunction with the project is discussed in Chapter 9 – Regional cumulative impacts.
Figure 8.16  Key development areas along the project alignment
8.3.3.3 City shaping benefits

Higher and better land use outcomes

The project would assist in supporting greater urban densification at stops and along the corridor, reflected in more residential and commercial land being rezoned to allow for higher permissible floor space ratios.

The project would also assist in accelerating the growth in dwellings and commercial space by 10 years, as the transport amenity and permanency of a new light rail system would make it attractive to both households and developers. For example, being within the vicinity of a light rail stop would have the potential to increase land values (refer to section 8.4.2).

The project would also unlock additional growth in new dwellings and jobs where changes to planning controls are dependent on the project. This includes Camellia, Parramatta CBD north, Rydalmere, North Parramatta and Telopea. This additional investment in these areas is estimated to be valued at about $2.6 billion by 2041.

Reduced costs of urban sprawl

The project would support residential densification and is forecast to attract additional medium and high density dwellings to the GPOP priority growth area, reducing urban sprawl. This would reduce the need for low density dwellings in greenfield areas elsewhere in the Sydney Greater Metropolitan Area.
Infrastructure to support infill (brownfield) development in the GPOP priority growth area (such as water, gas and electricity utilities), would also be cheaper per dwelling than developing new infrastructure networks in greenfield locations. This is because infill areas often have spare infrastructure capacity and require fewer resources to upgrade existing systems.

**Improved housing affordability**

As discussed previously in section 2.3, the project would provide a catalyst for urban renewal by focusing new housing and employment around safe, connected and diverse urban precincts. The project could also assist in improving housing affordability by unlocking housing supply in urban renewal projects such as Parramatta North, Camellia, Telopea and Rydalmere and providing the opportunity for the development of additional and more diverse housing options.

**8.3.3.4 Place making benefits**

**Improved liveability and sustainability**

The project would help to provide a catalyst for urban renewal by focusing new housing and employment around safe, connected and diverse urban precincts. The provision of frequent light rail services throughout the day and off-peak periods would enhance liveability, promote activity, increase safety through passive surveillance and attract a range of retail opportunities within stop precincts.

The project would play a key role in accommodating Sydney's future growth needs by unlocking significant opportunities for new housing and jobs in precincts that promote sustainable travel behaviours, while also enhancing liveability. Specifically the project would:

- Enable changes to zoning from industrial and commercial to residential and mixed uses in Parramatta North, Rydalmere and Camellia precincts. This will activate these precincts throughout the day, increasing their vibrancy and safety.
- Increase pedestrian activity, which would provide an incentive for additional shops, services and jobs within local proximity to the project. This would provide potential health benefits for every additional kilometre walked due to avoided medical and hospital costs and increased productivity.
- Provide high light rail service frequencies at night (every 10 minutes from 5 am to 7 am and from 7 pm until 11 pm, and every 15 minutes until 1 am), which would increase passive surveillance and create a safer environment for pedestrians.
- Contribute to the public domain by providing six kilometres of new active transport links, removing cars from sections of Church Street providing a wider space for pedestrians and diners (Eat Street restaurant area) and a grade-separated pedestrian crossing of James Ruse Drive. The project would also connect with existing walking corridors designated by the City of Parramatta and link up with the existing and proposed regional cycleway.

**Health benefits of walking and cycling**

The project would also provide a catalyst for more active travel by providing additional active transport infrastructure and also by increasing the number of walking trips to access light rail stops. More than half of the population of GPOP priority growth area would be within walking distance of a stop by 2026. The project would reduce the reliance on cars for localised travel, and the need for car spaces in the city and in new developments, assisting in meeting the City of Parramatta Councils policy of reducing parking for new developments where access to public transport is available.

Reduced car use and improved urban amenity would increase walking and cycling to access shops, services and jobs in the local area, and the Carlingford active transport link (refer to
section 5.7) would encourage cycling trips to commute to the Parramatta CBD or access the Western Sydney University campus in Rydalmere.

**Amenity from enhanced pedestrian environments**

The project would lead to potential improvements to existing pedestrian environments along the alignment. For example, the provision of new pedestrian links at Carlingford and Parramatta North as part of the project would improve pedestrian and cyclist amenity. Users of these areas would benefit from passive surveillance from the light rail and help points at each light rail stop. The proposed pedestrian path at Parramatta North would also provide a link from the light rail stop to the future town centre.

The Church Street restaurant quarter (Eat Street) would also be enhanced as a vibrant, pedestrian friendly environment. As part of the operation of the project, general vehicular traffic would be removed between Market Street and Macquarie Street, reducing noise and pollution.

The project would also include a new pedestrian/cyclist bridge over James Ruse Drive, avoiding eight lanes of traffic. This connection would also provide a direct link to the future Camellia town centre.

**8.3.3.5 Access between centres and access to local community services**

The project would provide increased access options for a range of community services located at centres along the project alignment (such as medical services at Westmead or educational facilities at Westmead, within the Parramatta CBD and at Rydalmere) and across the wider GPOP priority growth area as well as providing improved access to and from the Parramatta CBD as the central hub of GPOP.

Particular improvements would be provided to those travelling to and from Westmead and Carlingford at either end of the project. Students and staff travelling from these locations to the Western Sydney University campuses along the project alignment would benefit from improved and more reliable services. The expanding Westmead Health Precinct would also be able to better accommodate an increasing number of staff and visitors travelling to the precinct for specialist care from across the wider Western Sydney regions.

**8.4 Regional economic impacts**

An economic ‘impact’ affects the level of economic activity generated in a defined area either positively or negatively. The assessment of likely impacts resulting from a particular project allows for the identification (and where possible) quantification of impacts as either likely benefits or negative impacts.

Economic impacts may directly affect a range of factors such as the:

» Economic wellbeing of an area’s residents.

» Viability of businesses, workforce availability or trade, by changing factors that influence opportunities for employment or business growth.

» Ease of doing business and the environment in which business is conducted.

Economic impacts may also alter the scope of demand for services and accessibility to those services. The geographic range of an economic impact is dependent on the nature of the proposed development and its scope of influence. The geographic influence of an impact can range from individual dwellings or streets through to suburbs, local government areas, states and countries.

The following sections provide a summary of the potential regional economic impacts of the project.
8.4.1 Existing regional economy

8.4.1.1 Western Sydney economy

The City of Parramatta is a $24 billion economy, making it the sixth largest local government area economy in Australia, and the second largest in NSW. It includes the economic anchors of the Parramatta CBD and Westmead Health Precinct and employs 157,000 people, with a significant catchment of skilled workers. The City of Parramatta is home to four Western Sydney University campuses and a University of New England campus, and more than one in four residents have attained a bachelor degree or higher (more than the average across Greater Sydney).

More specifically, the region potentially impacted by the project (including GPOP priority growth area) comprises a number of key economic activity centres including the following:

» Westmead – Westmead is the western centre of the GPOP priority growth area and contains significant employment generators including public/private health facilities, education and an industrial precinct. In 2011, Westmead supported around 14,000 jobs with a majority of these jobs (around 8,200) in the hospital precinct.

» North Parramatta – North Parramatta contains a diverse range of businesses and employment industries, with the largest employer being the Cumberland Hospital, which employed around 410 persons (of the total 5,360 jobs generated within the wider locality). The wide range of businesses and employment industries are a result of a mixture of business and industrial zones, includes industrial and enterprise corridor zonings which transition to mixed use areas around the hospital and Church Street.

» Parramatta CBD – Parramatta is the business centre of Western Sydney. It is Australia’s third largest economy and more than 20 percent of Australia’s top 500 companies have a strong presence within Western Sydney. The Parramatta CBD Precinct is considered to be the primary financial and administrative centre outside of Sydney CBD. The Parramatta CBD also contains a large number of government and administration uses, employing over 7,100 persons in these fields.

» Rosehill and Camellia – This precinct contains a large area of industrial zoned land. As of 2015, the area provided around 350 hectares of industrial zoned land, constituting around 61 per cent of all employment zoned land within Parramatta LGA. Other major stakeholders which generate substantial economic inputs include, Rosehill Gardens Racecourse and Sydney Speedway. The precinct provides around 13,650 jobs, with the largest employment industry being road and freight transport, employing 820 persons.

» Carlingford – Businesses along the existing T6 Carlingford Line predominately consist of neighbourhood shops and commercial services located around the existing railway stations. These businesses serve the local needs of residents, visitors and employees of the precinct. The precinct provided around 3,900 jobs (as of 2011) with the largest employment industry being supermarket and grocery stores (around 220 persons).

Further information regarding the existing economic characteristics along the project alignment are provided in Chapter 4 of the Business Impact Statement (Technical Paper 14, Volume 7 of this Environmental Impact Statement)

8.4.2 Regional impacts

8.4.2.1 Managing increased transport demand

By 2056, greater Sydney’s population is expected to grow from 4.7 million people eight million people. By 2031, Sydney’s economic output is expected to almost double to $565 billion a year with about 689,000 new jobs. In the next 20 years, Sydney’s population is estimated to grow by 1.6 million people, with 900,000 of this population growth occurring in Western Sydney, reinforcing the emergence of Parramatta as a second CBD for Sydney.
As described in Chapter 2 – Strategic context and need, to meet the housing need for this new population, the NSW government has identified the GPOP priority growth area, a region spanning 13 kilometres east to west from Strathfield to Westmead, extending seven kilometres north to south from Carlingford to Granville as one of three city metropolises. Within the GPOP priority growth area, the population, dwellings and jobs are set to increase substantially over the next 25 years as part of Sydney’s wider anticipated expansion.

Without additional transport investment and the associated changes to planning controls, investment would be less attractive to households and developers. This would particularly be the case in precincts along the project alignment with poor public transport accessibility such as:

» Parramatta North – No heavy rail services and no direct bus connection between Cumberland Hospital and Westmead Hospital.

» Camellia – Only a single road access point via the congested James Ruse Drive (volumes are 86 per cent capacity in the two-hour morning peak) and Grand Avenue, and a 28 minute bus journey to travel 2.5 kilometres to the Paramatta CBD or transfer between heavy infrequent heavy rail services.

» Carlingford – Serviced by infrequent heavy rail services with a transfer to reach the Parramatta CBD, and no north-south bus connection with Telopea, Rydalmere and Camellia.

The project would provide an alternative public transport option to serve future residents and jobs in the GPOP priority growth area, providing a high frequency, turn-up-and-go light rail service that would be direct, fast and reliable, with new stops located close to where people would live and work in the future. This would assist in reducing demands on the existing transport network.

8.4.2.2 Improved transport integration leading to improved productivity

The project integrates with key public transport interchanges within the GPOP priority growth area, including the heavy rail interchanges at Westmead and the Parramatta CBD for commuters and businesses requiring travel to the Sydney CBD. Heavy rail services at these stations are frequent and suited to a turn-up-and-go light rail service for connection.

The project would also interface with key bus interchanges in Westmead (T-way), the Parramatta CBD, Rydalmere and Carlingford, and ferry services in the Parramatta CBD. The project would also increase the potential reach of the future Sydney Metro West train line, extending its proposed catchment along the Parramatta Light Rail corridor. The conversion of the T6 Carlingford Line from heavy rail to light rail operation would also provide immediate benefits to commuters by providing a more frequent service, replacing the infrequent (two services an hour in peak) heavy rail service, which also requires an interchange to get to the Parramatta CBD.

The improved connection of these areas is anticipated to increase overall economic productivity through reduced travel times between economic centres and bringing businesses closer to their employees by increasing the public transport catchment.

Further discussion regarding the potential transport benefits associated with the project has also been discussed previously in section 2.3 of this Environmental Impact Statement.

8.4.2.3 Supporting sports, arts, culture and tourism

The project would support the development of regional sports and arts and cultural centres by providing additional transport capacity during events and connecting future residential centres with key assets such as Western Sydney Stadium (a new 30,000 capacity Western Sydney Stadium proposed to be completed in 2019) and the Riverside Theatres.

Similarly, the Camellia stop would be located within walking distance of the Rosehill Gardens Racecourse, while the Eat Street stop would be located within walking distance from major events which occur in the Parramatta CBD and Parramatta Park. Supporting the sports, arts, cultural and heritage areas in Parramatta would improve the quality of life for residents and would boost the
local economy through increased tourism, both from within other parts of Sydney and further abroad.

The benefits of light rail to tourism would also relate to the extended hours of service and the support this would bring to the night time economy. A stronger night time economy is not only beneficial for economic reasons but would also create activity and excitement in a city centre, improving its sense of safety and lifestyle appeal.

8.4.2.4 Agglomeration and productivity benefits

Agglomeration (concentration of industries in one place) benefits are the productivity benefits that businesses derive from being located in close proximity to each other, enabling increased knowledge transfer and collaboration. The project would bring businesses closer together by reducing travel times, facilitating more face-to-face meetings, and attracting more businesses to locate in close proximity of each other in areas in the Parramatta CBD. This includes:

» Westmead – including opportunities for the agglomeration of medical facilities/centres.

» Between the Westmead, Parramatta and Rydalmere campuses of Western Sydney University.

» Within and between the future Parramatta North Urban Transformation area.

The project would play an important role (as part of the wider public transport system in Western Sydney) in supporting the increased densification of the Parramatta CBD and surrounding region, in addition to areas currently identified as part of the GPOP priority growth area (refer to section 8.3.2). This would in turn enhance Parramatta CBD’s capacity to support the agglomeration of businesses, the associated economic benefits to private business and consumers, and Western Sydney’s role as part of the greater Sydney metropolis.

8.4.2.5 Employment benefits

The operation of the project would increase the labour pool that is accessible to employers by connecting employment and residential centres, reducing public transport commuting times, reducing congestion, unlocking affordable housing supply and attracting households to move closer to businesses. The project would also provide improved access to public transport for people within 30 minutes of the Parramatta CBD.

In addition, the project is also estimated to create up to 1,000 direct jobs per year during construction of the light rail. This would include jobs that are directly related to the construction of the project, as well as indirect jobs as more expenditure occurs in the local area. This would also increase the demand for, and production of, associated goods and services within Western Sydney. An estimated 130 to 145 permanent jobs per annum would also be generated by the management, operation and maintenance of the project.

New business opportunities would also be fostered by commercial outlets at the new stops and surrounding areas (where these are in existing or proposed commercial or mixed use areas such as the Parramatta CBD or the future Parramatta North Urban Transformation area), resulting in a positive macroeconomic impact for the Greater Parramatta region.

Further discussion regarding potential employment benefits associated with the project have been discussed in section 2.3 of this Environmental Impact Statement.
8.4.2.6 Land values and rent return

Land and property values have a tendency to respond to various positive and negative influences. These influences are based on three elements.

1. Market perception – such as a community's perception of construction activity impacts, property acquisition, etc.
2. Locational attributes – such as positive or negative elements directly affecting a property such as view corridors, noise sources, etc.
3. General market forces – such as interest rates, international investment, supply/demand, population and market growth.

Extended periods of construction, whether direct or cumulative due to other construction can have the potential to place downward pressure on property values or rents in the short term. However, general market forces remain the key influence on the market's direction in the long term.

Concerns regarding the impact of construction on property and lease values have been raised during consultation with businesses. Specific concerns include impacts upon commercial property and rent prices arising from:

» The uncertainty surrounding whether businesses would need to be acquired.
» Several property acquisitions in one location and the potential effect it would have on supply and demand and local business precinct identity.
» Visual impacts, reduced (negative) or increased (positive) access to property, increased congestion, loss of on-street parking, increased competition for parking and reduced amenity.

Public transport accessibility can make developments more attractive to households, as indicated by the significant positive impact that proximity to public transport can have on land values. This is supported by case studies which have been conducted for the extension to the Inner West (Dulwich Hill) light rail and the Epping to Chatswood heavy rail projects. These case studies estimated the potential land value uplift from being within 400 metres of stops or stations associated with these projects (in comparison to land values prior to the operation of the new public transport links).

The case studies identified that following the extension of the Inner West light rail and the construction of the Epping to Chatswood heavy rail line, the estimated land value increases (within 400 metres of a stop or stations associated with these developments) were estimated at around seven per cent and around 48 per cent (for light rail and heavy rail respectively).

The development of the project is expected to result in similar impacts on those identified in the previous case studies, for a number of the GPOP priority growth area precincts. The project would assist in making these locations more attractive to households, who, in turn, would be willing to pay more for developments at these locations, resulting in overall increase to existing land values.

8.4.3 Economic assessment

An economic assessment was carried out for the project using a cost benefit analysis framework. This compares the costs and benefits of the project over 30 years of operations to a base case. For the assessment, the base case assumed a continuation of the existing transport network, though did include currently planned and committed investments in transport infrastructure. The economic appraisal estimated that the value of the economic benefits of the project would be $140 million by 2026, increasing to $2.7 billion (including productivity and option value) by 2041.

Over 30 years of operation, the economic benefits of the project are estimated to exceed costs by:

» Around $192 to $496 million (present value), including transport and city shaping benefits.
» Around $476 to $780 million (present value), including transport, city shaping and productivity benefits.
Regional cumulative impacts

This chapter provides an assessment of potential cumulative impacts and benefits associated with construction and operation of the Parramatta Light Rail Project (‘the project’) and other major proposed developments along the proposed light rail corridor and surrounding region.

9.1 Purpose and assessment approach

When considered in isolation, the environmental impacts and benefits of an individual project may not be significant; however, when combined with the effects of other developments, the resultant cumulative effects can potentially result in a greater extent, magnitude or duration of impacts. Identifying potential cumulative impacts assists in developing appropriate management measures and provides a basis for coordinated regional planning and environmental monitoring.

The selection of projects assessed as part of this cumulative impact assessment was based on the following criteria:

- The project location – projects in close proximity to the project where there is potential for impacts to spatially overlap. This included potential for shared use of roads for construction access.
- The project timeframe and planning approval – only projects likely to be built concurrently or sequentially with the project were considered. This included relevant projects currently under construction and/or projects that have already received planning approval. Projects at a conceptual or pre-approval stage were identified for completeness but generally not assessed due to uncertainty around project scope and/or timeframe.
- The project size – projects considered in this assessment are typically large-scale developments that would involve one or more of the following criteria:
  - Substantial temporary changes to existing traffic conditions, including traffic generation and changes to traffic flows, large truck movements and disruptions to key access routes.
  - Substantial temporary changes to the existing noise environment.
  - Impacts on numerous and/or significant heritage items.
  - Substantial changes to the existing land use.
  - Substantial changes to the existing urban landscape.

The cumulative assessment was predominantly qualitative based on the current/publicly available information available for each project. Proposed developments with the potential for cumulative impacts to occur with the project were identified through:

- Consultation with key stakeholders, City of Parramatta Council, Transport for NSW, the Sydney Coordination Office, and the wider project team.
- A search of the Department of Planning and Environment’s major projects register in February 2017.
- A search of the NSW Planning Assessment Commission’s project register for the City of Parramatta local government area (LGA) in February 2017.
- A review of other available background documents including planning strategies and major facility master plans.
Regional cumulative impacts

Key issues identified for the project and cumulative impact requirements identified in the Secretary's environmental assessment requirements (SEARs) for the project have been considered as part of this cumulative impact assessment. The key issues included impacts on construction and operational traffic and transport, non-Aboriginal and Aboriginal heritage, biodiversity, construction noise and vibration, flooding, landscape and urban design, property, land use and business, social impacts and community infrastructure. In addition to these key issues, other impact issues were considered where there was likely to be potential cumulative impacts given the nature of the likely interaction with adjacent projects.

The potential cumulative impact associated with other environmental issues such as land use and property; groundwater and geology; soils, contamination and water quality; flooding and hydrology; hazard and risk; waste management; and sustainability were considered to be of a typically minor nature, and not substantial enough to result in significant cumulative impacts. The mitigation measures identified throughout this Environmental Impact Statement are considered appropriate and adequate to address any potential residual cumulative impacts for these other issues.

9.2 Potential cumulative impacts

9.2.1 Overview

The following subsections provide an overview of the types of cumulative impacts that may occur during the construction and operation of the project and other major developments proposed throughout the Greater Parramatta area.

9.2.1.1 Construction-specific cumulative effects

Construction-specific cumulative effects are most likely to occur where construction works overlap in terms of timing and/or location. Cumulative effects from construction activities usually relate to noise and vibration, traffic and access, visual amenity and air quality impacts. The scale of the impacts largely depends on the type of work, its duration and the sensitivity of surrounding land uses.

A number of the identified projects are within close proximity to each other, with a series of the proposed developments located directly along the project alignment. As such, a number of cumulative construction impacts may occur where the construction timing of the various projects occur (concurrently resulting in construction fatigue) including:

» Cumulative increases in construction vehicle traffic on public roads resulting in a series of impacts including:
  • Potential disruption to access and circulation routes to properties along the project alignment.
  • Additional noise/vibration and air quality impacts on sensitive receivers.
  • Increased localised congestion from higher numbers of heavy vehicles navigating through the area.

» Cumulative noise impacts associated with multiple construction works, especially at night.

» Disturbance to existing and future land uses and access.

» Cumulative heritage impacts.

» Cumulative noise, dust and amenity impacts during construction.

» Minor cumulative impacts on utilities and services. Services would be maintained throughout construction with no more than minor disturbances.
Regional cumulative impacts

» Cumulative changes to water quality of nearby waterways or groundwater from runoff from multiple construction sites.

» Cumulative temporary visual amenity impacts.

In addition to occurring simultaneously, projects may have cumulative effects if they follow progressively and are concentrated in a general locality, resulting in an overall increased duration of disturbance on sensitive receivers, particularly residents. This effect is often termed ‘construction fatigue’. This is potentially a key issue for certain locations along the project due to the length of the construction program and the concentration of a number of major development projects in close proximity, particularly in the Parramatta central business district (CBD).

9.2.1.2 Operational-specific cumulative effects

Cumulative operational impacts and benefits of the project and other major developments may be associated with:

» Changes to the distribution of traffic and access arrangements, and associated changes in amenity, including noise.

» Changes to the visual amenity of an area.

» Property and land use impacts and urban renewal.

9.2.2 Cumulative impacts with identified major developments

A number of major developments with the potential for cumulative impacts with the project have been identified. The relevant projects and proposed developments which have been assessed as part of the cumulative assessment for the project are described in Table 9.1 along with their indicative timeframe (as known at the time of preparation of this Environmental Impact Statement). This table also briefly considers the key potential impacts/issues which may have a cumulative impact between the project and the proposed development.

The relevant projects which have been considered as part of the assessment include developments:

» Along or within the immediate vicinity of the project alignment that have been approved but where construction has not commenced.

» That have recently commenced construction (and which may still be under construction during the proposed construction period of light rail).

» That have recently been completed along the project alignment.

The developments assessed have been considered as they are considered to be large developments which may result in a cumulative impact during the construction or operation of the project.

A number of these sites are shown on Figure 9.1 below.

9.2.3 Potential future projects and programs

Other planned projects that may result in cumulative impact but that have not yet been approved/do not have a definitive timeframe are also identified in Table 9.2. A number of local strategic plans have also been considered as they influence subsequent development that has the potential to result in cumulative impacts with the project.

Where relevant, these projects have been identified but the potential impacts have not been able to be fully assessed given the uncertainty of the status and timing of these projects.
Regional cumulative impacts

1. Western Sydney residential development (WSU)
2. Mixed use development (private)
3. Westmead Health Precinct redevelopment (Health Infrastructure)
4. Parramatta North Urban Transformation Area (UrbanGrowth NSW)
5. Heritage building repairs (Cumberland Hospital site)
6. Western Sydney Stadium redevelopment (Infrastructure NSW)
7. Parramatta Leagues Club
8. Mixed use development
9. Altitude (Marlton)
10. New Powerhouse Museum (NSW Government)
11. O’Connell Street Primary School redevelopment (NSW Department of Education)
12. Parramatta Square (various)
13. Parramatta Public School (NSW Department of Education)
14. Arthur Phillip High School (NSW Department of Education)
15. Macquarie Street residential development
16. Macquarie Towers residential
17. Commercial development
18. Mixed use development (Lennox Tower)
19. Riviera Apartments
20. Promenade residential development
21. The Galleria mixed use development
22. Proposed residential precinct development
23. Mixed development – residential and commercial
24. Residential development
25. Residential development
26. Sydney Metro West
27. Camellia town centre (Department of Planning and Environment)
28. Telopea Priority Precinct

Figure 9.1 Planned future land use developments within the Greater Parramatta region

Note:
The projects shown in this figure are based on the known major developments (as at mid-2017) adjacent to or within the immediate vicinity of the project alignment that had either been approved but not yet commenced construction, had relatively commenced construction (and which may still be under construction during the proposed construction period of light rail), or have recently been completed along the project alignment.

These developments are intended to illustrate the large amount of ongoing development currently being undertaken within the Greater Parramatta region.
### Table 9.1 Major developments with potential for cumulative impacts with the project

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<th>PRECINCT IMPACTED</th>
<th>PROJECT DETAILS</th>
<th>STATUS AND INDICATIVE TIMING</th>
<th>LIKELY PROJECT OUTCOMES RESULTING IN CUMULATIVE IMPACTS</th>
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| 1   | Western Sydney University residential developments (158-164 Hawkesbury Road, Westmead) | Westmead precinct | Two separate developments currently in planning development on the Western Sydney University, Westmead campus. These are:  
 » Construction of two residential buildings containing around 556 apartments and basement car parking. The proposed buildings range in height from four to 24 storey buildings.  
 » Construction of a residential building containing 355 units and basement car parking, with heights ranging between 6 and 21 storeys, with associated site works, engineering works, tree removal and landscaping. | The development applications (DA) for these developments have been lodged with the City of Parramatta Council and are currently with the Sydney West Joint Regional Planning Panel for determination. Subject to development approval, the projects are estimated to be completed by early 2019 (first project) and beyond 2021 (second project). | Potential environmental impacts/issues would likely include:  
» Traffic, transport and access during construction and operation  
» Noise, dust and amenity impacts during construction  
» Visual and urban design considerations. |
| 2   | Mixed-use development (24-26 Railway Parade Westmead) | Westmead precinct | A mixed-use development is currently in the planning stage of development/DA preparation. The proposed development would include an up to 15 storey tower. | Pre-lodgement information is currently being assessed by the City of Parramatta Council. Subject to formal preparation of a DA and planning approval, the project is currently estimated to be completed by late 2021. | Potential environmental impacts/issues would likely include:  
» Traffic impacts (construction and operation)  
» Built form, urban design, privacy and overshadowing issues  
» Noise and vibration impacts from demolition and construction activities. |
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<th>LIKELY PROJECT OUTCOMES RESULTING IN CUMULATIVE IMPACTS</th>
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| 3   | Westmead Hospital redevelopment (Hawkesbury Road, Westmead) | Westmead precinct | The Westmead Health Precinct is currently undergoing a major renewal (over $900 million) through the implementation of a number of projects including refurbishment of existing facilities, provision of additional car parking, a new emergency department, and development of other new buildings. The number of people employed in the precinct is expected to grow by an additional 11,000 jobs by 2031. Current approved works includes:   
   » Construction of the Westmead Central Acute Services Building consisting of:      
     • A building up to 13 storeys to accommodate acute inpatient care services, emergency departments, operating theatres, surgical wards, intensive care services, various clinical and medical support services and a University of Sydney Innovation Centre.   
     • A forecourt area with two levels of underground car parking, drop-off/pick-up areas and landscaping.   
     • Overhead pedestrian links to other hospital buildings and other ancillary facilities.   
     • A number of car parks within the precinct.   
     • A new four-storey family accommodation building containing 60 self-contained units (Ronald McDonald House). | The works currently in planning phase or being delivered are generally expected to be completed between 2018 and 2020 (depending on the proposed scale of the wider precinct development works). | > Expected to have cumulative long term benefits in terms of social and community benefits.   
   > Potential environmental impacts/issues would likely include:      
     • Access and circulation due to construction traffic in the surrounding area or within the hospital precinct      
     • Heritage conservation      
     • Landscape and open space      
     • Urban design, visual amenity and privacy      
     • Safety and security. |
## Regional cumulative impacts

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| 4   | Parramatta North Urban Transformation area (Former Cumberland Hospital site) | Westmead and Parramatta North precincts | The Parramatta North Urban Transformation area was rezoned in 2015 to provide a new residential and commercial centre north of the Parramatta CBD, within the former Cumberland Hospital site. Parramatta Light Rail would pass through the development site in an east west direction, between Bridge Road, Westmead and Factory Street, North Parramatta. Key features of the proposed development include provision for:  
  » Around 3,000 new residential properties.  
  » A village centre of providing a mix of retail and commercial space.  
  » Open space and community facilities.  
  The Parramatta North Urban Transformation area is anticipated to development over the next 10 years. | UrbanGrowth NSW has submitted the first DA (as at January 2017) to the City of Parramatta Council for the first stage of the development, including large lot subdivision, construction of internal roads, landscaping, rehabilitation of the foreshore, removal of some vegetation and demolition of some buildings (including a series of heritage listed properties). The early works application is currently with the Sydney West Central Planning Panel for assessment and approval.   
Beyond 2017, the site is proposed to be progressively subdivided for release for future development which would include a number of subsequent development applications.  
NSW Health facilities continue to operate at the site. | » Urban design, public domain and built form issues.  
» Social impacts, including impacts on socially disadvantaged residents currently within the precinct.  
» Traffic, transport and accessibility (construction and operation).  
» Built and Aboriginal heritage considerations (noting that the assessment of the project is based on the assumption that the existing DA includes the removal of a number of heritage items).  
» Amenity impacts during construction and operation.  
» Anticipated benefits include:  
  • Economic benefits  
  • Urban renewal and social development benefits, including affordable housing. |
## Regional cumulative impacts

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<tr>
<th>REF</th>
<th>PROJECT</th>
<th>PRECINCT IMPACTED</th>
<th>PROJECT DETAILS</th>
<th>STATUS AND INDICATIVE TIMING</th>
<th>LIKELY PROJECT OUTCOMES RESULTING IN CUMULATIVE IMPACTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td><strong>Heritage building repairs</strong>&lt;br&gt;(Former Cumberland Hospital site)</td>
<td>Parramatta North precinct</td>
<td>Restoration works are currently being carried out on some of the heritage buildings within the former Cumberland Hospital site. The works include restoration of four historic buildings within the Cumberland Hospital site and two buildings within the Norma Parker Centre.</td>
<td>Restoration works have commenced within the site. Heritage repairs are proposed to continue until about mid-2018.</td>
<td>» Amenity impacts on the heritage context of the restored buildings during construction and operation.&lt;br&gt;» Vibration impacts on restored heritage items during construction and operation activities associated with the project.</td>
</tr>
</tbody>
</table>
| 6   | **Western Sydney Stadium**<br>(O’Connell Street, Parramatta) | Parramatta North precinct | The redevelopment of the existing Western Sydney Stadium along O’Connell Street, North Parramatta (approximately 400 metres west of the proposed alignment along Church Street). The new stadium would provide for a new 30,000 seat stadium, comprising:<br>» Demolition of the existing Parramatta Pool and related buildings and structures.<br>» Construction of a new stadium including allowance for future ancillary facilities on O’Connell Street.<br>» Provision of approximately 500 car parking spaces on site, including retention and relocation of existing at grade car parking for the stadium. | Stage 1 (Concept and Stage 1 Demolition) of the project was given development approval in December 2016 by the Minister for Planning. Site establishment and demolition of Parramatta Pool commenced in early 2017. The State Significant development application for Stage 2 (which covers the construction and operation of the new stadium) was exhibited over March and April 2017. Subject to approval, the new stadium would be operational by 2019. | » Significant economic and employment generation – during and post-construction due to new stadium development and future improved access by light rail.<br>» Potential environmental impacts/issues would likely include:<br>• Traffic impacts (construction and operation)<br>• Noise and vibration impacts from demolition and construction activities<br>• Pedestrian and access impacts<br>• Built form, urban design issues/ opportunities<br>• Potential privacy and...
### Paramatta Leagues Club (1 Eels Place, Parramatta)

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<th>LIKELY PROJECT OUTCOMES RESULTING IN CUMULATIVE IMPACTS</th>
</tr>
</thead>
</table>
| 7   | Parramatta Leagues Club North precinct | Parramatta Leagues Club is proposing to carry out a number of stages of development. The stages proposed to be carried out are as follows:  
» Stage 1: Construction of a new multi-level car park  
» Stage 2: Development of a new entertainment and fitness centre  
» Stage 3: Development of a new hotel. | Stage 1 DA is currently under assessment by the City of Parramatta Council. Stage 2 and 3 are currently in the design phase of development. Subject to planning approval, it is anticipated that the proposed works for Stage 1 would be finalised in early 2021. | Significant economic and employment generation – during and post-construction due to new development and future improved access by light rail.  
Potential environmental impacts/issues would likely include:  
» Traffic impacts (construction and operation)  
» Noise and vibration impacts from construction activities  
» Built form, urban design and visual amenity impacts  
» Demand generated during special events at the stadium. | residential amenity impacts  
» Demand generated during special events at the stadium. |
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<th>LIKELY PROJECT OUTCOMES RESULTING IN CUMULATIVE IMPACTS</th>
</tr>
</thead>
</table>
| 8   | Mixed-use development (5 Victoria Road, Parramatta) | Parramatta North and Parramatta CBD precincts | A new eight storey mixed-use development has been approved for the demolition of the existing structures on the site. The development will include around 24 residential apartments and retail tenancies, and over basement car parking. | The project was determined by the City of Parramatta Council in September 2016 and is estimated to be completed by mid to late 2021. | » Traffic impacts (construction and operation).  
» Noise and vibration impacts from demolition and construction activities.  
» Built form and urban design integration. |
| 9   | Altitude by Meriton (330 Church Street, Parramatta) | Parramatta North and Parramatta CBD precincts | A mixed-use development that includes an ‘east’ tower of about 30-storeys (inclusive of about 240 serviced apartments), a ‘west’ tower of about 53-storeys (inclusive of about 355 residential apartments), and a number of commercial tenancies. | This development is currently under construction and is expected to be completed by mid-2017. | » Traffic impacts (construction and operation).  
» Noise and vibration impacts from demolition and construction activities.  
» Built form and urban design integration.  
» Potential additional impact on Aboriginal artefacts due to increase impacts on Parramatta Sand Body. |
## Regional cumulative impacts

<table>
<thead>
<tr>
<th>REF</th>
<th>Project</th>
<th>Precinct Impacted</th>
<th>Project Details</th>
<th>Status and Indicative Timing</th>
<th>Likely Project Outcomes Resulting in Cumulative Impacts</th>
</tr>
</thead>
</table>
| 10  | The new Powerhouse Museum and Riverside Theatres Cultural Hub | Parramatta CBD precinct | The NSW Government announced the relocation of the Powerhouse Museum and a partnership with City of Parramatta Council for the redevelopment of the Riverside Theatres in July 2017. The site for the new Powerhouse Museum is located along the south bank of the Parramatta River between Wilde Avenue and Church Street. | Consultation with the community on the development of the new Powerhouse Museum is in progress. Timing for each development is yet to be announced. | » Traffic impacts (construction and operation).  
» Noise and vibration impacts from demolition and construction activities.  
» Built form and urban design integration.  
» Potential additional impact on Aboriginal artefacts due to increase impacts on Parramatta Sand Body. |
| 11  | O'Connell Street primary (Macquarie Street, Parramatta) | Parramatta CBD precinct | The redevelopment of the Old Kings School campus along O'Connell Street, North Parramatta, to accommodate a new public primary school. The redevelopment would include:  
» Refurbishment of a number of the existing buildings within the site to accommodate new spaces for administration, office, library and classroom uses.  
» Construction of a new hall and a covered outdoor learning area.  
The development is also proposed to include upgrades to services, a bus pick-up and drop-off area off Marist Place, decontamination works, tree removal and new landscaping. | Development consent for the State Significant development application was granted in February 2017 and commenced construction in 2017 with estimated completion by early 2019. | » Traffic, transport and access during construction and operation, including access and parking.  
» Noise, dust and amenity impacts during construction, including potential disruption to school operations during construction.  
» Visual and urban design considerations.  
» Potential additional impact on Aboriginal artefacts due to increase impacts on Parramatta Sand Body. |
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<th>REF</th>
<th>PROJECT IMPACTED</th>
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<th>STATUS AND INDICATIVE TIMING</th>
<th>LIKELY PROJECT OUTCOMES RESULTING IN CUMULATIVE IMPACTS</th>
</tr>
</thead>
</table>
| 12  | **Paramatta Square** (Macquarie, Church Smith and Darcy Streets, Parramatta) | Parramatta Square is a three hectare mixed-use redevelopment precinct located in the Parramatta CBD. The precinct is bounded by the project alignment along Macquarie Street, in addition to Church Street, Smith Street and Darcy Street. Construction on the redevelopment has commenced and, when completed, will comprise six key sections within the overall precinct, including:  
» A new Western Sydney University campus (now operational).  
» New office and commercial towers.  
» A new residential development (estimated at between 70 and 90 storeys).  
» A new community and civic area.  
» Around 20,000 square metres of open space/urban domain. | Construction of the precinct has commenced, with the Western Sydney University campus completed. Construction works for the subsequent buildings are currently ongoing. The overall redevelopment of the precinct is expected to be completed by late 2021. | ➜ Traffic impacts (construction and operation).  
 ➜ Parking and access impacts.  
 ➜ Noise and vibration impacts from demolition and construction activities.  
 ➜ Built form, urban domain integration.  
 ➜ Non-Aboriginal and Aboriginal heritage impacts including potential additional impact on Aboriginal artefacts due to increase impacts on Parramatta Sand Body. |
| 13  | **Arthur Phillip High School** (Macquarie Street, Parramatta) | A new Arthur Phillip High School and new Parramatta Public School campus is proposed to provide for up to 2,000 high school and 1,000 primary school students, respectively. The site for the school campus is located on both sides of Macquarie Street, Parramatta, to the east of Smith Street. The project includes a range of indoor and outdoor teaching spaces, sporting and recreation spaces, support services and | The project obtained development consent in December 2016 and commenced construction in early 2017. The project is anticipated to be completed by early 2019. | ➜ Traffic, transport and access during construction and operation, including access and parking.  
 ➜ Noise, dust and amenity impacts during construction including potential disruption to school operations during construction (increased noise, etc.). |
Regional cumulative impacts

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<th>PROJECT</th>
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</table>
|     | administration spaces as well as potential for community and shared spaces. The campus will include development of a ‘vertical school’ for secondary school students, with a total height of around 17 storeys. |                   | ✷ Visual and urban design considerations.  
✦ Potential heritage and archaeological impacts including potential additional impact on Aboriginal artefacts due to increase impacts on Parramatta Sand Body. | The project commenced construction in 2016 and is expected to be completed by early 2021. |                                          |
| 14  | **Macquarie Street residential redevelopment**  
(142-154 Macquarie Street, Parramatta) | Parramatta CBD precinct | A series of residential tower developments that include three separate towers comprising up to 910 residential apartments, 14,000 square metres of commercial space and about 7,000 square metres of retail space. | The project commenced construction in 2016 and is expected to be completed by early 2021. | ✷ Traffic, transport and access during construction and operation, including access and parking.  
✦ Noise, dust and amenity impacts during construction.  
✦ Visual and urban design considerations/ integration. |
| 15  | **Macquarie Towers residential redevelopment**  
(185 Macquarie Street, Parramatta) | Parramatta CBD precinct | A new residential tower and a new commercial tower above a multi deck public car park. The development will provide approximately 425 units and about 715 public car parking spaces. | The development has commenced construction and is expected to be completed by mid-2017. | ✷ Traffic, transport and access during construction and operation, including access and parking.  
✦ Noise, dust and amenity impacts during construction.  
✦ Visual and urban design considerations/ integration. |
### Regional cumulative impacts

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</table>
| 16  | Commercial building (105 Phillip Street, Parramatta) | Parramatta CBD precinct | A 13-storey commercial building comprising of about 20,500 square metres of floor space. | The development has commenced construction and is expected to be completed by mid-2018. | » Traffic, transport and access during construction and operation, including access and parking.  
» Noise, dust and amenity impacts during construction.  
» Visual and urban design considerations/ integration. |
| 17  | The Lennox residential apartments (12 Phillip Street, Parramatta) | Parramatta CBD precinct | This site is proposed to be redeveloped for construction of a 47-storey tower with around 410 apartments and ground level retail areas, and associated basement parking. | The project is expected to be completed by 2019. | » Economic benefits.  
» Traffic, transport and access during construction and operation, including access and parking.  
» Noise, dust and amenity impacts during construction.  
» Visual and urban design considerations/ integration. |
| 18  | Riviera Apartments (2-8 River Road West, Parramatta) | Rosehill and Camellia precinct | An 11 to 12-storey mixed-use development. This development includes two levels of basement, three ground floors of retail tenancies and about 270 dwellings. | The development has commenced construction with completion estimated for late-2021. | » Traffic, transport and access during construction and operation, including access and parking.  
» Noise, dust and amenity impacts during construction.  
» Visual and urban design considerations/ integration. |
## Regional cumulative impacts

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<tr>
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<th>LIKELY PROJECT OUTCOMES RESULTING IN CUMULATIVE IMPACTS</th>
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</thead>
</table>
| 19  | 'Promenade' residential development (Broughton and Morton Streets, Parramatta) | Rosehill and Camellia precinct | A staged residential development including the construction of about 770 apartments across 12 new residential buildings. The development includes about 1,000 car spaces across the site. This site is located on the northern side of the Parramatta River. | The development has commenced construction with completion of the development estimated for mid-2018. | » Traffic, transport and access during construction and operation, including access and parking.  
» Noise, dust and amenity impacts during construction.  
» Visual and urban design considerations/ integration. |
| 20  | 'The Galleria' (23-29 Hassall Street & 113-117A Wigram Street, Harris Park) | Rosehill and Camellia precinct | A 20-storey mixed-use development containing about 140 apartments and seven commercial units including over basement car parking. | The development has commenced construction with completion estimated for mid-2019. | » Traffic, transport and access during construction and operation, including access and parking.  
» Noise, dust and amenity impacts during construction.  
» Visual and urban design considerations/ integration. |
| 21  | Residential precinct development (former Rydalmere Industrial precinct) | Rosehill and Camellia precinct | The City of Parramatta Council is currently investigating the potential transformation of an existing 104 hectare industrial precinct in Rydalmere into a high-tech/knowledge precinct. The industrial precinct is located about three kilometres from the Parramatta CBD and adjoins the University of Western Sydney (Parramatta campus) at Rydalmere. The current site is characterised by industrial and business uses ranging considerably in size, industry type and operation. | The City of Parramatta Council is currently carrying out a series of planning studies to inform a future masterplan for the precinct. | » Traffic, transport and access during construction and operation, including access and parking.  
» Noise, dust and amenity impacts during construction.  
» Visual and urban design considerations/ integration. |
<table>
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<tr>
<th>REF</th>
<th>PROJECT</th>
<th>PRECINCT IMPACTED</th>
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</tr>
</thead>
</table>
| 22  | Mixed use development (7-13 Jenkins Road & 2-14 Thallon Street, Carlingford) | Carlingford precinct | A mixed-use development including about 408 residential units and retail commercial floor space. | The development has commenced construction with completion estimated for late-2021. | » Traffic, transport and access during construction and operation, including access and parking.  
» Noise, dust and amenity impacts during construction.  
» Visual and urban design considerations/ integration. |
| 23  | Residential development (17-19 Jenkins Road, Carlingford) | Carlingford precinct | An eight-storey residential flat building comprising about 72 dwellings with basement parking. | The development has commenced construction with completion of construction estimated for late-2021. | » Traffic, transport and access during construction and operation, including access and parking.  
» Noise, dust and amenity impacts during construction.  
» Visual and urban design considerations/ integration. |
| 24  | ‘The Carl’ residential development (2-8 James Street, Carlingford) | Carlingford precinct | An 18-storey residential development with 140 dwellings and three levels of basement car parking. | The development has commenced construction with completion of construction estimated for mid-2017. | » Noise, dust and amenity impacts during construction.  
» Traffic, transport and access during construction and operation, including access and parking.  
» Visual and urban design considerations/ integration. |
### Table 9.2 Other projects and programs with potential cumulative impacts

<table>
<thead>
<tr>
<th>REF</th>
<th>PROJECT</th>
<th>PRECINCT IMPACTED</th>
<th>PROJECT DETAILS AND PROXIMITY TO PROJECT</th>
<th>STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>Sydney Metro West</td>
<td>Westmead, Parramatta CBD and Rosehill and Camellia precincts</td>
<td>The NSW Government has announced a new underground metro railway line linking the Paramatta and Sydney CBDs, and communities along the way in November 2016. The Sydney Metro West project is proposed to address Sydney’s rapid growth and cater for the growing nature of Western Sydney, in particular the corridor between Greater Paramatta and central Sydney which is expected to cater for more than 300,000 additional jobs by 2036. With respect to the Paramatta Light Rail project, the current corridor for the Sydney Metro West project is expected to include connections between Sydney Olympic Park and the Greater Paramatta CBD. The currently identified corridor for the project extends between the Sydney CBD and the Parramatta CBD, as an underground tunnel structure, including potential for the route to cross under the alignment for the Paramatta Light Rail.</td>
<td>The Sydney Metro West project is currently in the planning phase with the preferred alignment expected to be identified by late 2018 and commencement of operations by the second half of the 2020s.</td>
</tr>
<tr>
<td>REF</td>
<td>PROJECT</td>
<td>PRECINCT IMPACTED</td>
<td>PROJECT DETAILS AND PROXIMITY TO PROJECT</td>
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<tr>
<td>27</td>
<td>Camellia Town Centre / masterplan</td>
<td>Rosehill and Camellia precinct</td>
<td>The Department of Planning and Environment and the City of Parramatta Council have developed a Land Use and Infrastructure Strategy for the Camellia Town Centre. The intent of this strategy is to guide revitalisation of the existing industrial area, including the development of a new town centre at Camellia. The precinct is shown on Figure 9.1 and generally encompasses the land to the north of Grand Avenue east of James Ruse Drive.</td>
<td>The Land Use and Infrastructure Strategy was exhibited in late 2015. The DP&amp;E and the City of Parramatta Council are currently preparing the detailed rezoning proposal. This proposal is anticipated to be placed on public exhibition in mid-2017.</td>
</tr>
<tr>
<td>28</td>
<td>Telopea priority precinct</td>
<td>Carlingford precinct</td>
<td>A draft master plan report has been prepared in collaboration with NSW Family and Community Services and City of Parramatta Council for the redevelopment of the Telopea Town Centre. It is estimated that the master plan for Telopea could deliver between 3,500 and 4,500 additional dwellings by 2036 within the 64 hectare boundary. New developments are also anticipated to include around 1,000 social and affordable housing dwellings in addition to new or improved community facilities, shopping, centre and open space revitalisation. The proposed light rail service is identified in the master plan as being central to the growth of Telopea and a catalyst for future redevelopment. The precinct is shown on Figure 9.1 and generally encompasses the land to the north of Grand Avenue east of James Ruse Drive.</td>
<td>A draft master plan for the suburb was released in August 2016 for public comment. The master plan is currently being updated to incorporate community submissions/comments. The new master plan for Telopea was finalised in March 2017. The NSW Land and Housing Corporation and City of Parramatta Council are currently working with the NSW Department of Planning and Environment to rezone the land as part of the Telopea Priority Precinct. It is anticipated that the exhibition of the new planning controls will occur in mid-2017.</td>
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</table>
### Regional cumulative impacts

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<tr>
<th>REF</th>
<th>PROJECT</th>
<th>PRECINCT IMPACTED</th>
<th>PROJECT DETAILS AND PROXIMITY TO PROJECT</th>
<th>STATUS</th>
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<tbody>
<tr>
<td>29</td>
<td>Rydalmere and Parramatta wharf upgrades</td>
<td>Parramatta CBD and Rosehill and Camellia precincts</td>
<td>Roads and Maritime Services is currently investigating new and upgraded wharf and interchange opportunities as part of the NSW Transport Access Program. This includes potential improvements at Rydalmere and Parramatta wharves. Preliminary investigations and field work including community feedback have been carried out for each of the wharf sites and Roads and Maritime Services is currently considering the feedback received to identify potential improvement options.</td>
<td></td>
</tr>
</tbody>
</table>
9.2.4 Future stages of Parramatta Light Rail

As discussed in section 3.5 of this Environmental Impact Statement, the Parramatta Light Rail network would be delivered in stages, with the first stage consisting of the network between Westmead to Carlingford, via the Parramatta CBD (the current project). The project would support the more immediate planned growth in Westmead, Parramatta CBD and along the T6 Carlingford Line precincts in the next five to 10 years.

The rollout of further stages of the Parramatta Light Rail network is dependent on:

» Resolving the timing of the land use planning in the eastern section of the preferred network, including finalisation of the Camellia Masterplan, Sydney Olympic Park Masterplan and Sydney Markets land use strategy.

» The final alignment and station locations for Sydney Metro West to ensure the Parramatta Light Rail project and metro projects are integrated.

» Community feedback regarding potential future stages of the project, including consideration of extensions to Epping.

Planning for additional Stage 2 (and other potential future stages) of the Parramatta Light Rail is currently progressing, including consideration of project feasibility and development of a business case. As the proposed future stage(s) are still being developed, the cumulative impact assessment of any future extension to the project would be documented in detail in the relevant environmental impact assessment(s) for these stage(s). Relevant cumulative impact issues would be considered as part of the preparation of these environmental impact assessment(s).

9.3 Management and mitigation

The potential temporary and permanent changes associated with multiple developments across the Parramatta CBD and wider region is complex to mitigate and is highly dependent on the status of construction for other projects. As such, a key management and mitigation measure would be to consider a coordinated approach to all development in the region. During the construction of the project, Transport for NSW would seek to coordinate construction activities through the Sydney Coordination Office and with the proponents of the other major projects in order to identify potential cumulative impacts and identify potential strategies to minimise these impacts.

Notwithstanding, the project has commenced a series of mitigation strategies to minimise potential cumulative impacts with known major future developments. This has included ongoing consultation with key stakeholders and design integration with major development such as the Parramatta North Urban Transformation area and the Camellia Town Centre masterplan.

As a minimum, the following construction management plans would incorporate measures, where feasible, to manage cumulative construction impacts:

» Construction traffic management plan; identifying and coordinating (where possible or feasible) appropriate haulage routes and road closures with consideration of other surrounding developments.

» Construction noise and vibration management plan; coordinating (where possible or feasible) respite periods between the project and other developments.

» Construction compounds and ancillary facilities management plan; including identification of opportunities to collocate compounds with those from other developments to minimise widespread impact and consider the location of the compound in context of the surrounding areas and access roads required for operation of the compound.

» Earthworks management plan; including measures to manage water quality.

The potential cumulative construction impacts associated with the project and other major developments would be further considered as the detailed design and construction planning are
developed. Specific management and mitigation measures that would be implemented to address potential cumulative impacts are listed in Table 9.3.

**Table 9.3  Management and mitigation measures - cumulative impacts (construction)**

<table>
<thead>
<tr>
<th>REF.</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
</tr>
</thead>
</table>
| RC-1 | The project team would manage and coordinate the interface with projects under construction at the same time. Coordination and consultation with Transport for NSW, the Sydney Coordination Office and the following stakeholders would occur at the appropriate project stages:  
» Department of Planning and Environment.  
» Other Transport for NSW agencies (including Roads and Maritime Services; Sydney Trains; and Sydney Buses).  
» Sydney Water.  
» City of Parramatta Council.  
» UrbanGrowth NSW.  
» Western Sydney University.  
» Emergency service providers.  
» Utility providers.  
» Construction contractors.  
Coordination 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 construction management plans and additional mitigation strategies in order to manage conflicts. Depending on the nature of the conflict, this could involve:  
  • Adjustments to the Parramatta Light Rail (Stage 1) construction program, work activities or haul routes; or adjustments to the program, activities or haul routes of other construction projects.  
  • Coordination of traffic management arrangements between projects. | All precincts |
10 Other regional environmental impacts

10.1 Purpose and approach

This chapter provides an assessment of the potential environmental impacts associated with the project that would apply to the whole project and/or would have an impact on the broader Sydney region. Environmental issues that have been considered in this chapter comprise:

» Biodiversity (refer to section 10.2).
» Aboriginal heritage (refer to section 10.3).
» Hydrology, drainage and surface water quality (refer to section 10.4).
» Groundwater (refer to section 10.5).
» Soils and geology (refer to section 10.6).
» Contamination (refer to section 10.7).
» Air quality (refer to section 10.8).
» Utilities and services (refer to section 10.9).
» Greenhouse gases (refer to section 10.10).
» Climate change adaptation (refer to section 10.11).
» Waste, energy and resource management (refer to section 10.12).
» Hazards and risks (refer to section 10.13).
» Privacy impacts (refer to section 10.14).

10.2 Biodiversity

This section provides a summary of an ecological assessment carried out for the project. Details are provided in the Biodiversity Assessment Report (Technical Paper 4 Volume 3 of this Environmental Impact Statement). This report was prepared in accordance with the Secretary's Environmental Assessment Requirements (SEARs) and relevant guidelines and legislative requirements.

The assessment comprised a desk-based search of relevant databases and historical records, and a series of site inspections to assess vegetation and habitat characteristics (October 2016 and December 2016). Biodiversity impacts were assessed in accordance with the current Framework of Biodiversity Assessment (FBA), including values not covered by the FBA (as identified in section 2.3 of the FBA which requires the assessor to consider other biodiversity values not considered under the framework). Further additional biodiversity matters were assessed in regards to Grey-headed Flying-fox, threatened microchiropteran bats and riparian vegetation along the Parramatta River.

10.2.1 Existing environment

10.2.1.1 Vegetation types

Field surveys along the project alignment have verified that six communities and one miscellaneous ecosystem occur within the biodiversity study area. The study area defined for the purposes of the biodiversity assessment is the area directly affected by the development (i.e. within the project
impact footprint) and any additional areas likely to be affected by the development, either directly or indirectly.

The locality of the communities identified within the vicinity of the project are shown in Figure 10.1a to Figure 10.1h and comprise:

» Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion: This vegetation type covers approximately 0.05 hectares of the biodiversity study area and occurs as ‘moderate to good’ condition. This vegetation community occurs around the lower freshwater reaches of Vineyard Creek and immediately adjacent to and at slightly higher elevation than Flax-leaved Paperbark (refer below) open to closed mesic forest on alluvial riverflats in the Sydney region.

» Flax-leaved Paperbark open to closed mesic forest on alluvial riverflats in the Sydney region: This vegetation type covers approximately 0.11 hectares of the biodiversity study area and occurs entirely in ‘moderate to good condition’. This vegetation type occurred on low-lying sandy alluvial soil around the lower freshwater reaches of Vineyard Creek immediately upstream of the tidal limit.

» Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion: This vegetation type covers approximately 0.03 hectares of the biodiversity study area and occurs entirely in ‘moderate to good condition’. This vegetation type was recorded along the banks of Parramatta River in one location (at Queens Wharf Reserve), where it occurred in areas of regular tidal inundation.

» Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion: This vegetation type covers approximately 0.02 hectares of the biodiversity study area and occurs entirely in ‘moderate to good condition’. This vegetation type occurred adjacent to mangrove forests fringing Vineyard Creek and Parramatta River in areas above the zone of tidal inundation but still influenced by increased soil salinity.

» Turpentine – Grey Ironbark open forest on shale in the lower Blue Mountains, Sydney Basin Bioregion: This vegetation type covers approximately 0.20 hectares of the biodiversity study area and occurs entirely in ‘moderate to good condition’. This vegetation type occurs along the existing Carlingford rail corridor.

» Smooth-barked Apple – Turpentine – Blackbutt tall open forest on enriched sandstone slopes and gullies of the Sydney region: This vegetation type covers approximately 0.12 hectares of the biodiversity study area and occurs entirely in ‘moderate to good condition’. This vegetation type occurs in a sandstone gully around the upper freshwater reaches of Vineyard Creek north of Kissing Point Road at Dundas. In the biodiversity study area, it occurs as a mixture of immature regrowth and revegetated forest.

Notably, industrial and residential development, associated weed invasion and soil disturbance has resulted in the loss and/or degradation of most of the original vegetation in the biodiversity study area. Remaining areas of native vegetation now comprise bushland in generally medium to poor condition. The miscellaneous ecosystem identified in these areas, that covers approximately 11.36 hectares of the biodiversity study area, contains highly degraded vegetation and do not align to a vegetation type within the NSW Vegetation Types Database and was therefore unable to be assessed for condition against vegetation benchmark data.
Other regional environmental impacts

Parramatta Light Rail | Stage 1 – Westmead to Carlingford via Camellia

Environmental Impact Statement

Figure 10.1a Vegetation zones
Other regional environmental impacts:

Figure 10.1b Vegetation zones
Figure 10.1c Vegetation zones
Other regional environmental impacts

Parramatta Light Rail | Stage 1 – Westmead to Carlingford via Camellia

Environmental Impact Statement

Figure 10.1d Vegetation zones
Figure 10.1e Vegetation zones

- Light rail alignment
- Existing railway
- Disturbance footprint
- Watercourse
- Precinct boundary

Highly disturbed areas with no or limited native vegetation

PCT 1234/BVT MED23: Swamp Oak swamp forest fringe

PCT 1789/BVT ME163: Flax-leaved Paperbark open to closed mosaic forest on alluvial riverfronts in the Sydney region

PCT 0203/BVT MED34: Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion
Other regional environmental impacts

Parramatta Light Rail | Stage 1 – Westmead to Carlingford via Camellia

Environmental Impact Statement

Figure 10.1f Vegetation zones
Other regional environmental impacts

Parramatta Light Rail | Stage 1
– Westmead to Carlingford via Camellia

Environmental Impact Statement

Figure 10.1g Vegetation zones
Other regional environmental impacts

10 - 10

Parramatta Light Rail | Stage 1 – Westmead to Carlingford via Camellia

Environmental Impact Statement

Figure 10.1h Vegetation zones
10.2.1.2 **TSC-listed threatened ecological communities**

A desktop analysis predicted 14 threatened ecological communities (TECs) listed under the Threatened Species Conservation Act (TSC Act) to occur within the locality of the biodiversity study area. Each TEC aligns to a NSW plant community type in accordance with the Vegetation Information System (VIS) classification version 2.1. Detailed field surveys have confirmed the presence of four of these TECs within the biodiversity study area.

The identified TECs and their associated plant community type are detailed in Table 10.1.

**Table 10.1**  **TSC Act listed threatened ecological communities predicted within biodiversity study area and confirmation of presence following field surveys**

<table>
<thead>
<tr>
<th>THREATENED ECOLOGICAL COMMUNITIES</th>
<th>TSC ACT STATUS</th>
<th>PRESENT WITHIN THE STUDY AREA?</th>
<th>ASSOCIATED PLANT COMMUNITY TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue Gum High Forest in the Sydney Basin Bioregion</td>
<td>CE</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td>Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion</td>
<td>V</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td>Cooks River/Castlereagh Ironbark Forest in the Sydney Basin Bioregion</td>
<td>E</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td>Cumberland Plain Woodland in the Sydney Basin Bioregion</td>
<td>CE</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td>Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions</td>
<td>E</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td>Moist Shale Woodland in the Sydney Basin Bioregion</td>
<td>E</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td>River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions</td>
<td>E</td>
<td>Yes</td>
<td>Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion</td>
</tr>
<tr>
<td>Shale Gravel Transition Forest in the Sydney Basin Bioregion</td>
<td>E</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td>Shale Sandstone Transition Forest in the Sydney Basin Bioregion</td>
<td>CE</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td>Southern Sydney sheltered forest on transitional sandstone soils in the Sydney Basin Bioregion</td>
<td>E</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td>Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions</td>
<td>E</td>
<td>Yes</td>
<td>Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion</td>
</tr>
</tbody>
</table>
Other regional environmental impacts

### Threatened Ecological Communities

<table>
<thead>
<tr>
<th>Threatened Ecological Communities</th>
<th>TSC Act Status</th>
<th>Present within the Study Area?</th>
<th>Associated Plant Community Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Comer Bioregions</td>
<td>E</td>
<td>Yes</td>
<td>Flax-leaved Paperbark open to closed mesic forest on alluvial riverflats in the Sydney region</td>
</tr>
<tr>
<td>Sydney Turpentine-Ironbark Forest</td>
<td>E</td>
<td>Yes</td>
<td>Turpentine – Grey Ironbark open forest on shale in the lower Blue Mountains, Sydney Basin Bioregion</td>
</tr>
<tr>
<td>Western Sydney Dry Rainforest in the Sydney Basin Bioregion</td>
<td>E</td>
<td>No</td>
<td>None</td>
</tr>
</tbody>
</table>

E = Endangered; CE = Critically Endangered under the TSC Act

### 10.2.1.3 Fauna habitat and species

Fauna habitats that were identified within the biodiversity study area include sclerophyll open forest, estuarine forest, aquatic habitat, and disturbed land with limited native trees. Each fauna habitat is described in detail below.

**Sclerophyll open forest**

The plant community types associated with this fauna habitat includes:

- Forest Red Gum – Rough-barked Apple grassy woodland.
- Turpentine – Grey Ironbark open forest.
- Smooth-barked Apple – Turpentine – Blackbutt tall open forest.

These communities varied throughout the biodiversity study area from poor quality to moderate condition, with the majority of the canopy comprising native species including Angophora floribunda (Rough-barked Apple), Corymbia maculata (Spotted Gum), Eucalyptus resinifera (Red Mahogany) and Syncarpia glomulifera (Turpentine) but an understory and groundcover dominated by exotic species including Lantana camara* (Lantana) Ehrharta erecta* (Panic Veldtgrass), Anredera cordifolia* (Madeira Vine), Tradescantia fluminensis* (Wandering Jew) Asparagus aethiopicus* (Asparagus Fern) and Cynodon dactylon* (Common Couch). The canopy of these communities forms a moderate to dense cover of immature, semi-mature and mature trees. Such canopy provides a variety of tree hollows and stags suitable as nesting opportunities for birds, nesting dens for arboreal mammals and roosting habitat for microchiropteran bats. The canopy also provides foraging habitat for nectar-feeding and seed-eating fauna and variety of tree hollows and stags suitable as nesting opportunities for birds such as small to large parrots, owls, tree roosting microchiropteran bats and small to large arboreal mammals.

The dominance of weed species in the mid to lower layer across all communities has resulted in reduced structural complexity, resulting in scarcer availability of microhabitats (i.e. fallen timber, leaf litter and shrubby ground cover). However microhabitat attributes were evident in parts of these communities and would provide the opportunity to support a range of ground dwelling fauna, including reptiles and small mammals.
Estuarine forest

The plant community types associated with this fauna habitat include:

- Mangrove Forests in estuaries.
- Flax-leaved Paperbark open to closed mesic forest on alluvial riverflats.
- Swamp Oak swamp forest fringing estuaries.

These communities occurred along areas of Vineyard Creek and the Parramatta River in headwaters and inlets of alluvial flats. The majority of these vegetation communities are in poor quality due to the occurrence of weed species, especially in the understorey. However, areas where mangrove forests occurred displayed reasonably good condition with majority of vegetation displaying remnant structural characteristics with minimal weed invasion. The canopy of estuarine forest communities and retained native canopy species provide foraging habitats for nectar-feeding and seed-eating fauna such as Swift Parrot and Glossy Black-cockatoo. In addition, areas where canopy species of Eucalyptus spp. occurred, tree hollows and stags suitable as nesting opportunities for birds, nesting dens for arboreal mammals and roosting habitat for microchiropteran bats are provided.

Areas of mangrove forests where tidal inundation occurred provided an understorey of open mudflats with scattered saltmarsh herbs. These areas provide foraging habitat for a variety of estuarine bird species such as White-faced Herons (Egretta novaehollandiae).

Bridge crossings over the Parramatta River near Western Sydney University and Cumberland Hospital also provide potential artificial roosting opportunities for microchiropteran bats such as Southern Myotis (Myotis macropus) and Eastern Bent-wing Bat (Miniopterus schreibersii oceanensis).

The understorey of both Swamp Oak forest and Flax-leaved Paperbark forest were, in areas, heavily modified due to weed invasion or disturbance. As such, the presence of microhabitat (fallen timber, shrubs and extensive leaf litter) were minimal with limited available fauna habitat. Fauna that are likely to utilise these areas would be those that adapt well to disturbance or fauna that can traverse across fragmented landscapes.

Areas of mangrove forests, where tidal inundation occurred, provided an understorey of open mudflats with scattered saltmarsh herbs. These areas provide foraging habitat for a variety of estuarine bird species such as White-faced Herons (Egretta novaehollandiae).

Disturbed land with limited native vegetation

This vegetation type occurred along the banks of the Parramatta River which has been cleared of its original native vegetation and terraced for urban development or for recreational parkland. These areas typically occurred as cleared open areas with manicured lawns, garden beds, retained trees and planted trees. The ground cover is dominated by exotic grasses and herbaceous weeds. These areas are likely to provide foraging habitat for common species typical of urban parklands and gardens (e.g. Noisy Miners, Australian White Ibis and Brush-tail Possums).

Fauna habitat assessed under the FBA credit calculator

The Framework for Biodiversity Assessment (FBA) Credit Calculator identified a number of species as potentially present within the biodiversity study area based on the landscape habitat features. These species and their associated habitat features are shown in Table 10.2.
Table 10.2 Species likely to be present within the biodiversity study area based on habitat features

<table>
<thead>
<tr>
<th>COMMON NAME</th>
<th>SCIENTIFIC NAME</th>
<th>LANDSCAPE FEATURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern Osprey</td>
<td>Pandion cristatus</td>
<td>Land within 40 m of fresh/brackish/saline waters of large rivers or creeks; estuaries, coastal lagoons, lakes and/or inshore marine waters.</td>
</tr>
<tr>
<td>Broad-Billed Sandpiper</td>
<td>Limicola falcinellus</td>
<td>Intertidal mudflats and sandflats, ocean beaches, sandy spits.</td>
</tr>
<tr>
<td>Green and Golden Bell Frog</td>
<td>Litoria aurea</td>
<td>Land within 100 m of emergent aquatic or riparian vegetation.</td>
</tr>
<tr>
<td>Wahlenbergia multicaulis (Tadgells Bluebell) - endangered population</td>
<td>Wahlenbergia multicaulis</td>
<td>Land situated in damp, disturbed sites.</td>
</tr>
<tr>
<td>Cumberland Plain Land Snail</td>
<td>Meridolum comeovirens</td>
<td>Land containing bark or leaf litter accumulation.</td>
</tr>
<tr>
<td>Hypselia sessiliflora</td>
<td>Hypselia sessiliflora</td>
<td>Wet and damp areas only.</td>
</tr>
<tr>
<td>Red-crowned Toadlet</td>
<td>Pseudophryne australis</td>
<td>Heath or eucalypt forest on sandstone with a build-up of litter or other debris and containing, or within 40 m of, ephemeral or intermittent drainage lines.</td>
</tr>
<tr>
<td>Broad-headed Snake</td>
<td>Hoplocephalus bungaroides</td>
<td>Land within 500 m of sandstone escarpments with hollow-bearing trees, rock crevices or flat sandstone rocks on exposed cliff edges and sandstone outcropping.</td>
</tr>
</tbody>
</table>

10.2.1.4 Aquatic habitat

Aquatic habitats identified within the biodiversity study area included areas along the Parramatta River, Clay Cliff Creek and Vineyard Creek. Vineyard Creek is an intermittent creek with clearly defined banks, rocky substrates, occurrence of semi-permanent to permanent pools and the presence of aquatic vegetation. Vineyard Creek is heavily influenced from surrounding urban runoff and high nutrient levels. As a result, the majority of the creekline vegetation is heavily disturbed and dominated with exotic weed species. Due to the influx of high nutrient loads and weed dominance, aquatic habitats within the biodiversity study area are only likely to provide habitat for aquatic invertebrates, amphibians and waterbird species which are well adapted to disturbed environments. Targeted amphibian surveys identified commonly occurring amphibian species such as Striped Marsh Frog and Peron’s Tree Frog.

The following provides a summary of the key aquatic habitat along the project alignment.
Other regional environmental impacts

Upstream of Charles Street Weir, Parramatta CBD

Upstream of the Charles Street Weir, mapped riparian vegetation communities comprise:

» Forest Red Gum – Rough Barked Apple grassy woodland of the alluvial flats of Cumberland plain.

» Cumberland Swamp Oak Riparian Forest.

» High occurrence of weeds and exotic species including Lantana (Lantana camara), Balloon vine (Cardiospermum grandiflorum), Giant Reed (Arundo donax), Canary Island Date Palm (Phoenix canariensis) and Ash (Fraxinus spp.) and Box Elder Maple (Acer negundo).

Instream habitats that provide habitat for fish in the freshwater reach of the Parramatta River include unvegetated river sediments and large vegetative debris. Aquatic macrophytes such as reeds have also been recorded at only a few locations within this reach.

Downstream of Charles Street Weir, Parramatta CBD

Where not comprised of stone, concrete or reinforced by rocks, river banks downstream of the Charles Street Weir are dominated by Grey mangroves which form mainly continuous bands of varying width. This general description, mapped as ‘Estuarine Mangrove Forest’, describes riparian vegetation from downstream of the Charles Street Weir, the riverbanks at the mouth of Clay Cliff Creek and in the vicinity of the rail bridge south of the University of Western Sydney.

10.2.1.5 Saltmarsh

Very little saltmarsh exists in the aquatic ecology study area, with a total of 0.89 hectares mapped in the Parramatta LGA. Most saltmarsh mapped in the aquatic ecology study area occurs on the northern river bank in the vicinity of the Baludarri Wetlands in small patches that have low frequency of sensitive saltmarsh species such as the Vulnerable Wilsonia backhousei.

The Baludarri Wetlands are located to the east of James Ruse Drive on the northern bank of the Parramatta River about 250 metres north of the project alignment and are not expected to be affected by the project.

10.2.1.6 Foreshore erosion

The estuarine river channel downstream of the tidal limit is characterised by a narrow channel, shallow water depths, banks vegetated with mangroves and is subject to long wave durations from river vessels. Boat movements in combination with other factors (severe storms, flooding, high tides and informal public access which over time destabilises banks) has resulted in a high percentage of eroded river banks in the Parramatta LGA. Measures to retard foreshore erosion evident within the aquatic ecology study area include construction of seawalls and placement of rock armour under bridge structures and in the vicinity of bends in the river.

The identified aquatic riparian vegetation identified within the vicinity of the project are shown on Figure 10.1a to Figure 10.1h.

Further details regarding the existing aquatic habitat and ecology within the biodiversity study area is provided in Appendix G of the Biodiversity Assessment Report (Technical Paper 4, Volume 3).

10.2.1.7 Groundwater dependant ecosystems

Groundwater dependant ecosystems (GDE) are communities of plants, animals and other organisms whose extent and life processes are dependent on groundwater (Department of Land and Water Conservation, 2002). These ecosystems range from those entirely dependent on groundwater, to those that may use groundwater while not having a dependency on it for survival.

Within the biodiversity study area there are no GDEs reliant on the surface expression of groundwater present (wetland vegetation are fed by the Parramatta River). Four vegetation
Other regional environmental impacts

Communities associated with vegetation in Vineyard Creek Reserve at Telopea, and some vegetation along the Parramatta River were considered to be partially reliant on subsurface groundwater based on available information gathered from the NSW Office of Water (Department of Primary Industries – Water, 2012), Atlas of Groundwater Dependant Ecosystems (Australian Bureau of Meteorology, 2017) and geological characteristics of each vegetation type (Office of Environment and Heritage, 2013).

These communities have been outlined in Table 4.20 of the Biodiversity Assessment Report (Technical Paper 4, Volume 3) and shown in Figure 10.1a to Figure 10.1h.

10.2.1.8 Commonwealth matters of national environmental significance

A review of the relevant Commonwealth matters of national environmental significance (matters of NES) was carried out with respect to threatened species, populations and communities, listed migratory species and wetlands of international significance under the EPBC Act. A summary of the relevant matters of NES is provided in the following sections.

Wetlands of international significance

Database searches did not reveal any wetlands of international importance located within 10 kilometres of the project. Towra Point Nature Reserve is the nearest RAMSAR wetland to the biodiversity study area, located on the northern side of Kumell Peninsula, approximately 20 kilometres south-east of the project. It is approximately 600 hectare and features seagrass meadows, mangroves, saltmarshes, dune woodlands, Casuarina forest, small occurrences of littoral rainforest and sand dune grasslands.

Due to the scale and distance of the project it is considered that the works would not likely impact any wetlands of international importance.

Threatened ecological communities

Nine TECs listed under the Commonwealth Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act) were identified to be known or predicted to occur within a 10 kilometre radius of the biodiversity study area. Desktop analysis and detailed field surveys identified two of these TECs as potentially occurring within the study area as outlined in Table 10.3.

<table>
<thead>
<tr>
<th>THREATENED ECOLOGICAL COMMUNITY (EPBC)</th>
<th>EPBC STATUS</th>
<th>PRESENT WITHIN THE STUDY AREA?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subtropical and Temperate Coastal Saltmarsh</td>
<td>V</td>
<td>Potential</td>
</tr>
<tr>
<td>Coastal Upland Swamps in the Sydney Basin Bioregion</td>
<td>E</td>
<td>No</td>
</tr>
<tr>
<td>Turpentine-Ironbark Forest in the Sydney Basin Bioregion</td>
<td>CE</td>
<td>Potential</td>
</tr>
<tr>
<td>Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest</td>
<td>CE</td>
<td>No</td>
</tr>
<tr>
<td>Blue Gum High Forest in the Sydney Basin Bioregion</td>
<td>CE</td>
<td>No</td>
</tr>
<tr>
<td>Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion</td>
<td>E</td>
<td>No</td>
</tr>
<tr>
<td>Cooks River/Castlereagh Ironbark Forest in the Sydney Basin Bioregion</td>
<td>CE</td>
<td>No</td>
</tr>
<tr>
<td>Shale Sandstone Transition Forest in the Sydney Basin Bioregion</td>
<td>CE</td>
<td>No</td>
</tr>
<tr>
<td>Western Sydney Dry Rainforest and Moist Woodland on Shale</td>
<td>CE</td>
<td>No</td>
</tr>
</tbody>
</table>

E = Endangered; V = Vulnerable; CE = Critically Endangered under the EPBC Act
Potential for Turpentine-Ironbark Forest in the Sydney Basin Bioregion

One vegetation community recorded within the biodiversity study area, Turpentine – Grey Ironbark open forest on shale in the lower Blue Mountains, Sydney Basin Bioregion, is associated with the TEC, Turpentine-Ironbark Forest in the Sydney Basin Bioregion which is listed as Critically Endangered under the EPBC Act. Only high quality remnant patches which contain some characteristic native plant species present in all structural layers and that have the following characteristics are part of the EPBC Act listed community:

- Tree canopy cover is greater than 10 per cent and the patch area is greater than one hectare, or
- Tree canopy cover is less than 10 per cent, the patch area is greater than one hectare and the patch is located within native vegetation with an area greater than five hectares (Threatened Species Scientific Committee 2005).

Detailed field survey and mapping of this vegetation in the biodiversity study area has revealed that none of the Sydney Turpentine-Ironbark Forest potentially affected by project meets the criteria for inclusion in the EPBC Act listed Turpentine-Ironbark Forest in the Sydney Basin Bioregion community due to the lack of representative species from all structural layers, canopy cover and/or no patches greater than one hectare in area are found in the biodiversity study area.

Potential for Subtropical and Temperate Coastal Saltmarsh

A small area (approximately seven metres by two metres) of the mapped vegetation community, Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion contains a dense ground layer of the saltmarsh species *Sarcocornia quinqueflora* immediately south of the mangroves on the southern bank of the Parramatta River at the Western Sydney University (Parramatta) campus at Rydalmere. Given this vegetation’s isolation from any areas of mapped or known Coastal Saltmarsh, the dominance of mature grey mangrove (*Avicennia marina*) canopy layer, and evidence of vegetation clearing and importation of fill, this area is considered to be disturbed Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion as opposed to Coastal Saltmarsh, and therefore is inconsistent with definitions of Coastal Saltmarsh as listed under the EPBC Act.

Threatened flora species

No threatened flora species listed under the EPBC Act were identified as having a moderate or high likelihood of occurring within the biodiversity study area.

Threatened terrestrial fauna species

Database searches identified 20 terrestrial threatened fauna species listed under the EPBC Act as potentially occurring within the biodiversity study area. Of these, the likelihood of occurrence assessment identified two threatened fauna species as having a moderate or high likelihood of occurring; Grey-headed Flying Fox and Swift Parrot. The nature and extent of potential impacts on these threatened species is provided in section 10.2.2.

Threatened aquatic fauna species

Database searches identified 20 aquatic threatened fauna and communities listed under the EPBC Act as potentially occurring within the biodiversity study area. Of these, the likelihood of occurrence assessment identified one threatened fauna species as having a moderate or high likelihood of occurring; Black Rockcod. The nature and extent of potential impacts on this threatened species is discussed in section 10.2.2.
Listed threatened migratory species

Database searches revealed 53 threatened migratory fauna species listed under the EPBC Act as potentially occurring within the biodiversity study area. Of these, the likelihood of occurrence assessment identified five threatened migratory fauna species as having a moderate or high likelihood of occurring; Rufous Fantail, Satin Flycatcher, Black-faced Monarch, White-bellied Sea Eagle and Oriental Cuckoo. The nature and extent of potential impacts on these migratory species is discussed in section 10.2.2.

10.2.2 Direct impacts

10.2.2.1 Removal of native vegetation

The combined development footprint would impact on approximately 0.5 hectares of remnant native vegetation. Details are provided in Table 10.4. These impacts take into consideration potential temporary disturbance during construction, including compound sites.

Table 10.4 Plant communities requiring an assessment of impacts

<table>
<thead>
<tr>
<th>PLANT COMMUNITY</th>
<th>TSC ACT STATUS</th>
<th>EPBC ACT STATUS</th>
<th>CONDITION</th>
<th>AREA OF NATIVE VEGETATION IMPAECTED (HA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion</td>
<td>Forms Endangered Ecological Community: River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Comer Bioregions</td>
<td>Not Listed</td>
<td>Moderate-Good (Poor Quality)</td>
<td>0.02</td>
</tr>
<tr>
<td>Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Comer Bioregion</td>
<td>Not Listed</td>
<td>Vulnerable</td>
<td>Moderate-Good (High Quality)</td>
<td>0.03</td>
</tr>
<tr>
<td>Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Comer Bioregion</td>
<td>Forms Endangered Ecological Community: Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Comer Bioregions</td>
<td>Not Listed</td>
<td>Moderate-Good (Poor Quality)</td>
<td>0.02</td>
</tr>
<tr>
<td>Turpentine - Grey Ironbark open forest on shale in the lower Blue Mountains, Sydney Basin Bioregion</td>
<td>Forms Endangered Ecological Community: Sydney Turpentine-Ironbark Forest</td>
<td>Does not meet EPBC Act condition thresholds for this community</td>
<td>Moderate-Good (Poor Quality)</td>
<td>0.20</td>
</tr>
</tbody>
</table>
### PLANT COMMUNITY

<table>
<thead>
<tr>
<th>PLANT COMMUNITY</th>
<th>TSC ACT STATUS</th>
<th>EPBC ACT STATUS</th>
<th>CONDITION</th>
<th>AREA OF NATIVE VEGETATION IMPACTED (HA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flax-leaved Paperbark open to closed mesic forest on alluvial riverflats in the Sydney region</td>
<td>Forms Endangered Ecological Community: Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Comer Bioregions</td>
<td>Not Listed</td>
<td>Moderate-Good (Poor Quality)</td>
<td>0.11</td>
</tr>
<tr>
<td>Smooth-barked Apple – Turpentine – Blackbutt tall open forest on enriched sandstone slopes and gullies of the Sydney region</td>
<td>Not Listed</td>
<td>Not Listed</td>
<td>Moderate-Good (Medium Quality)</td>
<td>0.12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>0.5</strong></td>
</tr>
</tbody>
</table>

(1) The Moderate to Good category is split into High, Medium, Poor & Other condition sub-categories for calculation purpose within the FBA credit calculator.

In addition to the loss of native vegetation discussed above and as discussed in Part D of this Environmental Impact Statement, the project would require the removal of vegetation from the ‘Miscellaneous ecosystem’ plant community type. These trees are predominately horticultural plantings of both exotic and non-indigenous native species of limited habitat value and are discussed in detail on a precinct by precinct basis in Part D of this Environmental Impact Statement.

The removal of Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Comer Bioregion due to construction works associated with the Parramatta River Bridge would contribute to the Key Threatening Process ‘Degradation of native riparian vegetation along New South Wales water courses’ which listed under the Fisheries Management Act 1994. These impacts would be minimised through the implementation of mitigation and management measures (refer to section 10.2.4).

#### 10.2.2.2 Impacts on threatened species

The nature, extent and significance of potential impacts on the identified threatened species is summarised in Table 10.5.
### Table 10.5  EPBC listed threatened species impacts within biodiversity study area

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>SPECIES</th>
<th>EPBC ACT STATUS</th>
<th>NATURE AND EXTENT OF LIKELY IMPACT</th>
<th>SIGNIFICANT IMPACT</th>
</tr>
</thead>
</table>
| Threatened terrestrial fauna species | Grey-headed Flying-fox | V               | Removal of a relatively small proportion of the available winter-foraging habitat in the locality including:  
  » Approximately 0.54 hectares of forest dominated by winter-flowering *Eucalyptus* spp.  
  » Isolated individual trees including; *Eucalyptus robusta*, *Corymbia citriodora*, *C. maculata*, and *E. sideroxylon*.  
Removal of a relatively small proportion of the available foraging and roosting in the locality including:  
  » Approximately 0.62 hectares of native vegetation communities  
  » Relatively small increase in the potential for additional collision/electrocution of individuals on new overhead wiring. | No                |
| Threatened aquatic fauna species | Swift Parrot        | CE              | Removal of potential marginal foraging habitat including:  
  » Approximately 0.47 hectares of forest dominated by winter-flowering *Eucalyptus* spp.  
  » Isolated individual trees including; *Eucalyptus robusta*, *Corymbia citriodora*, *C. maculata* and *E. sideroxylon*.  
Removal of general habitat for foraging and roosting including:  
  » Approximately 0.5 hectares of native vegetation communities  
  » Collision/electrocution of individuals on new overhead wiring. | No                |
| Threatened aquatic fauna species | Black Rock Cod      | V               | Removal of estuarine habitats (mangroves) surrounding the existing rail truss across the Parramatta River south of the Western Sydney University (Parramatta) campus. | No                |
Other regional environmental impacts

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>SPECIES</th>
<th>EPBC ACT STATUS</th>
<th>NATURE AND EXTENT OF LIKELY IMPACT</th>
<th>SIGNIFICANT IMPACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Listed threatened migratory species</td>
<td>Black-faced Monarch</td>
<td>Marine; Migratory (Bonn)</td>
<td>Removal of approximately 0.5 hectares of potential marginal foraging habitat consisting of native vegetation communities. Negligible impact on the species’ life cycle as it is unlikely to currently breed on the site.</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Oriental Cuckoo</td>
<td>Marine Migratory (CAMBA, JAMBA, ROKAMBA)</td>
<td>Removal of approximately 0.5 hectares of potential marginal foraging habitat consisting of native vegetation communities. Negligible impact on the species’ life cycle as it does not breed in Australia.</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Rufous Fantail</td>
<td>Marine; Migratory (Bonn)</td>
<td>Removal of approximately 0.5 hectares of potential marginal foraging habitat consisting of native vegetation communities. Negligible impact on the species’ life cycle as it is unlikely to currently breed on the site.</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Satin Flycatcher</td>
<td>Marine; Migratory (Bonn)</td>
<td>Removal of approximately 0.5 hectares of potential marginal foraging habitat consisting of native vegetation communities. Negligible impact on the species’ life cycle as it is unlikely to currently breed on the site.</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>White-bellied Sea-Eagle</td>
<td>Marine</td>
<td>Minor disturbance to aquatic foraging habitat during construction. Possible slight increase in collision hazard due to new overhead wiring at Parramatta North Bridge crossing location. Negligible impact on the species’ life cycle as it is unlikely to currently breed on the site.</td>
<td>No</td>
</tr>
</tbody>
</table>

E = Endangered; V = Vulnerable; CE = Critically Endangered under the EPBC Act
10.2.2.3 Construction of instream structures

Project activities include the modification or addition of instream structures at sites where new structures are proposed or existing structures would be modified that may impact on aquatic habitats or environments. The key sites where impacts could occur include:

» New bridge over Parramatta River at North Parramatta (Parramatta North Bridge).
» Bridge modifications to the Parramatta River Bridge at Camellia.
» New bridge over Vineyard Creek at Rydalmere.

Potential direct impacts as a result of the modification or addition of instream structures would include:

» Damage or removal of riparian vegetation.
» Sedimentation of the waterway or erosion of disturbed river or creek bed or bank sediments due to piling and excavation.
» Contamination of the waterway by construction materials, fuel or lubricant spills.
» Blockage of/impact on existing fish passage due to additional stream obstacles (bridge piers) associated with the proposed new structures once constructed.
» Runoff from LRVs and rail infrastructure into Parramatta River or creeks when crossing the waterway during operation.

The potential impacts identified at each key structure along the project alignment are summarised as follows:

» New bridge over Parramatta River at North Parramatta – Construction activities at this site would include the installation of one set of instream piers to support the new bridge. New pier structures would be aligned with the mid-stream piers of the existing structure (upstream) to minimise blockage of fish passage and riverbed erosion.

» Bridge over the Parramatta River at Camellia – Construction activities at this site would include modifications to the abutments, widening of the truss bridge and installation of a cantilevered active transport corridor. The construction methodology includes the use of vessels and temporary wharf structures. Bank scour protection in the form of rock armour exists along both banks at this site, making significant bank or riverbed erosion due to the additional piers unlikely.

» New bridge over Vineyard Creek at Rydalmere – Construction activities at this site would include removal of the existing low rail bridge and installation of new, wider bridge. The new single-span bridge would avoid the installation of an instream pier. Existing pier structures would be removed to below creek bed level. The net result at this site would be a reduction in the number of instream structures, resulting in a lower potential for creek bed and bank erosion and blockage of fish passage compared to the existing condition.

There is a low risk for impacts on aquatic biodiversity at Lennox Bridge (over Parramatta River) or the James Ruse Drive Bridge (over Clay Cliff Creek) due to the nature of construction works, bridge design and/or the biodiversity values of the waterway at (or in the vicinity of) the crossing location.

Overall the extent of impacts would not be significant and in many cases result in improvements. Further discussion regarding instream impacts associated with the project is provided in Chapter 6 of Appendix G of the Biodiversity Assessment Report (Technical Paper 4, Volume 3).

10.2.3 Indirect impacts

10.2.3.1 Aquatic impacts

Waterway crossings have potential to modify the natural hydrology of waterways, which affect the aquatic plant and animals that use an area (Fairfull & Witheridge 2003). Key aquatic ecology issues...
would include the need to maintain fish passage, potential impacts on protected mangrove plants and habitats and potential for indirect impacts downstream associated with suspension and transport of bank and riverbed sediments.

The aquatic biodiversity of the Parramatta River is already modified as a result of habitat degradation due to changes to environmental conditions and the introduction of invasive species. Due to the degraded condition of this waterway, the native species that persist are likely to consist of disturbance tolerant species less sensitive to alterations in environmental conditions than species restricted to relatively unmodified environments.

As described above, construction of the bridges is likely to require minor instream works at two sites on the Parramatta River however this is unlikely to involve removal of any submerged or emergent aquatic vegetation. Changes to the amount of sunlight reaching the substrate of the river may however affect the ability of any submerged aquatic plants to photosynthesise. This may result in changes to the structure and extent of aquatic vegetation and associated habitat for aquatic animals. Given the relatively small area affected, and the existing degraded condition of the river, this possible reduction in vegetation and modification of habitat is unlikely to be significant.

The project proposes instream works at two sites on the Parramatta River, one of them downstream of the tidal barrier at Charles Street, Parramatta CBD. Indirect impacts on downstream saline wetland habitats would be minimised by management and mitigation measures proposed for instream works which aim to minimise suspension of sediments and restrict disturbance to a small local area for short periods during construction (refer to section 10.2.4). Potential environmental risks due to the project in the freshwater reach of the Parramatta River would be low and focused on the suspension and downstream transport of disturbed bank and riverbed sediments.

Additionally, the project would remove very small areas of riparian vegetation that provides habitat for a range of aquatic species that have been assessed in the Biodiversity Assessment Report. As no GDEs reliant on surface expression of groundwater have been identified as being present within the project study area, the project is unlikely to significantly impact on GDEs. A detailed assessment of aquatic habitat and ecology within the study area is provided in Appendix G of the Biodiversity Assessment Report.

### 10.2.3.2 Fragmentation of identified biodiversity links and habitat corridors

Habitat fragmentation relates to the physical dividing up of once continuous habitats into separate smaller ‘fragments’ (Fahrig, 2002). The project is considered unlikely to result in a large increase to landscape scale fragmentation as it largely follows existing rail easements and roadways. The impacts from the project would largely involve ‘trimming’ the edges of vegetation patches adjacent to the existing rail corridor, which would not result in additional habitat fragmentation.

The project is however likely to result in a minor increase in localised fragmentation of the regional wildlife corridor along the Parramatta River. Due to the importance of connectivity, dispersal opportunities and habitat quality for species at a local scale, this impact has the potential to be detrimental to the dispersal of relatively sedentary species such as mammals, frogs, and reptiles. However, due to the previously disturbed, urban setting of the project, most if not all, native animal species which are sensitive to habitat fragmentation and predation (e.g. native ground-dwelling mammals, arboreal mammals (except for adaptable common possum species) and monitor lizards are likely to have already been lost from the habitats in the study area.

Mobile species such as birds and bats are unlikely to be affected by this fragmentation as the landscape in which they currently exist is fragmented and the predicted level of fragmentation would not be enough to restrict their dispersal between habitat patches.

The predicted level of fragmentation from the project is not expected to be enough to prevent the breeding and dispersal of plant pollinators or the dispersal of plant propagules (i.e. seed or other vegetative reproductive material) between habitat patches. The existing functional connectivity for many species would therefore remain in the study area.
10.2.3.3 Edge effects on adjacent native vegetation and habitat

Edge effects refer to the changes in environmental conditions (e.g. altered light levels, wind speed, temperature) that occur along the edges of habitats. These new environmental conditions along the habitat edges can promote the growth of different vegetation types (including weeds), promote invasion by pest animals specialising in edge habitats, or change the behaviour of resident animals.

Along the project alignment, many patches of vegetation are small, irregularly shaped, and already fragmented. As such, many areas of vegetation within and directly adjacent to the project footprint are already subject to considerable edge effects. In many cases, the vegetation patches are so small that no unaffected core habitat exists. Consequently, it is unlikely that the project would increase the overall extent of edge effects across the majority of the biodiversity study area where the habitat is restricted to small fragments.

10.2.3.4 Injury and mortality of fauna

Fauna injury or death has the greatest potential to occur during vegetation clearing and the extent of this impact would be proportionate to the extent of vegetation that is cleared. The potential for fauna occurrence and injury will have the greatest potential in areas where remnant vegetation is situated, however, the removal of 0.62 hectares of remnant vegetation is unlikely to lead to significant fauna mortality. Some mobile species, such as birds, may be able to move away from the path of clearing and may not be greatly affected unless they are nesting. However, other species that are less mobile (e.g. ground dwelling reptiles), or those that are nocturnal and nest or roost in trees during the day (e.g. arboreal mammals and microchiropteran bat species), may find it difficult to move rapidly when disturbed. Common fauna species such as possums, reptiles and frogs are the most likely to be affected.

Entrapment of wildlife in any trenches that are dug during construction is possible if the trenches are deep and steep sided. Wildlife may also become trapped in machinery stored in the biodiversity study area overnight which may result in injury or death.

Injury and mortality of fauna, particularly birds and bats, is also possible during the operational phase of the project. The possible level of mortality associated with the overhead wiring and fences is unlikely to be significantly increased by the project beyond that already existing in the locality associated with existing powerlines, the overhead wiring of the T6 Carlingford Line railway and other infrastructure. Opportunities for minimising the potential for injury and mortality of wildlife associated with overhead wiring and fences would be explored during the detailed design of the project.

10.2.3.5 Invasion and spread of weeds and pests

Proliferation of weed and pest species is an indirect impact (i.e. not a direct result of project activities) that may have cumulative effects as each project activity may act together to increase the chances of weed and pest proliferation. Proliferation of weed and pest species is likely to occur during construction and operation, although impacts would be greatest as a result of vegetation clearing during the construction phase. The effects of proliferation of weed and pest species may not be experienced immediately but would likely commence a few months after the construction phase commences and gradually increase over months and seasons.

Project activities have the potential to disperse weeds into areas of remnant vegetation where weed species are currently limited or in low density. Project activities also have the potential to import new weed species. The most likely causes of weed dispersal and importation associated with the project include earthworks, movement of soil, and attachment of seed (and other propagules) to vehicles and machinery during all stages of construction. However, in the context of the project, this impact is predicted to be minimal as all vegetation in the biodiversity study area is impacted by weeds. The magnitude of this impact is considered to be low.
The biodiversity study area is currently habitat for a range of pest species, most notably, foxes and rabbits. Project activities have the potential to disperse pest species out of the development site across the surrounding landscape and increase the ability of pest species to utilise habitats due to habitat modification. However, in the context of the project this impact is predicted to be minimal as all vegetation in the biodiversity study area is likely to be impacted by foxes and cats. The magnitude of this impact is considered to be low.

10.2.3.6 Invasion and spread of pathogens

Several known NSW pathogens have the potential to impact on biodiversity as a result of moving between infected sites or due to spreading contaminated material during construction. Of these, three are listed as a key threatening process under either the EPBC Act and/or TSC Act including:

- Dieback caused by Phytophthora (Root Rot) (EPBC Act and TSC Act).
- Infection of frogs by amphibian chytrid fungus causing the disease chytridiomycosis (EPBC Act and TSC Act).
- Introduction and establishment of exotic Rust Fungi of the order Pucciniales on plants of the family Myrtaceae (TSC Act).

While these pathogens were not observed or tested for in the biodiversity study area, the three pathogens have all been recorded in the Sydney Basin Bioregion and have potential to occur within the project area at present or in the future. The main way in which Exotic Rust Fungi and Phytophthora Root Rot Fungus may be spread is through the movement of infected plant material and/or soil. The construction and operation of the project may increase the risk of disturbing and spreading these pathogens. With the implementation of hygiene procedures for the use of vehicles and the importation of materials to the project area, the risk of introducing these pathogens would, however, be low. Preferential use of plant materials sourced on-site (e.g. mulch, seeds) used for vegetation restoration would also help to minimise this risk.

Amphibian Chytrid Fungus can be spread through the movement of infected animals or water (including mud or moist soil) from infected areas. With the implementation of hygiene procedures for the use of vehicles and the importation of materials to the project area, the risk of introducing this pathogen to uninfected areas is low.

10.2.3.7 Noise, vibration, dust, light and contaminants

During all phases of the project there would be increased noise and vibration levels along the project alignment and immediate surrounds due to vegetation clearing, ground disturbance, machinery and vehicle movements, and general human presence. The noise and vibration from activities associated with the project would potentially disturb fauna and may disrupt foraging, reproductive, or movement behaviours. The impacts from noise emissions are likely to be localised to the construction areas and are not considered likely to have a significant, long-term impact on wildlife populations outside the area of impact. Further discussion of potential noise and vibration impacts is provided in the local impacts sections of this Environmental Impact Statement in Part D.

Elevated levels of dust may be deposited onto the foliage of vegetation adjacent to the project activities. This has the potential to reduce photosynthesis and transpiration and cause abrasion and heating of leaves resulting in reduced growth rates and decreases in overall health of the vegetation. Dust is likely to be generated throughout the lifecycle of the project, although dust pollution is likely to be greatest during periods of substantial earthworks, vegetation clearing, vehicle movements for construction and decommissioning activities and during adverse weather conditions. However, deposition of dust on foliage is likely to be highly localised, intermittent, and temporary and is therefore not considered likely to be a major impact of the project.

Ecological light pollution is the descriptive term for light pollution that includes direct glare, chronic or periodic increased illumination, and temporary unexpected fluctuations in lighting (including lights from passing vehicles), that can have potentially adverse effects on wildlife. (Longcore and
Rich, 2004). Some night works would be required during construction and lighting would be installed along the alignment to meet operational requirements. As such, the immediate area surrounding the project activities, and areas lit during operation, would be subject to artificial lighting, essentially creating permanent ‘daylight’ conditions.

Ecological light pollution may potentially affect nocturnal fauna by interrupting their life cycle. Some species (i.e. light tolerant microchiropteran bats) may benefit from the lighting due to increased food availability (insects attracted to lights) around these areas. Due to the frequency and sustained nature of the lighting, it is likely that animals would alter their behaviour in response to the light disturbance and a long-term impact in the area of lighting is likely. Due to the existing urban environment most, if not all, areas of habitat are already impacted by ecological light pollution associated with existing fixed lighting, residences and train and road vehicle movements. The changes to light conditions associated with the project, though essentially permanent, would therefore be unlikely to have a significant impact on local fauna populations.

During construction localised release of contaminants (i.e. hydraulic fluids, oils, fluids, etc.) into the surrounding environment (including drainage lines) could accidentally occur. The most likely result of contaminant discharge would be the localised contamination of soil and potential direct physical trauma to flora and fauna that come into contact with contaminants. Any accidental release of contaminants is likely to be localised and would be unlikely to have a significant effect on the already highly modified environments of the biodiversity study area, particularly due to the implementation of mitigation measures to immediately address any spills. Further discussion of potential contamination impacts is provided in section 10.7 (Contamination).

### 10.2.4 Management and mitigation

This section outlines the measures taken to avoid and minimise the direct and indirect impacts of the project on biodiversity values in accordance with section 8 of the Framework for Biodiversity Assessment (FBA). Following detailed design and prior to construction, detailed flora and fauna management and mitigation measures would be developed and presented as part of the environmental management plans relating to the construction and operation of the project.

Management and mitigation measures specific to ecological impacts are described below. Other environmental management and mitigation measures for the project as detailed in Chapter 17 (e.g. dust suppression, sedimentation controls, tree management measures and offset strategy) would also contribute to the mitigation of construction and operation phase impacts on the ecological values of the site.

The management and mitigation measures that would be implemented to address potential biodiversity impacts, in particular during construction are listed in Table 10.6.

**Table 10.6 Management and mitigation measures - biodiversity impacts (detailed design)**

<table>
<thead>
<tr>
<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
</tr>
</thead>
</table>
| BI-1 | Management and mitigation measures which would be investigated during detailed design to minimise potential biodiversity impacts include:  
» Minimising the need for new instream structures.  
» Appropriate design and alignment of new instream structures with existing conditions to minimise turbulence, erosion and scouring.  
» Options for minimising impacts on habitat connectivity, including establishment of native vegetation and habitat elements such as rock piles and large woody debris under the bridges to provide cover for fauna.  
» Opportunities for minimising the potential for injury and mortality of wildlife associated with overhead wiring and fences would be explored in consultation with an ecologist and implemented where practicable | All precincts |
The management and mitigation measures that would be implemented to address potential biodiversity impacts, in particular during construction are listed in Table 10.7.

### Table 10.7 Management and mitigation measures – biodiversity impacts (construction)

<table>
<thead>
<tr>
<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
</tr>
</thead>
</table>
| BI-2 | Where possible, the removal of native vegetation would be minimised as far as practicable. Measures to minimise the removal of native vegetation would include:  
  » Vegetation clearing extents would be clearly identified during the construction process as ‘no-go’ areas. These would be marked on maps provided to contractors, as well as on the ground using high visibility fencing (such as barrier mesh).  
  » A trained ecologist would accompany clearing crews in order to ensure disturbance is minimised and to assist any native animals to relocate to adjacent habitat. | All precincts           |
| BI-3 | The following measures would be implemented to mitigate impacts on aquatic habitats during construction:  
  » Preparation of acid sulfate soils/contaminated soils management plan.  
  » Establishment and marking of vegetation buffer zones in areas of vegetation removal in riparian zones.  
  » Design and implementation of site-specific soil and erosion management and mitigation measures in accordance with Managing urban stormwater: soils and construction (Landcom, 2004).  
  » Removal of existing pier footings to below river or creek bed levels to reduce instream blockage to fish passage.  
  » Crossing design would adhere to the fish friendly passage guidelines (Fairfull and Witheridge, 2003) for waterway crossings, and avoid/minimise disruption to fish movements.  
  » Construction compounds would be located within previously disturbed areas, away from riparian vegetation (to the extent possible).  
  » Use of platforms/temporary wharfs in preference to weirs for instream construction works.  
  » Use of floating booms around work zones.  
  » Use of silt curtains around new piers during piling to restrict turbidity.  
  » Remediation and revegetation of disturbed banks and aquatic habitats as soon as possible following disturbance. | All precincts           |
| BI-4 | Mitigation measures to avoid and minimise the risk to mangroves would be implemented during construction. This would include (but is not limited to):  
  » Minimisation of the disturbance footprint on banks.  
  » Establishment and mark vegetation exclusion zones.  
  » Work area planning and management of activities to avoid removing existing mangrove plants.  
  » Temporary wharf/platforms and vessel routes would be planned to avoid pneumatophore zones and minimise erosion.  
  » Bund integrity would be maintained around all works on/near river banks, including equipment wash-down areas and construction compounds. | All precincts           |
### Other regional environmental impacts

<table>
<thead>
<tr>
<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Use of silt curtains around new piers during piling to restrict turbidity.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Prohibition dumping of excavated materials or untreated runoff water in the river.</td>
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</tr>
<tr>
<td></td>
<td>Employment floating booms around work zones.</td>
<td></td>
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<tr>
<td></td>
<td>Remediation of disturbed banks with mangroves/native vegetation, and if required, use of mangrove shrubs/seedlings transplanted from disturbed areas.</td>
<td></td>
</tr>
<tr>
<td>BI-5</td>
<td>To mitigate fragmentation and reduced habitat connectivity, plant species chosen for revegetation under the bridges would be selected for their shade-tolerance (e.g. rainforest understorey species native to the Sydney Basin Bioregion) even if these species are not usually found in the Alluvial Woodland/Riparian Forest vegetation types.</td>
<td>All precincts</td>
</tr>
<tr>
<td>BI-6</td>
<td>To mitigate habitat loss as a result of the project, the following would be investigated and implemented:</td>
<td>All precincts</td>
</tr>
<tr>
<td></td>
<td>Consideration would be given to fitting roost boxes to the bridge over the Parramatta River at Cumberland Hospital to provide roost sites for the Large-footed Myotis and other species of microbats (e.g. Eastern Bentwing-bat) which may utilise such structures. The quantity and location of roost boxes would be determined in consultation with an ecologist to meet the specific needs for the targeted species and would be installed prior to structure disturbance.</td>
<td></td>
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<tr>
<td></td>
<td>Nest boxes of a variety of designs would be installed including boxes suitable for roosting by microbats. Relocation of natural hollows by either affixing them to existing live retained trees or to poles/trunks of felled trees installed in revegetated areas would also be considered as an alternative to nest box installation. The quantity and location of roost boxes would be determined in consultation with an ecologist to meet the specific needs for the targeted species and would be installed prior to disturbance in the area.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Important habitat elements (e.g. large woody debris) would be moved from the construction area to locations outside the clearing area in native vegetation remnants or to stockpiles for later use in vegetation/habitat restoration.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Suitable winter-flowering trees would be preferentially planted in landscaped areas of the site to provide a winter foraging resource for migratory and nomadic nectar-feeding birds and the Grey-headed Flying-fox.</td>
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</tbody>
</table>
| BI-7| To minimise the likelihood of fauna injury or death during the clearing of vegetation, a staged habitat removal protocol would be developed as part of the environmental management plans and implemented. It would include the following measures:  
  » All habitat trees in the area to be cleared would be identified (by an arborist) and marked.  
  » A pre-clearing procedure that encourages animals to leave prior to clearing.  
  » Pre-clearing surveys would be conducted at least 12 to 48 hours prior to vegetation clearing to search for native wildlife (e.g. reptiles, frogs) which can be captured and relocated. | All precincts          |
### 10.3 Aboriginal heritage

This section presents a summary of the assessment of Aboriginal archaeological potential and impacts along the project alignment, prepared in accordance with the Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW (the then Department of Environment, Climate Change and Water (DECCW) 2010). Appropriate management and mitigation protocols for potential impacts are also identified. Further detail on the assessment of the impact of the project on Aboriginal archaeological is presented in full in the Parramatta Light Rail: Aboriginal Cultural Heritage Assessment, Technical Paper 5 in Volume 3.

#### 10.3.1 Existing environment

**10.3.1.1 Landscape context**

The study area for the Aboriginal heritage assessment traverses a range of landscapes, which would have offered an abundance and diversity of raw materials and resources for the local Aboriginal people, including Parramatta River and its tributaries. These landscapes have variable potential to retain archaeological evidence of Aboriginal occupation depending on topography, soils, and the effects of natural disturbance such as flooding and erosion. In particular, the alluvial terrace sands set back from the river (known as the Parramatta Sand Body) have been found to contain significant Aboriginal archaeology beneath surface disturbances. It is also listed in the State Heritage Register (Ancient Aboriginal and Early Colonial Landscape) and is considered in section 14.5.

Due to the long and intensive European settlement history of Parramatta and surrounding suburbs, the majority of the study area is highly disturbed, with the project alignment mainly traversing existing roads and railways, and commercial, residential and industrial areas. The heavy rail corridor between Camellia and Carlingford is particularly disturbed. The likelihood of intact Aboriginal archaeological deposits in such areas is low or negligible given the extent of past excavation and construction works. Archaeological potential in the study area remains where suitable substrate...
exists intact below surface disturbance, or in other areas of low disturbance conducive to the preservation of archaeological deposit. This is further discussed in section 10.3.2.

10.3.1.2 Historical background

The study area lies within a landscape which was important to, and intensively used by, past Aboriginal peoples (Attenbrow 2002). The study area lies in a landscape traditionally considered the province of the Darug people. The Parramatta area is associated with the Baramattagal clan of the Darug (alternatively Baramatagal/Booramidigal/Boromedegal). The Parramatta area was rich in natural resources and was a natural focal point for Aboriginal occupation in the landscape. For example the location of Parramatta at the head of Parramatta River meant that freshwater, estuarine and terrestrial resources were all available and all of these were exploited. The arrival of European settlers caused major social and economic upheaval for the Aboriginal people living on the Cumberland Plain. Contact with Europeans introduced diseases, such as smallpox, that drastically altered the size and structure of the Aboriginal population, whilst the expansion of settlements and establishment of farmland subsumed the traditional areas used to meet subsistence needs (Attenbrow 2002). However as the settlement at Parramatta was established and grew in size, interactions became more frequent and relations improved during the early years evidenced by a barter trade between local Aboriginal people and the military officers, followed by some conflict in the 1790s.

Over the years, the introduction of diseases, various armed conflicts, the subsuming of traditional lands by white settlement and the forced assimilation policies of colonial government all combined to devastate and fracture the Aboriginal communities of Sydney. However Aboriginal cultural links to the Parramatta area remain strong. Aboriginal people remained, and continue to live, in Parramatta today and Aboriginal cultural heritage forms a key aspect of the modern city of Parramatta.

10.3.1.3 Previously registered Aboriginal heritage sites

Extensive searches of the NSW Office of Environment and Heritage (OEH) Aboriginal Heritage Information System (AHIMS) identified four registered Aboriginal sites recorded within the study area (defined for the purposes of the Aboriginal cultural heritage assessment as the area directly affected by the development (i.e. within the project impact footprint)). No Aboriginal places have been declared along or within the immediate vicinity of the project alignment. Four registered sites have however been identified within the broader region.

A summary of the four registered sites is provided below:

» AHIMS 46-6-2559 (Sydney Turf Club Car park) is an artefact scatter situated on raised flat ground adjacent to the former storm water canal which forms a tributary of Clay Cliff Creek on the southern side of Grand Avenue North. Numerous artefacts were discovered across an area measuring approximately 60 metres by 9 metres and were made from silcrete, indurated mudstone, quartz and chert. Small pieces of shell and fragments of charcoal were also discovered at the site.

» AHIMS 45-6-3195 (Cumberland Hospital East) is a registered potential archaeological deposit (PAD) located on raised flat ground on the northern bank of Parramatta River near North Parramatta Bridge. This site has been assessed as having high archaeological potential due to its proximity with Parramatta River and the undisturbed nature of the site.

» AHIMS 45-6-3157 and 45-6-3158 (Harris Street Footpath/Robin Thomas Reserve) is an open context site listed as an Aboriginal Resource Gathering site, with artefacts and associated PAD. The western portion of the site is registered on the NSW State Heritage Register (SHR) (Item 01863) which notes the area would have been rich with resources due to the proximity of the two water bodies (Parramatta River and Clay Cliff Creek). Soil core samples taken from the site indicate that the deep soil profiles are suitable for the preservation of subsurface Aboriginal
archaeological material. An archaeological test excavation program carried out within the site identified a total of 59 artefacts.

In addition, 120 previously recorded Aboriginal heritage sites were identified within the broader locality but outside of the potential impact zone associated with the project. As well as identification of registered (known) sites within a given area, an AHIMS search also helps to characterise local archaeology by illustrating the distribution, context and type of sites within the local landscape.

Results from the AHIMS database search divide archaeological sites into two contexts – ‘open’, meaning existing in an open landscape context, and ‘closed’, meaning associated with a rock shelter. The AHIMS results indicated the predominance of open sites with artefacts (i.e. open camp sites or artefact scatters) around the project area associated with Parramatta River, major creeks and tributaries. In 9.2 per cent of cases, open sites with artefacts were also associated with areas of PAD while one open site with artefacts was associated with a culturally modified tree and another was associated with shell. Twenty nine (29) areas of PAD without surface artefacts have also been recorded. Other site features present at open sites in the search area included grinding grooves (3.3 per cent), culturally modified trees (0.8 per cent) and waterholes (0.8 per cent).

Sites in closed contexts have been identified to the west and north-west of the study area in sandstone country, with the majority of registered closed context sites located adjacent to Northmead Gully and around Lake Parramatta. Of the closed (shelter) sites, the most common site features were PADs (9.2 per cent), followed by artefacts (7.5 per cent) and sites containing either pigmented or engraved art (1.7 per cent).

The range of site types and features indicated in the AHIMS search results illustrate the rich archaeological resource within the vicinity of the study area, with many and varied manifestations of past Aboriginal peoples’ presence and use of the environment and natural resources of the region. In particular, the frequency of sites in close proximity to Parramatta River and major creeks demonstrate the importance of these resources to past Aboriginal people.

10.3.1.4 Archaeological survey results

An archaeological survey was conducted over the full extent of the study area in December 2016. Based on the archaeological background and landform context of the project area, the survey closely inspected any areas of surface exposure for artefacts and evidence of intact soils and considered long term flood activity. The locations of the previously identified archaeological sites were inspected to assess the potential for associated subsurface deposits within the study area.

The survey found that the majority of the study area contained little to no potential for subsurface archaeology due to extensive subsurface disturbance from modern land use practices including the construction of buildings and roads, the installation of above and below ground utilities, landscaping and bulk earthworks. Low lying areas along the banks of Parramatta River and major creeks are likely to have been heavily disturbed by high energy flooding events, which scour subsurface deposits. Soils on adjacent slopes of these waterways along the alignment revealed sections of disturbance and ongoing erosion.

Potential archaeological deposits identified during the survey

The survey recorded seven previously unidentified PADs within the study area. These PADs were identified based on their location in close proximity to waterways (such as Parramatta River or Clay Cliff Creek), low level of disturbance and elevated position location within the Parramatta Sand Body. In addition, the three previously identified sites identified through the AHIMS search were located and assessed as part of the survey. The locations and details of each of these PADs is outlined in Table 10.8 and Figure 10.2a to Figure 10.2h.
### Table 10.8  Identified Aboriginal archaeological sites/ PADs by type

<table>
<thead>
<tr>
<th>SITE</th>
<th>SITE TYPE</th>
<th>PRECINCT</th>
<th>ARCHAEOLOGICAL POTENTIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Existing / known site</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AHIMS 45-6-3195 (Cumberland Hospital East)</td>
<td>Potential Archaeological Deposit</td>
<td>Parramatta North</td>
<td>Moderate</td>
</tr>
<tr>
<td>AHIMS 45-6-3157 AHIMS 45-6-3158 (Harris Street Footpath/Robin Thomas Reserve)</td>
<td>Aboriginal Resource &amp; Gathering, Artefact Scatter, Potential Archaeological Deposit</td>
<td>Parramatta CBD</td>
<td>Moderate</td>
</tr>
<tr>
<td>AHIMS 45-6-2559 (Sydney Turf Club car park)</td>
<td>Artefact Scatter</td>
<td>Rosehill and Camellia</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Newly recorded sites</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PLR PAD 1</td>
<td>Potential Archaeological Deposit</td>
<td>Parramatta North</td>
<td>Moderate</td>
</tr>
<tr>
<td>PLR PAD 2</td>
<td>Potential Archaeological Deposit</td>
<td>Parramatta CBD</td>
<td>Moderate</td>
</tr>
<tr>
<td>PLR PAD 3</td>
<td>Potential Archaeological Deposit</td>
<td>Parramatta CBD</td>
<td>Moderate</td>
</tr>
<tr>
<td>PLR PAD 4</td>
<td>Potential Archaeological Deposit</td>
<td>Rosehill and Camellia</td>
<td>Moderate</td>
</tr>
<tr>
<td>PLR PAD 5</td>
<td>Potential Archaeological Deposit</td>
<td>Rosehill and Camellia</td>
<td>Moderate</td>
</tr>
<tr>
<td>PLR PAD 6</td>
<td>Potential Archaeological Deposit</td>
<td>Rosehill and Camellia</td>
<td>Moderate</td>
</tr>
<tr>
<td>PLR PAD 7</td>
<td>Potential Archaeological Deposit</td>
<td>Carlingford</td>
<td>Moderate</td>
</tr>
</tbody>
</table>
Figure 10.2a | Potential archaeological deposits along the project alignment
Other regional environmental impacts

Figure 10.2b Potential archaeological deposits along the project alignment
Figure 10.2c | Potential archaeological deposits along the project alignment
Figure 10.2d Potential archaeological deposits along the project alignment
Other regional environmental impacts

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Figure 10.2e | Potential archaeological deposits along the project alignment
Other regional environmental impacts

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Figure 10.2f Potential archaeological deposits along the project alignment
Figure 10.2g | Potential archaeological deposits along the project alignment
Figure 10.2h Potential archaeological deposits along the project alignment
10.3.1.5 Test excavations

Based on background research and the results of the field survey, it was identified that additional investigation would be required in order to characterise the nature and extent of any existing Aboriginal archaeological deposit identified (i.e. PAD 1-7).

Additionally, two of the previously registered sites, Cumberland Hospital East and Harris Street Footpath/Robin Thomas Reserve, were also investigated to further evaluate the nature of deposits in these areas. In relation to the Cumberland Hospital East site, it is noted that in addition to test excavation being carried out for the purpose of the project, concurrent excavations unrelated to the project were also inspected and assessed. Test excavation at the previously recorded Sydney Turf Club car park site was not deemed necessary as the surface of the site was sufficient to characterise its nature.

Two additional areas identified during the survey but not previously identified as a PAD, O’Connell Street Bridge and Wilde Avenue Bridge, were also investigated to inform potential design refinements for the project since the design was not finalised at the time of the assessment. Both areas were located in close proximity to Parramatta River along the southern foreshore and adjacent grass strips.

Subsurface investigation at these locations in the form of an Aboriginal archaeological test excavation was conducted in April and May 2017 in accordance with the OEH Code of Practice for the Archaeological Investigation of Aboriginal Objects in New South Wales (OEH 2010). The methodology for the test excavation program was prepared by Kelleher Nightingale Consulting Pty Ltd (KNC) in consultation with registered Aboriginal stakeholder groups. A more detailed methodology and location of test squares and boreholes carried out as part of the test excavation at each location, as well as detailed results are outlined in the Parramatta Light Rail: Aboriginal Cultural Heritage Assessment (Technical Paper 5, Volume 3).

A summary of the results of the test excavation are summarised in Table 10.9.

Table 10.9 Results of Aboriginal archaeological test excavation

<table>
<thead>
<tr>
<th>SITE</th>
<th>PRECINCT</th>
<th>RESULT OF TEST EXCAVATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLR PAD 1</td>
<td>Parramatta North</td>
<td>» No Aboriginal objects recovered</td>
</tr>
<tr>
<td></td>
<td></td>
<td>» The area retains no Aboriginal archaeological potential and is not a PAD.</td>
</tr>
<tr>
<td>PLR PAD 2</td>
<td>Parramatta CBD</td>
<td>» One artefact identified, designated as site PLR AFT 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>» The recovered artefact is in a secondary context (i.e. not in situ) and is not representative of an archaeological deposit at this location. The area displays no additional archaeological potential.</td>
</tr>
<tr>
<td>PLR PAD 3</td>
<td>Parramatta CBD</td>
<td>» No Aboriginal objects were recovered</td>
</tr>
<tr>
<td></td>
<td></td>
<td>» The area retains no Aboriginal archaeological potential and is not a PAD.</td>
</tr>
<tr>
<td>PLR PAD 4</td>
<td>Rosehill and Camellia</td>
<td>» Two artefacts were recovered, designation as site PLR AFT 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>» No modern disturbance was evident and the deposit appeared to be an intact portion of the Parramatta Sand Body. The subsurface integrity of the Sand Body at this site is relatively high, contained beneath a moderate layer of more recent disturbance approximately half a metre thick.</td>
</tr>
</tbody>
</table>
### Other regional environmental impacts

<table>
<thead>
<tr>
<th>SITE</th>
<th>PRECINCT</th>
<th>RESULT OF TEST EXCAVATION</th>
</tr>
</thead>
</table>
| PLR PAD 5           | Rosehill and Camellia | » No Aboriginal objects recovered  
» The area retains no Aboriginal archaeological potential and is not a PAD.                                                                                                                                   |
| PLR PAD 6           | Rosehill and Camellia | » No Aboriginal objects recovered  
» The area retains no Aboriginal archaeological potential and is not a PAD.                                                                                                                                   |
| PLR PAD 7           | Carlingford         | » No Aboriginal objects recovered  
» The area retains no Aboriginal archaeological potential and is not a PAD.                                                                                                                                   |
| AHIMS 45-6-3195     | Parramatta North    | » A total of 33 artefacts were recovered, confirming the presence of intact archaeological deposit associated with the Parramatta Sand Body at this site  
» Beneath the disturbance, integrity of the sand body was generally high, especially on the raised flat adjacent to the river. Recovered artefacts are comparable with those recorded during previous excavations of similar intact sands in terms of raw material and reduction types. |
| AHIMS 45-6-3157     | Parramatta CBD      | » A total of nine artefacts were recovered, confirming the presence of intact archaeological deposit associated with the Parramatta Sand Body at this site  
» Recovered artefacts are comparable with those recorded during previous excavations of other parts of the site in terms of raw material and reduction types.                          |
| AHIMS 45-6-3158     | Parramatta CBD      |                                                                                                       |                                                                                                                                |
| O’Connell Street Bridge | Parramatta North | » No Aboriginal objects recovered  
» The area retains no Aboriginal archaeological potential and is not a PAD.                                                                                                                                   |
| Wilde Avenue Bridge | Parramatta North    | » No Aboriginal objects recovered  
» The area retains no Aboriginal archaeological potential and is not a PAD.                                                                                                                                   |

*AFT = *Objects such as stone tools, and associated flaked material, spears, manuports, grindstones, discarded stone flakes, modified glass or shell demonstrating evidence of use of the area by Aboriginal people.*

In summary, a total of five Aboriginal archaeological sites have been identified for the project as follows:

» Cumberland Hospital East site located within the Parramatta North precinct.
» Harris Street Footpath/Robin Thomas Reserve site located within the Parramatta CBD precinct.
» PLR AFT1 (formerly PLR PAD 2) located at Prince Alfred Square within the Parramatta CBD precinct.
» PLR AFT2 (formerly PLR PAD 4) located within the vegetated median to the south-east of the intersection of Purchase Street and George Street, within the Rosehill and Camellia precinct.
Other regional environmental impacts

» Sydney Turf Club car park site located within the grounds of the Australian Turf Club, within the Rosehill and Camellia precinct.

These sites are further assessed below in terms of their archaeological significance, potential impact as a result of the project and associated management and mitigation measures.

Test excavation did not identify any Aboriginal objects at the other sites investigated being PLR PAD 1, PLR PAD 3, PLR PAD 5, PLR PAD 6, PLR PAD 7, O’Connell Street Bridge and Wilde Avenue Bridge. Therefore no further assessment of these sites has been carried out.

10.3.1.6 Archaeological significance

As identified above, the project contains five identified Aboriginal archaeological sites as defined under the National Parks and Wildlife Act 1974. Assessment of archaeological significance has been carried out for these sites based on the social/cultural, historic, scientific and aesthetic significance of Aboriginal heritage values as identified in The Burra Charter (Australia ICOMOS 2013). The identification of significance has been developed in consultation with the registered Aboriginal stakeholders for the project. Significance assessment has focussed on the intactness, representativeness and research potential of these sites within the landscape.

The outcomes of the significance assessment are summarised in Table 10.10 below, based on a rating of significance from low to high. Further detail is provided in Parramatta Light Rail: Aboriginal Cultural Heritage Assessment (Technical Paper 5, Volume 3).

Table 10.10 Aboriginal archaeological significance

<table>
<thead>
<tr>
<th>SITE NAME</th>
<th>AHIMS NUMBER</th>
<th>ARCHAEOLOGICAL SIGNIFICANCE</th>
<th>PRECINCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cumberland Hospital East</td>
<td>45-6-3195</td>
<td>Moderate-high</td>
<td>Parramatta North</td>
</tr>
<tr>
<td>Harris Street Footpath/Robin Thomas Reserve</td>
<td>45-6-3157/45-6-3158</td>
<td>Moderate-high</td>
<td>Parramatta CBD</td>
</tr>
<tr>
<td>PLR AFT 1 (formerly PLR PAD 2)</td>
<td>-</td>
<td>Low</td>
<td>Parramatta CBD</td>
</tr>
<tr>
<td>PLR AFT 2 (formerly PLR PAD 4)</td>
<td>-</td>
<td>Moderate</td>
<td>Rosehill and Camellia</td>
</tr>
<tr>
<td>Sydney Turf Club car park</td>
<td>45-6-2559</td>
<td>Moderate</td>
<td>Rosehill and Camellia</td>
</tr>
</tbody>
</table>

10.3.1.7 Cultural/social significance

The study area and wider Parramatta area have cultural value for the local Aboriginal community. Aboriginal cultural significance may include social, spiritual, historic and archaeological values and is determined by the Aboriginal community. The presence for Aboriginal objects is not required for a site to hold value for the Aboriginal community.

Aboriginal cultural values of the study area (and identified Aboriginal archaeological sites within) as assessed by the registered Aboriginal stakeholders is described in Chapter 2 of Technical Paper 5 in Volume 3, and include (but not limited to) ancestral association with the land, creeklines, artefact sites, indigenous plants, animals and ecological communities, and a general concern for burials. Stakeholders have repeatedly expressed the high Aboriginal cultural values of the study area and wider region, in particular the intact deposits associated with the Parramatta Sand Body.

Of the five identified Aboriginal archaeological sites, the majority do not demonstrate historical or aesthetic Aboriginal cultural values and no specific social or cultural value of the sites have been expressed by the registered Aboriginal stakeholders. The exception to this is the Harris Street Footpath/Robin Thomas Reserve sites which are representative of the Parramatta Sand Body and were determined to have special significance (social) to local Aboriginal people.
10.3.2 Impacts during construction

Test excavation did not identify any Aboriginal objects at PLR PAD 1, PLR PAD 3, PLR PAD 5, PLR PAD 6 or PLR PAD 7, thereby effectively removing these as potential Aboriginal heritage constraints for the project.

Although the majority of the study area is confined to disturbed areas associated with existing road and rail infrastructure corridors, given the linear nature and spatial constraints of the project, some impact on Aboriginal archaeological sites cannot be avoided. Where impact on sites of moderate-high significance is proposed, the impacted portions represent a small fraction of the total site area.

All five Aboriginal archaeological sites would be subject to some level of impact as a result of the project, including partial impact on three items and total impact on two items. This is summarised in Table 10.11 and shown in Figure 10.3a to Figure 10.3h.

Table 10.11 Impact on Aboriginal archaeological sites

<table>
<thead>
<tr>
<th>SITE NAME</th>
<th>AHIMS NUMBER</th>
<th>SCOPE OF IMPACT</th>
<th>TYPE OF IMPACT</th>
<th>CONSEQUENCE OF IMPACT</th>
<th>PRECINCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cumberland Hospital East</td>
<td>45-6-3195</td>
<td>Partial</td>
<td>Direct</td>
<td>Partial loss of value</td>
<td>Parramatta North</td>
</tr>
<tr>
<td>Harris Street Footpath/ Robin Thomas Reserve</td>
<td>45-6-3157/ 45-6-3158</td>
<td>Partial</td>
<td>Direct</td>
<td>Partial loss of value</td>
<td>Parramatta CBD</td>
</tr>
<tr>
<td>PLR AFT1 (formerly PLR PAD 2)</td>
<td>-</td>
<td>Total</td>
<td>Direct</td>
<td>Total loss of value</td>
<td>Parramatta CBD</td>
</tr>
<tr>
<td>PLR AFT 2 (formerly PLR PAD 4)</td>
<td>-</td>
<td>Total</td>
<td>Direct</td>
<td>Total loss of value</td>
<td>Rosehill and Camellia</td>
</tr>
<tr>
<td>Sydney Turf Club car park</td>
<td>45-6-2559</td>
<td>Partial</td>
<td>Direct</td>
<td>Partial loss of value</td>
<td>Rosehill and Camellia</td>
</tr>
</tbody>
</table>

PLR AFT 1 is highly disturbed, exhibited low archaeological value and would not require mitigation. The other remaining four sites that would be directly impacted exhibit moderately intact archaeological deposits, relatively intact soil structure, information bearing archaeological objects and Aboriginal cultural value. Mitigation and management measures are detailed in section 10.3.4.

The loss of intrinsic Aboriginal cultural value linked to these impacted sites as a result of the project cannot be offset, however the salvaged information would increase the understanding, strengthen interpretation and improve ongoing and future management of Aboriginal heritage in the surrounding area. This would be particularly valuable in relation to the Parramatta Sand Body for which the spatial extent and nature of intact archaeological deposits is not yet well understood.
Other regional environmental impacts

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Figure 10.3a Proposed impacts on archaeological sites
Figure 10.3b Proposed impacts on archaeological sites
Other regional environmental impacts

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Figure 10.3c Proposed impacts on archaeological sites
Other regional environmental impacts

Figure 10.3d Proposed impacts on archaeological sites
Other regional environmental impacts

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Figure 10.3e | Proposed impacts on archaeological sites
Other regional environmental impacts

Figure 10.3f Proposed impacts on archaeological sites
Other regional environmental impacts

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Figure 10.3g | Proposed impacts on archaeological sites
Other regional environmental impacts

Figure 10.3h Proposed impacts on archaeological sites
10.3.3 Impacts during operation

Impact on Aboriginal archaeological sites would be confined to the construction stage of the project. No further impact would occur during operation of the project.

10.3.4 Management and mitigation

The proposed management and mitigation measures to address potential impacts on Aboriginal heritage, in particular during detailed design, are listed in Table 10.12.

**Table 10.12 Management and mitigation measures - Aboriginal heritage impacts (detailed design)**

<table>
<thead>
<tr>
<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AB-1</td>
<td>Appropriate Aboriginal heritage interpretation would be incorporated into the design of the project in consultation with registered Aboriginal stakeholders.</td>
<td>All precincts</td>
</tr>
</tbody>
</table>

The proposed management and mitigation measures to address potential impacts on Aboriginal heritage, in particular during construction, are listed in Table 10.13. As noted above, the PLR AFT1 site is highly disturbed exhibiting low archaeological value and would therefore not require any mitigation.

**Table 10.13 Management and mitigation measures - Aboriginal heritage impacts (construction)**

<table>
<thead>
<tr>
<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
</tr>
</thead>
</table>
| AB-2 | Archaeological salvage excavation (in accordance with the methodology detailed in Technical Paper 4 - Parramatta Light Rail: Aboriginal Cultural Heritage Assessment would be carried out for the following sites prior to the commencement of construction:

  » Cumberland Hospital East
  » Harris Street Footpath/Robin Thomas Reserve
  » PLR AFT2 (formerly PLR PAD 2)
  » Sydney Turf Club Carpark.
The strategy for conservation of salvaged Aboriginal objects would be detailed in the heritage management plan. | Paramatta North
Paramatta CBD
Rosehill and Camellia |
| AB-3 | Exclusion zones would be established during construction for the following partially impacted sites to protect the portion of the site located outside the project construction disturbance boundary:

  » Cumberland Hospital East
  » Harris St Footpath/Robin Thomas Reserve.
Suitable controls would be identified in the heritage management plan, which may include barrier fencing to delineate the exclusion zones. | Paramatta North
Paramatta CBD |
| AB-4 | In the event of unexpected finds (including burials), the Transport for NSW Unexpected Heritage Finds Guideline (2014) would be implemented. This would be incorporated into the heritage management plan to be developed as part of the CEMP for the project. | All precincts |
10.4 Hydrology, drainage and surface water quality

The following sections provide a summary of a desktop water quality assessment carried out for the project. This includes a description of existing surface water resources and identification of users and other sensitive receptors that are reliant on these resources. Further details are provided in the Water Quality Impact Assessment (Technical Paper 6, Volume 4 of this Environmental Impact Statement).

In addition, preliminary flood modelling has been carried out to describe the existing flooding and drainage conditions and potential impacts. The Flooding Impact Assessment is located in Technical Paper 7, Volume 4 of this Environmental Impact Statement.

10.4.1 Existing environment

10.4.1.1 Waterways and catchments

The project lies within the Parramatta River catchment, an area of approximately 297 square kilometres. The Parramatta River Catchment is made up of 29 sub-catchments, and is largely referred to as the Upper and Lower Parramatta River. The catchment terrain varies throughout the project, and is generally mildly sloping through the Westmead and Parramatta North precincts, becoming flatter through the Parramatta CBD and Rosehill and Camellia precincts. Within the Carlingford precinct the terrain ascends uphill north of the Parramatta River, reaching a height of approximately 100 metres AHD at the existing Carlingford train station.

The Upper Parramatta River refers to the freshwater section of the river. This is controlled by a series of weirs including Kiosk Weir and Upstream Weir in Parramatta Park and Charles Street Weir in the Parramatta CBD which defines the tidal boundary with the lower Parramatta River. The headwaters of the Parramatta River are formed in the upper catchment by the confluence of Toongabbie Creek and Darling Mills Creek. The Lower Parramatta River refers to the salt water river downstream of Charles Street Weir which is tidally influenced and drains to Sydney Harbour approximately 30 kilometres downstream of Charles Street. Significant tributaries of the Parramatta River downstream of the weir include Duck River, Vineyard Creek, Ponds/Subiaco Creek, Haslams Creek and Archers Creek.

The Parramatta River catchment has undergone significant development and today is a highly urbanised area. A number of areas within the catchment have historic industrial uses, which are known to contain contaminated sediments, with high concentrations typically associated with point sources (e.g. current and former industrial sites at Camellia) or where creeks and stormwater outlets enter the estuary in the upper reaches of embankments. Some areas have potential for acid sulfate soils (ASS) to occur (refer to section 10.6 (Soils and geology) for details).

Five main waterways are located within the vicinity of the project alignment. These waterways and the existing water quality are discussed in Table 10.14 and have been shown previously on Figures 5.2a to Figure 5.2h. Generally existing water quality in the Parramatta region is poor, especially with respect to nutrient concentrations. Higher levels of nutrient concentrations occur due to the highly disturbed, heavily urbanised catchment, which is influenced from historical and current land uses discharging directly into the waterways.
### Table 10.14 Waterways within the vicinity of the project alignment

<table>
<thead>
<tr>
<th>WATERWAY</th>
<th>DESCRIPTION OF ENVIRONMENT</th>
</tr>
</thead>
</table>
| Parramatta River | The project alignment would traverse the Parramatta River at a number of locations and traverse the Clay Cliff Creek and Vineyard Creek tributaries. A number of waterways also lie in close proximity to the project including Domain Creek and Subiaco Creek. Water quality in the catchment, particularly upstream of the Charles Street Weir is dominated by catchment inputs including stormwater and waste water overflows. Human activities have resulted in elevated levels of nutrients and gross pollutants. Sediment contamination, due to urbanisation and industrialisation of the catchment, has also had an impact on water quality throughout the catchment.  

The Parramatta River has been monitored at a number of locations by the City of Parramatta Council and Sydney Water. The available data collected from 2012 to 2016 shows that turbidity and conductivity are within acceptable limits for protection of aquatic ecosystems. The pH and dissolved oxygen levels are generally compliant with acceptable levels with the exception of elevated pH levels within the vicinity of the Elizabeth Street footbridge and dissolved oxygen below the lower limit of 85 per cent upstream of the Parramatta ferry wharf.  

Further details regarding the water quality of the Parramatta River is presented in Table 4.2 and 4.3 of the Water Quality Impact Assessment (Technical Paper 6).                                                                                                                                                                                                                                                                                                                                                   |
| Clay Cliff Creek | Clay Cliff Creek drains a small catchment area of about 3.1 square kilometres extending from Merrylands in the west to Harris Park in the east. The creek is largely an open concrete lined channel (used for the conveyance of stormwater) that flows east and into the Parramatta River at James Ruse Drive Bridge. The open channel changes to closed culvert sections between Arthur Street and Hassall Street, and from River Road West to Parramatta River. Some areas within the vicinity of Clay Cliff Creek are subject to inundation, due to a combination of existing channel capacity constraints, and high tailwater levels of Parramatta River, which is assumed to also have a tidal influence. Upstream of River Road the creek is largely underground.  

No water quality data was available for Clay Cliff Creek.                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Vineyard Creek | Vineyard Creek drains a relatively small (about five square kilometres) but highly modified catchment that flows south and discharges into the Parramatta River downstream of the Parramatta River CBD. Substantial modification of Vineyard Creek and its tributaries have occurred due to ongoing urbanisation. The catchment is almost fully developed and composed of low-medium density urban precincts, a golf course adjacent to the creekline, significant areas of parkland throughout and light to medium industrial zones in the southern part of the catchment.  

Limited water quality data exists for Vineyard Creek. Sydney Water has carried out monitoring over a series of wet weather events in 2013 and 2014. Generally, the water quality following wet weather is nutrient rich with elevated concentrations of nitrogen (total, oxidised and ammonia) and phosphorus (total). This nutrient rich water would be due to stormwater runoff from the catchment. Other measured indicators including pH, conductivity, turbidity and total suspended solids remained within acceptable limits following rainfall.  

Further details regarding the water quality of Vineyard Creek is presented in Table 4.4 of the Water Quality Impact Assessment (Technical Paper 6).                                                                                                                                                                                                                                                                                                                                 |
Other regional environmental impacts

<table>
<thead>
<tr>
<th>WATERWAY</th>
<th>DESCRIPTION OF ENVIRONMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domain Creek</td>
<td>Domain Creek is a first order stream originating in Westmead that flows through Parramatta Park and under the Western railway line discharging to the Parramatta River. It has a number of engineered structures including piping, culverts, dams and gross pollutant traps. A historical study carried out in 2009/2010 by the (former) Parramatta City Council identified the creek as having poor water quality and biological health. The creek is a tributary of the Parramatta River that flows through Parramatta Park (Parramatta Park Trust 2015). Water quality data for Domain Creek is limited, comprising of a short term monitoring program carried out in 2015 by the Western Sydney University. Monitoring indicated that the water quality of Domain Creek near its confluence with the Parramatta River was poorly oxygenated with elevated levels of nutrients including median phosphate and nitrate concentrations. It could therefore be inferred that Domain Creek is slightly eutrophic (a body of water rich in nutrients such that it supports a dense plant population). All other indicators pH, turbidity and conductivity fell within recommended guideline limits for protection of aquatic ecosystems.</td>
</tr>
<tr>
<td>Subiaco Creek</td>
<td>Subiaco Creek is a joint northern tributary of the Parramatta River. The total catchment area is about 8.5 square kilometres with Subiaco Creek having a catchment area of about 3.7 square kilometres. Major flows in the Subiaco Creek originate in Ponds Creek, and flow through much of the creek is impeded by heavy vegetation growth in the riparian zone. At the downstream end of Subiaco Creek, the water level is influenced from flows in the Parramatta River due to tides. Whilst there is no current information on water quality of the creek, biological health was assessed in 2009 at a number of locations that presented good aquatic habitat. Results indicated severe pollution throughout the creek suggesting very poor ecological condition (EcoLogical, 2009). The water quality of Subiaco Creek has been measured by Sydney Water on an annual basis since 2006. The data is limited and only the indicators ammonia and conductivity have been measured. The conductivity of Subiaco Creek is slightly higher than upstream waterways due to the tidal influences. Median ammonia concentrations exceed the recommended guidelines for protection of aquatic ecosystems.</td>
</tr>
</tbody>
</table>

10.4.1.2 Flood behaviour

The latest version of Australian Rainfall and Runoff (Commonwealth of Australia (Geoscience Australia) 2016) proposes new terminology for flood risk that involves annual percentage probability to best convey the likelihood of flooding.

For very frequent events the term used is Exceedences per Year (EY). This term applies to flood events occurring up to once in any one year. A ‘1 EY’ relates to an event that can occur once per year. A 0.2 EY is an event that could occur once every five years. Previously this event would have been expressed as a five year average recurrence interval (ARI).

For more rare events the term used is Annual Exceedance Probability (AEP). This is the probability of an event being equalled or exceeded in any one year. Thus a one percent AEP event means a one percent chance of a flood event being equalled or exceeded in any given year. Previously this event would have been expressed as a 100 year average recurrence interval (ARI).

The project passes through a number of flood-prone areas. Flooding can usually be classified as mainstream (riverine) flooding or localised overland flow flooding. Flooding issues within each precinct are outlined in Table 10.15.
Localised overland flow flooding is the accumulation of surface runoff water and is known to occur on a frequent basis where the existing council drainage system, consisting mainly of pits and pipes, has limited capacity. In these locations when the capacity of the drainage pipes is exceeded, the existing roads act as overland flow paths, as summarised in Table 10.15.

Riverine flooding is generally confined to the banks of the Parramatta River between the Westmead precinct and O’Connell Street Bridge on the western edge of the Parramatta CBD precinct in all events up to the one per cent AEP. Further downstream of this point, riverine flooding also occurs in Brickfield Creek and Clay Cliff Creek, which discharge to the Parramatta River. In some flood events, the high water levels in Parramatta River prevent the overland flow runoff from draining out of the Brickfield Creek and Clay Cliff Creek catchments.

Mapping of the existing Probable Maximum Flood (PMF) shows a significant portion of the study area would be inundated, particularly through the Parramatta CBD, Rosehill and Camellia precincts, including some existing bridges. In these low laying areas, drainage is influenced by the river tides and high water levels during flood conditions.

### Table 10.15 Existing flooding conditions

<table>
<thead>
<tr>
<th>PRECINCT</th>
<th>EXISTING FLOOD BEHAVIOUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Westmead</td>
<td>The Westmead precinct is not impacted by mainstream flooding in all events up to and including the one per cent AEP. Overland flow flooding occurs in some localised areas. This is caused by low points in the road and insufficient capacity of the existing drainage network. This occurs at the intersection of Hawkesbury Road and Hainsworth Street in the 0.2 EY, five per cent AEP and the one per cent AEPs. The time of inundation is predicted to be less than one hour in all events.</td>
</tr>
</tbody>
</table>
| Paramatta North | The Paramatta North precinct is not impacted by mainstream flooding in all events up to and including the one per cent AEP. Overland flow flooding is predicted to occur due to localised low points and insufficient capacity of the existing drainage network at the following locations:  
  » Cumberland Hospital west of the oval, in the 0.2 EY, five per cent AEP and the one per cent AEP.  
  » Cumberland Hospital near roundabout south of the oval, in the 0.2 EY, five per cent AEP and the one per cent AEP. The predicted time of inundation is around one to two hours in the 0.2 EY and three to five hours in the one per cent AEP.  
  » South of the intersection of Church Street and Ross Street, in the 0.2 EY, five per cent AEP and the one per cent AEP. The predicted time of inundation is between 30 to 45 minutes in the one per cent AEP event.  
There is an overland flow path, which is partially also classified as a floodway, through part of North Paramatta from north of the Factory Street and the Church Street intersection into the Cumberland Hospital (east campus). The categorisation changes to a flood storage area as this flow enters the localised low point, where significant ponding is predicted to occur. There is also an area designated as floodway draining to the west of this low point towards Paramatta River.  
The low point at the Church Street and Ross Street intersection is shown as a significant flood storage area, which collects water from two overland flow paths (from Church Street and Villiers Street) that are classified as a floodway. The flow path drains out of this low point to the south (via Victoria Road), which is also classified as a floodway. |
Other regional environmental impacts

<table>
<thead>
<tr>
<th>PRECINCT</th>
<th>EXISTING FLOOD BEHAVIOUR</th>
</tr>
</thead>
</table>
| Parramatta CBD | Flooding is a known problem throughout much of the Parramatta CBD precinct, particularly when the water level in the receiving watercourses is high, preventing stormwater from being effectively discharged. Overland flow flooding is also a problem in several locations, primarily due to insufficient capacity in the stormwater network. Overland flow flooding is predicted to occur due to localised low points and insufficient capacity of the existing drainage network at the following locations:  
» Macquarie Street near the location of the Parramatta Square stop, in the 0.2 EY, five percent AEP and the one percent AEP. The predicted time of inundation is between 15-30 minutes in the 0.2 EY, and 1-1.5 hours in the one percent AEP  
» Macquarie Street near the location of the Harris Street stop, in 0.2 EY, five percent AEP and the one percent AEP. The predicted time of inundation is 2-3 hours in the 0.2 EY and up to 6-8 hours in the one percent AEP. The ability of this area to drain effectively is compromised by the existing stormwater network draining to the Clay Cliff Creek open channel to the south. Areas along Church Street, south of the Parramatta River, are also known to be flood-prone, based on anecdotal and photographic evidence. This is due to insufficient capacity of the existing drainage network and inverse grading of footpaths. |
| Camellia and Rosehill | Most of the area along the project alignment within the Clay Cliff floodplain is classified as a flood storage area.  
Where the creek is channelised, these areas are classified as floodway and are inundated as frequently as the 0.2 EY. In the one percent AEP, depths are predicted to be approximately 1.6 metres at the intersection of Arthur Street and Tramway Avenue. At the same location within the floodplain, the area is predicted to remain underwater for considerable periods of time even in more frequent events, with the time of inundation greater than five hours in the 0.2 EY. This is due to high water levels in Clay Cliff Creek and Parramatta River coinciding which prevents water escaping the relatively low laying area.  
In the 0.2 EY and above, floodwater overtops the bank of Clay Cliff Creek and would inundate much of the alignment along Tramway Avenue between Alfred Street and James Ruse Drive.  
Near the existing rail bridge crossing at Parramatta River, and areas south of the crossing are likely to be inundated during the one percent AEP. The area located between Parramatta River and the junction of the Sandown Line with the T6 Carlingford Line classified as a floodplain storage area.  
The existing T6 Carlingford Line embankment passes through a significant area of flood storage between the junction with the Sandown Line at Camellia and the Parramatta River. A floodway is shown to exist through the James Hardie underpass. Overland flow flooding is predicted to occur due to localised low points and insufficient capacity of the existing drainage network at the following locations:  
» Along the Sandown Line railway corridor within Camellia, in all events up to the one percent AEP.  
» At the Camellia Station, with the northern end of the stop likely to be inundated during the one percent AEP when the water level in Parramatta River peaks, with depths of up to 250 millimetres predicted at this location for a duration of one to two hours. |
### Precinct Existing Flood Behaviour

<table>
<thead>
<tr>
<th>Precinct</th>
<th>Existing Flood Behaviour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carlingford</td>
<td>The T6 Carlingford Line passes through the catchment boundary between the Vineyard and Subiaco Creek catchments to the north of the Parramatta River and is therefore largely free from any significant flooding. There is potential for some areas of minor ponding along the existing rail corridor. Some areas along the existing T6 Carlingford Line are also potentially classified as floodways. The area north of Carlingford Station is a flood storage area.</td>
</tr>
</tbody>
</table>

#### 10.4.2 Existing flood management

**Flood risk, management and response plans**

The existing City of Parramatta Council Flood Risk Management Plans and the Parramatta Local Disaster Plan (DISPLAN) outlines the existing management measures to respond to flooding and flood risk across the LGA, including areas relevant to the project.

The DISPLAN generally advocates an approach of Shelter-In-Place/stay at work rather than evacuation. If required, safe sites for evacuation have been designated in the plan as follows:

- Ollie Webb Reserve
- Macarthur Girls High School
- Parramatta Golf Course.

The Draft Update of Parramatta Floodplain Risk Management Plans (Molino Stewart, 2016), identified that the majority of Parramatta CBD would fall within the category of ‘low flood island’, which is where the evacuation route (typically the road network) is cut by flooding before the area itself is inundated. The draft plan supports a shelter in place strategy for the CBD due to the short time to peak for major flood events. The section of Macquarie Street between Smith Street and Argus Lane is classed as rising road access as it has an evacuation route that rises to a level above the PMF.

**Provisional hazard categorisation**

A preliminary provisional hazard categorisation has been established for the project for the one percent AEP in accordance with the NSW Floodplain Development Manual (2005), with areas categorised as either high or low hazard. This is summarised below:

- Areas of high hazard are generally limited to the major watercourses and the immediate surrounds. In relation to the project, this is limited to the area between Alfred Street and James Ruse Drive. In all other locations where existing roads/rail structures cross a watercourse denoted as high hazard, project would be above the one percent AEP, with the exception of the existing pedestrian footbridge over Clay Cliff Creek.

- While the existing T6 Carlingford Line is outside the one percent AEP and therefore outside of the high hazard categorisation, there are areas of high hazard flooding shown to exist on either side of the existing railway embankment between Camellia Junction and Parramatta River.

- The flood storage area north of the existing Carlingford station is classified as a high hazard area.
10.4.3 Impacts during construction

This section discusses the potential impacts on water quality and flooding during construction. Where the potential for impacts arise mitigation and management measures would be implemented to ensure that any residual impacts would be acceptable. Proposed mitigation and management measures are identified in section 10.4.4.

10.4.3.1 Surface water and water quality impacts

The construction phase of the project would present a potential risk to further degradation of water quality if suitable management measures are not implemented, monitored and maintained. Surface waters at most potential risk are those in close proximity to track works, road works, excavation sites, spoil placement areas, vegetation removal, worksites and other locations where significant earthworks might occur, particularly in the initial stages of site establishment.

Potential risks to the Parramatta River (which is the main waterway) would potentially arise from the location of compound sites close to the river and its tributaries. Compound sites can present a potential risk to water quality from spills of pollutants, particularly if compound sites are used for storage of chemicals and for vehicle wash down and/or refuelling.

The water quality of the Parramatta River also has the potential to be impacted due to the project crossing the river in three locations (Parramatta North bridge, Lennox Bridge, and Parramatta River Bridge). The duplication of the bridge over the Parramatta River at North Parramatta may impact on water quality through the construction of a temporary weir or pier to provide access for large plant to demolish and install piles. Construction of other watercourse crossings could also potentially create instream barriers, impact mangroves, increase erosion and interfere with natural flow regimes.

The construction of the project would present similar potential risks to the water quality of Clay Cliff Creek and Vineyard Creek. Any changes in water quality of Clay Cliff Creek and Vineyard Creek could influence the water quality of the Parramatta River at the confluence and downstream. At Clay Cliff Creek, water quality could be impacted by removal/relocation of the small services bridge that currently exists. Significant embankment works required for the James Ruse Drive Bridge may also present the risk of potential runoff from contaminated soil that is in the area.

All waterways in the study area may be potentially impacted through the disturbance and mobilisation of sediment associated with general earthworks including removal of vegetation, stripping of topsoil and filling, particularly when these works are located in close proximity to waterways. Removal of vegetation and/or filling is proposed at several locations including limited weed/exotic vegetation clearing around Vineyard Creek.

Specific impacts associated with the construction of the project are detailed in the following sections.

Sedimentation and surface water runoff

Construction would involve the removal of vegetation and removal or modification of built features (such as paved surfaces), which would expose soils. Excavation would be required along the project alignment, including excavation of existing embankments along the existing T6 Carlingford Line.

Excavation would involve disturbance of the existing ground cover and stockpiling of spoil prior to reuse or removal from site. These and related construction activities would result in the potential for erosion of unconsolidated material through entrainment by runoff and subsequent transport off site.
Soils transported into local drainage channels could have a number of impacts including:

» Reduced hydraulic capacity of the channel due to deposition of material.
» Degraded water quality including lower dissolved oxygen levels, increased nutrients (such as nitrogen, phosphorus), increased turbidity, and altered pH.
» Increased levels of nutrients, metals and other pollutants transported via sediment and runoff to receiving waterways leading to increased potential for bioaccumulation of heavy metals in aquatic species.
» Increased sedimentation smothering aquatic life and affecting aquatic ecosystems.

These potential impacts would be effectively managed through the implementation of mitigation and management measures as detailed in section 10.4.4.

Changes to surface water flow

Changes to surface flow can occur from stream diversions, construction of culverts and bridges. No stream diversions are proposed as part of the project however the project would require the installation of new drainage in some locations (refer to section 5.9). Changes to the natural flow of water and small increases to impervious surfaces due to construction of the project would have the potential to slightly increase flow velocity and volume of stormwater runoff, however these increases would be insignificant.

Disturbance of acid sulfate soils

Construction activities such as excavation, land clearing, and drainage pose a potential risk to water quality when the activity is carried out in areas of actual or potential ASS. Disturbance and exposure of potential ASS to oxygen from construction activities could generate sulphuric acid and toxic quantities of aluminium and other heavy metals that could be readily released into the surrounding environment polluting nearby surface water. The ASS probability within the majority of project alignment has been classified as a low probability of occurrence with small areas around the Parramatta River foreshore near Lennox Bridge and near the construction site south of the Western Sydney University (Parramatta) campus classified as ‘high probability of occurrence but with an unknown confidence’ (refer to section 10.6 (Soils and geology)). Potential impacts would be effectively managed through the implementation of mitigation and management measures as detailed in section 10.4.4.

Disturbance of contaminated land and introduction of litter and toxicants

The potential for construction activities to disturb contaminated land are discussed in section 10.7 (Contamination). Several contaminated sites are located in close proximity to waterways within the project alignment including potential ASS within the existing creek valleys, potential for contaminated fill along all the waterway embankments and the potential for contaminated sediments (including nutrients, metals, and asbestos) to occur within the Parramatta River.

During construction activities, there is the potential for contaminated sediments to enter waterways from surface runoff or via the local stormwater network if appropriate management measures are not implemented. The release of contaminated sediments into the water column has the potential to impact on aquatic ecosystems.

Construction activities could introduce additional materials to local drainage lines, particularly during high rainfall events. Contaminants could include those from construction materials, rubbish, fuel and chemicals from accidental spills.

With the implementation of the proposed management measures, distribution of contaminated materials is unlikely to occur and any contamination encountered would be managed in situ as appropriate or disposed of to a licensed facility.
10.4.3.2 Flooding and drainage

**Overland flows**

All construction works and construction compounds would have the potential to impact local overland flows and existing minor drainage paths. Runoff entering the construction area or rainfall falling directly into the construction area therefore has the potential to cause localised flooding issues and adverse downstream impacts if not appropriately managed through the implementation of relevant mitigation measures (section 10.4.4).

Potential impacts during construction would generally include:

- Interruption of overland flow paths by installation of temporary construction ancillary facilities or construction hoarding.
- Changed flood behaviour as a result of changes to site topography and installation of temporary buildings and other structures within the floodplain, resulting in increased flooding of adjacent areas due to temporary loss of floodplain storage or conveyance of floodwaters.
- Changed flood behaviour due to bridge construction activities.
- Disruption to existing drainage lines during decommissioning, upgrade or replacement of drainage pits and pipes, resulting in localised flooding upstream.
- Blocking of drainage networks through increased sedimentation of surface water.
- Damage to construction plant or machinery caused by inundation from flood waters.
- Adverse impacts on downstream waterways through mobilisation and release of sediment, pollution, hazardous materials and/or construction materials as a result of runoff from construction sites and compounds.

These potential impacts on overland flows would be relatively minor and would be effectively managed through the implementation of mitigation and management measures, as detailed in section 10.4.4.

The majority of construction sites are located outside areas impacted by mainstream flooding, with the exception of Alfred Street, and Carlingford Station. These compounds are located in proximity to rivers and creeks, and pose a risk if overland flows are impacted.

Construction compounds within floodplain areas and flood storage areas are summarised in Table 10.16.

**Table 10.16 Potential flood risk and impacts at construction compounds during the one percent AEP**

<table>
<thead>
<tr>
<th>COMPOUND</th>
<th>POTENTIAL IMPACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfred Street</td>
<td>Minor redirection of overland flows across the site as a result of removing existing buildings and introducing site phase structures. Unlikely to result in flood impact outside site boundary.</td>
</tr>
<tr>
<td>Carlingford Station</td>
<td>Proximity of construction activity to the flood storage area may result in sediment/materials being washed into the local drainage system. Depending on the proposed structures/storage on the site, there may be limited change in flood storage area.</td>
</tr>
</tbody>
</table>
Mainstream flooding

Potential mainstream flooding impacts would be generally minor to moderate in nature and mitigated by managing specific detailed design aspects of the construction compound and site planning to better suit identified flooding conditions and avoid the potential for off-site flooding impacts.

The project would involve the construction of new or modified waterway crossings at the following locations:

- Bridge Road, North Parramatta (Parramatta North bridge).
- Clay Cliff Creek/James Ruse Drive, Rosehill (James Ruse Drive Bridge).
- Parramatta River, Camellia/Rydalmere (Parramatta River Bridge).
- Vineyard Creek, Rydalmere (Vineyard Creek bridge).

Bridge construction and modification works in general along the alignment have the potential to impact flooding, due to the obstruction of floodwaters or restriction of flood flow capacity within the waterway due to temporary structures. This also has the potential for adverse impacts downstream due to the mobilisation of sediments or other materials.

The Parramatta River Bridge (south) compound and Vineyard Creek compound may be impacted by overbank flooding during the one percent AEP and PMF events. This may result in sediment/materials being washed into the River. Depending on the proposed structures/storage on the site, limited obstruction of floodwaters may occur.

The stabling and maintenance facility is located outside the one percent AEP, but within the PMF flood extent which inundates the majority of the Camellia area. The site is currently not subject to local overland flows from areas external to the site, therefore obstruction of overland flow associated with construction activities (including the stabling and maintenance facility slab), and management of sediment/pollutant transport would be managed through on-site construction phase stormwater and erosion controls (as provided in section 10.4.4).

Potential impacts would be subject to further assessment during detailed design, once site staging and site arrangements are finalised. Management and mitigation measures during construction where flood risks or potential flood impacts have been identified are provided in section 10.4.4. This would include the implementation of an emergency response plan, including the evacuation of the construction personnel based on certain heavy rainfall events.

10.4.4 Impacts during operation

This section discusses the potential impacts on water quality and flooding during operation of the project. Where the potential for impacts arise mitigation and management measures would be implemented to ensure that any residual impacts would be acceptable. Proposed mitigation and management measures are identified in section 10.4.4.

10.4.4.1 Water pollution from light rail vehicles

During operation of the project, light rail vehicles would produce minimal pollutants and chemicals, however very small amounts of metals oils and particulates may be generated such as during braking. There is also potential for storm water runoff from the light rail corridor to produce some sediment, nutrients bound to sediment, and domestic litter/rubbish from commuters.

Leakage of oils, lubricants, degreasers and wash down water brake could occur from the maintenance depot if not properly managed. Storage of hazardous substances or other potential stormwater contaminants would require bunding and spill management.

During wet weather conditions, the LRVs may be required to deposit small quantities of sand on the tracks ahead of the LRV to increase friction and improve the contact in wet conditions. In some circumstances, the application of sand to the rails may lead to generation of small amounts of
material that might be carried in suspension should the activity coincide with or follow heavy rain. The resultant impact on water quality and drainage systems is not expected to be significant given the small quantities.

Overall, the operational impacts of the project are likely to contribute to an overall reduction in contaminant sources from current road operations (such as brake dust, motor oil etc. from vehicles) through the anticipated reduction in motor vehicle traffic.

10.4.4.2 Increases in impervious surfaces

Given the existing road environment, substantial sections of the project alignment consist of existing sealed impervious surfaces. The project would however result in minor increases to impervious surfaces where construction of the track or footpaths is required in areas that are presently grassed or gardens (such as through the Parramatta North Urban Transformation area, or where the project would encroach on Robin Thomas Reserve). In these areas, there is potential for build-up of additional contaminants in dry weather which could be transported to surrounding watercourses during wet weather.

The main pollutants of concern relating to surface runoff would include:

- Sediments from the impervious surfaces from atmospheric deposition.
- Heavy metals attached to particles washed off the impervious surfaces.
- Oil and grease and other hydrocarbon products.
- Litter from the rail corridor including wind-blown litter from the road corridor.
- Nutrients such as nitrogen and phosphorus (organic compounds) from biological matter and from natural atmospheric deposition of fine soil particles.

The emphasis in stormwater quality management for surface runoff would include managing the export of suspended solids and associated contaminants (including heavy metals, nutrients, hydrocarbons and organic compounds). Pollutants such as nutrients, heavy metals and hydrocarbons are usually attached to fine sediments. Trapping suspended solids would therefore be the primary focus of the water quality management strategy for the operational phase of the project.

10.4.4.3 Disturbance of acid sulfate soils

The operation of the project is not expected to result in disturbance to ASS and, nor are there likely to be any ongoing effects on surface water quality from sites known to contain ASS. The ASS Management Plan would contain management measures that would identify, contain and monitor acid sulfate soils if encountered throughout construction, minimising risks to the environment.

10.4.4.4 Disturbance of contaminated land

The operation of the project is not expected to result in ongoing disturbance to contaminated land and, nor are there likely to be any ongoing effects on surface water quality from sites known to contain potential contamination.

10.4.4.5 Introduction of litter and toxicants

During the operation of the project, the main risks to water quality would be from the release of litter and toxicants such as heavy metals, polycyclic aromatic hydrocarbons and petroleum hydrocarbons due to surface runoff from tracks, paved surfaces and maintenance of LRVs.
10.4.4.6 Impacts of flooding and drainage on the project

**Light rail alignment**

At the time of preparing this Environmental Impact Statement, Transport for NSW had developed a flood model that demonstrates that it is hydraulically feasible to operate the project along its entire length up to a 0.2 EY. This assumes a maximum depth of standing water over the track of 80 millimetres. Operation of the light rail would rarely need to cease and when required would cease for a short amount of time.

The model also demonstrates that potential impacts up to the one percent AEP would be mitigated with the exception of some minor local impacts. These would be investigated further and specific mitigation measures developed on a risk basis as the design advances.

In flood events larger than the 0.2 EY, in some low-laying locations, ponded water around stormwater pits in the road would not be able to escape due to the high water levels in the Parramatta River and its tributaries. This would typically occur for up to a few hours around the time of the storm peak and would drain away thereafter.

**Ancillary infrastructure**

Impacts of flooding on critical ancillary infrastructure such as substations and the stabling and maintenance facility were assessed against the one percent AEP and Probable Maximum Flood (PMF) event.

During the one percent AEP only the substation at Camellia stop would be impacted by flooding. During the PMF, the following areas would be within the flood zone:

» Barrack Lane and Camellia substation.

» The stabling and maintenance facility, including the associated substation.

Impacts in a flood event can range from minor to significant, including:

» Water damage to substation infrastructure and communications.

» Loss of power for relevant infrastructure and potentially wider network.

» Temporary shutdown and closure of the light rail.

» Fire and loss of critical infrastructure.

**Other infrastructure**

Other infrastructure that would be important to the operation of the project includes track points and communications equipment and ticketing. Track points and the associated infrastructure are designed to be operable when submerged.

The final locations of communications equipment would be determined during detailed design however where at risk of potential damage during flood events; this equipment would be elevated or designed for submergence to mitigate this risk.

10.4.4.7 Impacts of the project on flooding and drainage

A conceptual stormwater design has been progressed to determine how potential flooding and drainage impacts could be avoided, managed and mitigated. In general the proposed road regrading in combination with drainage upgrades would result in either improvement (reduction) in flood levels or change to flood levels in locations where overland flows currently affect urban areas along the project corridor.

While the project generally does not propose to upgrade drainage beyond where on-corridor and off-corridor works are proposed, the installation of new drainage would create an opportunity for
others to connect into the proposed upgraded stormwater network. This would assist others seeking to manage flooding constraints.

The performance criteria for drainage and flooding for the project are to ensure that:

» No aspect of the project would materially adversely affect the existing flood characteristics of the land.

» The project would not seek to improve flood immunity levels outside the project boundary, unless required to achieve project flood immunity levels or mitigate materially adverse impacts.

» Where reasonably practicable, existing drainage assets directly impacted by the project will be replaced in a manner compliant with current laws and applicable standards.

An adverse affect on flood characteristics for the purposes of the project is defined as:

» A negative change to a flood hazard category.

» An increase in flood level that results in habitable flood levels or basements being inundated.

» Increase in potential risk to life and personal safety.

» A negative effect on the structural soundness of a habitable building.

» A negative effect on existing flood evacuation access routes.

» An increase in velocity that results in a significant increase in the potential for soil erosion and scouring.

» Damage to, or temporary loss of, service of existing critical infrastructure.

The impacts of the project on flooding and drainage have been assessed in terms of:

» Changes to the peak water levels during flood events.

» Changes to velocity and scouring of existing waterways.

» Changes to the hydraulic categorisation and flood hazard.

» Impacts on existing emergency management procedures.

» Sensitivity of predicted impacts to climate change.

» Critical infrastructure and sensitive facilities.

**Changes to the existing peak flooding levels**

The project would be designed so that operations are possible in all flood events up to the 0.2 EY. This has generally resulted in reduced water levels where overland flows affect the alignment in all events up to the 0.2 EY current climate scenario.

The predicted changes in peak flooding levels along the project alignment are summarised in Table 10.17. Impacts identified in Table 10.17 are based on preliminary flood modelling using an industry-standard approach. Due to the extent of road network modifications, a degree of the modelled afflux would occur solely as a consequence of changes to the road level, without significantly altering flood depth. The modelling includes mitigation provided by flood storage in Rosehill. Changes to the track level, platform levels and road levels may also be required to offset flooding impacts. The need for flood storage and modification to the track, platform and road level would be clarified through additional investigations and will considering flood impacts, urban design impacts and stakeholder consultation. Predicted increases in flood levels as presented in this Environmental Impact Statement would be resolved to satisfy performance criteria during the subsequent detailed design stages of the project (as discussed and summarised in Table 17.5). The final suite of mitigation measures to mitigate impacts up to the one percent AEP would be documented in the Flood Management Strategy during detailed design. Following the implementation of mitigation measures, flooding impacts would be deemed acceptable.
Other regional environmental impacts

Table 10.17  Changes to existing peak flood levels in the one per cent AEP

<table>
<thead>
<tr>
<th>PRECINCT</th>
<th>CHANGES TO EXISTING FLOODING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Westmead</td>
<td>Much of the Westmead precinct would experience a minor reduction in peak water levels during the 0.2 EY due to stormwater drainage upgrades being carried out as part of the project resulting in reductions of flood depths in most areas and increased flood storage within the road corridor and upgrades to the existing stormwater network. Increases in peak water levels during the one per cent AEP as a result of the project would be minor and generally confined to the project boundary with the exception of:</td>
</tr>
<tr>
<td></td>
<td>» East of the Westmead stop flooding would increase by up to 40 millimetres.</td>
</tr>
<tr>
<td></td>
<td>» The car park adjacent to The Westmead Institute of Medical Research would see an increase in flooding by up to 50 millimetres.</td>
</tr>
<tr>
<td></td>
<td>» Caroline Street road corridor would see an increase in flooding by up to 200 millimetres.</td>
</tr>
<tr>
<td></td>
<td>» Westmead Hospital car park would see an increase in flooding by up to 20 millimetres.</td>
</tr>
<tr>
<td></td>
<td>» Cumberland Hospital (west) near Parramatta North Bridge would see an increase in flooding by up to 20 millimetres.</td>
</tr>
<tr>
<td></td>
<td>» Parramatta River (adjacent to Parramatta North Bridge) would see an increase in flooding by up to 30 millimetres. The impact of the new Parramatta North Bridge on flood levels are contained within the Parramatta River corridor and do not impact upon any sensitive receivers adjacent to the river.</td>
</tr>
<tr>
<td></td>
<td>Improvements to peak water levels during the 0.2 EY would occur at the following locations:</td>
</tr>
<tr>
<td></td>
<td>» Cumberland Hospital (east) would experience a reduction in ponding to the west and south of the oval due to upgrades to stormwater drainage.</td>
</tr>
<tr>
<td></td>
<td>» Church Street and Ross Street where flooding is restricted to the road corridor for the 0.2 EY, such that the track remains operable.</td>
</tr>
<tr>
<td></td>
<td>Increases in peak water levels as a result of the project during the one per cent AEP would be minor and generally confined to the project boundary with the exception of:</td>
</tr>
<tr>
<td></td>
<td>» Cumberland Hospital (east) increased localised peak water levels of up to 160 millimetres.</td>
</tr>
<tr>
<td></td>
<td>» North of the intersection of Factory Street and Church Street would experience a minor increase in peak water levels.</td>
</tr>
<tr>
<td></td>
<td>» Albert Street and Church Street road corridor would experience a minor increase in localised peak water levels of up to 50 millimetres.</td>
</tr>
<tr>
<td></td>
<td>» Grose Street road corridor would experience a minor increase in localised peak water levels of up to 60 millimetres.</td>
</tr>
<tr>
<td></td>
<td>» Fennell Street road corridor would experience a minor increase in localised peak water levels of up to 15 millimetres.</td>
</tr>
<tr>
<td></td>
<td>» The intersection of Ross Street and Somell Street would experience a minor increase in localised peak water levels of up to 100 millimetres.</td>
</tr>
<tr>
<td></td>
<td>» Victoria Road (near Church Street) would experience a minor increase in localised peak water levels of up to 170 millimetres.</td>
</tr>
</tbody>
</table>
### PRECINCT | CHANGES TO EXISTING FLOODING

**Parramatta CBD**

Significant improvements to peak water levels throughout the CBD within Church Street and Macquarie Street would occur as a result of upgrades to stormwater drainage for events up to the one per cent AEP.

*Increases in peak water levels during the one per cent AEP would be minor and generally confined to the project boundary with the exception of:*

- The western Robin Thomas Reserve would experience a minor increase in peak water levels of up to 20 millimetres.
- George Street road corridor between Harris Street and Purchase Street and parts of Queen’s Wharf Reserve would experience a minor increase in peak water levels of up to 30 millimetres.
- Properties on George Street between Purchase Street and Alfred Street would currently be impacted by a one per cent AEP under the existing flood modelling.

**Rosehill and Camellia**

Improvements to peak water levels during the 0.2 EY would occur at the following locations:

- Tramway Avenue and Arthur Street intersection would experience a reduction in flooding of up to 150 millimetres.
- Tramway Avenue stop would experience a minor reduction in peak water levels.
- The Sandown Line and Camellia stop would no longer experience flooding.

*Increases in peak water levels during the one per cent AEP would be minor and generally confined to the project boundary with the exception of:*

- Alfred Street and Hassell Street road corridors would experience a minor increase in peak water levels up to 40 millimetres.
- River Road (near Clay Cliff Creek) road corridor would experience a minor increase in peak water levels.
- Area near the James Hardie underpass would experience a minor increase in peak water levels of up to 15 millimetres.

**Carlingford**

Improvements to peak water levels during the 0.2 EY would occur at the following locations:

- Intersection of Dudley Road and Crowley Street would experience a reduction in peak water levels of up to 200 millimetres.
- Kenny Place would experience a reduction in peak water levels of up to 70 millimetres.
- Carlingford stop would experience a reduction in peak water levels of up to 20 millimetres.

*Increases in peak water levels during the one per cent AEP would be minor and generally confined to the project boundary with the exception of:*

- Rydalmere stop would experience an increase in peak water levels on the western side of the track of up to 400 mm due to changes to the ground surface. This may temporarily impact upon pedestrian access at the Rydalmere stop.
- Leamington Road pedestrian underpass would experience an increase in peak water levels of over 400 millimetres due to the widening of the rail embankment removing some storage capacity. This may temporarily impact upon pedestrian access.
Other regional environmental impacts

<table>
<thead>
<tr>
<th>PRECINCT</th>
<th>CHANGES TO EXISTING FLOODING</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>» Adderton Road (north of Kissing Point Road intersection) road corridor would experience an increase in peak water levels of approximately 180 millimetres due to the widening of the rail embankment removing some storage capacity.</td>
</tr>
<tr>
<td></td>
<td>» Winter Street road corridor would experience an increase in peak water levels of greater than 180 millimetres.</td>
</tr>
<tr>
<td></td>
<td>» Intersection of Marshall Road and Sophie Street would experience an increase in peak water levels of greater than 60 millimetres.</td>
</tr>
<tr>
<td></td>
<td>» Intersection of Adderton Road and Homelands Avenue would experience an increase in peak water level of greater than 60 millimetres. The increased flow off the proposed alignment would result in an increase further downstream in Vineyard Creek of up to 120 millimetres.</td>
</tr>
<tr>
<td></td>
<td>» Adderton Road (south of Pennant Hills Road) road corridor would experience an increase in peak water level of approximately 400 millimetres.</td>
</tr>
</tbody>
</table>

**Increased velocity and scouring of existing waterways**

Increases in the velocity of watercourses can occur during flooding events resulting in scouring and erosion. This generally occurs when there is an increase in impermeable surfaces, resulting in additional rainwater running off into stormwater drainage and entering waterways. It was determined that the change in velocity as a result of the project were generally minimal relative to the existing velocities in the river.

Along the project alignment, changes to peak flow velocities would occur in some localised areas due to the change in road geometry. The change is predicted to be minimal and is not likely to result in potential scour or erosion along the largely impermeable corridor.

In the Parramatta River, changes to peak flow velocity would occur near the proposed bridges. The change would be minimal relative to the existing velocities in the river.

Appropriate scour protection measures would be incorporated into the design of the project, particularly at new bridge structures to protect the piers and abutments, and at new stormwater outlets.

**Changes to hydraulic categorisation and flood hazard**

High hazard areas are typically defined as those areas within major watercourses and immediate surrounds. Change in hydraulic categorisation and provisional flood hazard was assessed and the results indicate that the project would have minimal impact on existing hydraulic categorisation and flood hazard.

The project would require minimal works within high hazard areas and would be limited to placement of piers within Parramatta River for the Parramatta North bridge and adjacent to Clay Cliff Creek for the James Ruse bridge. For both structures, the piers would be positioned to minimise any hydraulic losses and there would be no significant increase to the floodway areas.

Changes to flood categorisation would occur at the following locations:

» The site of the proposed compensatory flood storage in Rosehill near James Ruse Drive. This is due to the possible depth of the compensatory storage area being more than one metre, and therefore automatically placing the storage area within the high hazard category. Risks to public would be mitigated through the construction of a fence (as appropriate) around the storage area.

» Tramway Avenue and James Ruse Drive, associated with changes in ground levels with the change in hazard categorisation located on the fringes of the existing one per cent AEP flood extent along these roads, noting areas of reduction of hazard would also occur.
Within the light rail corridor near Leamington Road associated with the widening of the embankment, as the light rail corridor would be inaccessible to the general public, risks to the public would be minimal.

The project alignment traverses a high hazard flood zone between Alfred Street and James Ruse Drive. The proposed stop location would be situated outside the high hazard flood zone for the five per cent AEP event. The depth of flooding along the alignment approaching the stop is such that the light rail operations would have already ceased prior to the stop becoming a high hazard area.

Based on the above, compatibility with hydraulic hazard and changes to hydraulic hazard associated with the project are anticipated to be managed through appropriate design and operational mitigation measures.

**Changes to flood risk management and response plans**

Changes to peak flooding as a result of the project would not be expected to impact the surrounding road network during the one per cent AEP or more frequent events. As such, the project would not affect the existing ‘shelter in place’ strategy outlined in the NSW Disaster Plan (DISPLAN). Existing CBD locations that have a Flood Emergency Response classification of ‘rising road access’ within the City of Parramatta Council’s flood risk management plan would not be affected by the project.

The project has considered, and would not preclude, potential future drainage improvement options presented in flood risk management planning prepared by City of Parramatta Council. Consultation with City of Parramatta would be ongoing throughout the design development. Transport for NSW would seek the project to be consistent with future floodplain risk management studies and planned development of the Parramatta River catchment.

**Impacts of future climate change on flood behaviour**

The impact of climate change scenarios (lower bound and upper bound) on the one per cent AEP compared with the base case operational flood modelling were assessed to determine the long term flood impacts of the project.

- **Lower bound:** 10 per cent increase in rainfall intensity and a 400 millimetre rise in sea level.
- **Upper bound:** 30 per cent increase in rainfall intensity and a 900 millimetre rise in sea level.

The key findings of the modelling were:

- **Westmead precinct:** There are no additional areas within the Westmead precinct that would be adversely impacted by the project under the lower or upper climate change conditions relative to the baseline comparison.

- **Parramatta North:** There would be a minor increase in peak water levels (up to 15 millimetres) predicted upstream of the Parramatta North bridge in the worst case however this would be contained to Parramatta River.

- **Parramatta CBD:** George Street (adjacent to Queen’s Wharf Reserve) and Alfred Street would be inundated under both climate change scenarios in the one per cent AEP. There are no other additional areas within the Parramatta CBD precinct that would be adversely impacted by the project under the lower or upper bound climate change scenarios relative to the baseline comparison in the one per cent AEP.

- **Rosehill and Camellia:** The western side of the T6 Carlingford Line corridor near Parramatta River would be impacted by both climate scenarios with an increase of up to 20 millimetres in peak water level under the upper bound scenario.

- **Carlingford:** Operation of the project may be impacted under the upper bound climate change scenario as water is shown to encroach on the track.
Impacts of the project on the Peak Maximum Flood event

The impact of the project on the PMF event would be relatively small. The majority of the alignment would be severely inundated during the PMF event under existing conditions. As such, changes in the road levels along the project alignment would have minimal impacts on peak flood levels.

The impact of raising the level of the stabling and maintenance facility by two metres would result in a localised afflux of 400 millimetres near the north-western corner of the stabling and maintenance facility, and an afflux of greater than 100 millimetres within a small section of the adjoining property. This impact would be reduced through further design refinement and the provision of additional stormwater drainage within the stabling and maintenance facility and affected roads.

Modelling indicates that there would be no adverse impacts as a result of the project on existing critical infrastructure or sensitive facilities such as hospitals and emergency services, schools and universities, utility infrastructure such as substations or pump stations or other social infrastructure during the peak maximum flood event.

10.4.5 Management and mitigation

The management and mitigation measures that would be implemented to address potential surface water, water quality and flooding impacts during detailed design are listed in Table 10.18.

<table>
<thead>
<tr>
<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HY-1</td>
<td>A water quality management program would be established prior to construction to ensure compliance with identified water quality objectives and enable potential impacts on surface and groundwater to be identified, controlled and reported. This would include targeted baseline monitoring of receiving waters and shallow groundwater prior to construction to identify baseline water quality conditions.</td>
<td>All precincts</td>
</tr>
<tr>
<td>HY-2</td>
<td>Contemporary good practice guidelines would be followed to ensure stormwater runoff from the project area receives adequate water quality treatment, where it is required. Water quality guidelines to be followed include Managing Urban Stormwater, Environmental Targets Consultation Draft (DECCW, 2007) and Managing Urban Stormwater: Council Handbook (EPA, 1997). This would include consideration of water quality treatment devices such as Gross Pollutant Traps (GPTs) and other Water Sensitive Urban Design (WSUD) treatment measures such as water quality basins where possible and biofiltration swales. The location and specification for these would be determined through the detailed design.</td>
<td>All precincts</td>
</tr>
<tr>
<td>HY-3</td>
<td>Opportunities to improve existing flood impacts along the project alignment would be considered during the detailed design of the project. Measures considered would include improved drainage, streetscape design and integration of WSUD measures.</td>
<td>All precincts</td>
</tr>
</tbody>
</table>
### Other regional environmental impacts

A Flood Management Strategy would be prepared for flood affected land as a result of the project prior to construction. The strategy would demonstrate how the project design achieves the desired Performance Criteria (refer to Table 17.5) and would be supported by additional flood modelling.

The Flood Management Strategy would identify design responses and construction management measures that would be implemented in design or during construction. Construction management procedures would be detailed in the Construction Environmental Management Plan.

A Surface Water Management Plan would be prepared as part of the environmental management plan prior to the commencement of construction. The plan would detail measures for reducing the incidence of sediment, litter and chemical pollution reaching Parramatta River, Clay Cliff Creek, Vineyard Creek and other nearby waterways within the study area during construction.

The management and mitigation measures that would be implemented to address potential surface water, water quality and flooding impacts, in particular during construction are listed in Table 10.19.

**Table 10.19  Management and mitigation measures – surface water, water quality and flooding impacts (construction)**

<table>
<thead>
<tr>
<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HY-4</td>
<td>A Flood Management Strategy would be prepared for flood affected land as a result of the project prior to construction. The strategy would demonstrate how the project design achieves the desired Performance Criteria (refer to Table 17.5) and would be supported by additional flood modelling. The Flood Management Strategy would identify design responses and construction management measures that would be implemented in design or during construction. Construction management procedures would be detailed in the Construction Environmental Management Plan.</td>
<td>All precincts</td>
</tr>
<tr>
<td>HY-5</td>
<td>A Surface Water Management Plan would be prepared as part of the environmental management plan prior to the commencement of construction. The plan would detail measures for reducing the incidence of sediment, litter and chemical pollution reaching Parramatta River, Clay Cliff Creek, Vineyard Creek and other nearby waterways within the study area during construction.</td>
<td>All precincts</td>
</tr>
</tbody>
</table>
| HY-6 | During construction any water collected from the worksites would be treated and discharged in accordance with current guidelines to avoid any potential contamination or local stormwater system impacts. These guidelines include:  
  - Transport for NSW Water Discharge and Reuse Guideline 7TP-SD-024. | All precincts |
| HY-7 | All water requiring disposal during construction would be tested and treated in accordance with the Transport for NSW Water Discharge and Reuse Guideline 7TP-SD-024 prior to disposal. If required, water treatment would occur to ensure guidelines are met prior to water disposal. Treatments may include sediment basins and pH neutralisation. | All precincts |
| HY-8 | Large areas of disturbance such as compound areas would be located away from any surface runoff flow paths and above flood levels. | All precincts |
| HY-9 | Where existing longitudinal pit and pipe drainage exists and needs to be reinstated or repaired, appropriate scour protection measures would be reinstated or improved at outlets to watercourses or drainage lines. Typical scour protection might include concrete energy dissipating structures or dumped stone rip rap. | All precincts |
| HY-10 | Stockpile sites would be located outside areas of frequent inundation, with an acceptable level of flood risk depending on the duration of use. | All precincts |
Other regional environmental impacts

The following measures would be adopted for construction of new bridges/ modification of new bridges over waterways:

- Maximising use of pre cast elements to minimise construction works within the floodplain.
- Minimising temporary formwork requirements and removal of formwork as soon as possible after completion of each work stage.
- Minimising temporary structures required within the waterway.
- Staging works to minimise the duration of construction activities within the waterway.

The management and mitigation measures that would be implemented to address potential surface water, water quality and flooding impacts, in particular during operation are listed in Table 10.20.

### Table 10.20 Management and mitigation measures - surface water and water quality (during operation)

<table>
<thead>
<tr>
<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HY-12</td>
<td>A Flood Operational Management Plan would be prepared to describe the project operational procedure for the network during flood events.</td>
<td>All precincts</td>
</tr>
</tbody>
</table>

### 10.5 Groundwater

The following sections provide a summary of a desktop groundwater assessment carried out for the project. The existing regime for groundwater resources including reliance by users and other sensitive receivers is described in this section. Further details are provided in the Water Quality Impact Assessment (Technical Paper 6, Volume 4 of this Environmental Impact Statement).

#### 10.5.1 Existing environment

#### 10.5.1.1 Aquifer systems

Two major aquifer systems are known to exist within the vicinity of the project alignment including:

- A shallow groundwater system comprising shallow weathered sandstone and shale overlain by alluvial deposits and fill.
- A regional groundwater unit is expected to exist within the deeper confined Hawkesbury Sandstone.

The average depth to groundwater in the shallow aquifer has been identified as being about five metres below ground level. Given the underlying geology contains areas of shale units (refer to section 10.6 (Soils and geology)) which have moderate potential for salinity, it is expected the groundwater in the shallow aquifer may be moderately saline (refer to section 10.6.1). Groundwater yields in the shallow aquifer are indicated to be relatively low (0.1 litres per second), which likely represents the relatively poor hydraulic conductivity in the weathered shale unit. Where bores penetrate only the overlying fill and alluvial units groundwater yields are likely to be higher compared to the underlying weathered sandstone and shale, potentially in the order of two litres per second to five litres per second, and groundwater is expected to be less saline due to the increased hydraulic conductivity and hence higher rates of rainfall recharge.
The depth of groundwater in the deeper aquifer was identified in two bores at greater than 60 metres below ground level. There was no information available on groundwater salinity however from a review of known bores, the groundwater quality is generally fresh water. The groundwater yield in the deeper aquifer indicates a range between about one litre per second and three litres per second. Given the proposed depth of likely excavation associated with the project, it is unlikely that interception with this aquifer would occur.

10.5.1.2 Sensitive groundwater receptors

Registered bores

A search of groundwater works (NSW Pinneena database) indicates that there are approximately 50 groundwater works (bores) located within a two kilometre radius of the project (refer to Figure 10.4). A summary of the detailed information on these groundwater users and any Water Access Licences (WALs) associated with the works is provided in Appendix A of the Water Quality Impact Assessment (Technical Paper 6).

Groundwater dependent ecosystems

A discussion regarding GDEs is provided in section 10.2 (Biodiversity). This identified that the project is unlikely to significantly impact on GDEs.

10.5.1.3 Groundwater contamination

A number of sites on the Camellia peninsula have been subject to remediation or investigation notices by the NSW EPA. A Contamination Information Sheet published by Veolia for 37 Grand Avenue, Camellia, confirmed the presence of elevated levels of hexavalent chromium in groundwater and soil across the Camellia peninsula where contaminated material was used as fill. Further details are provided in section 10.7 (Contamination).

10.5.2 Impacts during construction

The main groundwater impacts which have the potential to occur during construction relate to:

» Impacts on groundwater levels, flows and connectivity.

» Impacts on groundwater chemistry, including pollution of groundwater and changes to groundwater quality.

» Impacts on groundwater users: interference to aquifers resulting in a decrease or change in groundwater levels that subsequently affect groundwater users and/or groundwater dependent ecosystems and riparian areas and wetlands.

These impacts are discussed in greater detail in the following sections.

10.5.2.1 Impact on groundwater levels, flow and connectivity

As part of the project, a series of cuttings are proposed predominantly along the Carlingford section of the project alignment. The majority of cuttings required are not likely to be deep enough to intercept the shallow groundwater table. Excavations associated with the light rail construction are expected to be to a maximum depth of 2.5 metres below ground level. Piles to support buildings and bridges would be installed at a greater depth.

The closest excavations that may impact on the current groundwater table would be at Camellia. Bores in close proximity to the project alignment indicate the groundwater table is about three metres below ground level at this location. This is due to the close proximity to the Parramatta River.
Figure 10.4 | Existing groundwater bores
10.5.2.2 Impact on groundwater chemistry

There is a minor potential for spills or leaks from construction equipment that would enable hydrocarbon such as fuels, oils, and/or grease contamination to enter the shallow groundwater aquifers. Accidental spills or leakage from construction plant, vehicles and equipment would have the potential to contaminate aquifers. Groundwater could then become contaminated with sediment and/or construction materials, such as fuels, lubricants and hydraulic oils, during construction activities, resulting in the development of a contamination plume. Any decline in water quality or the contamination of groundwater could be problematic for groundwater users and sensitive receiving environments.

Any potential impacts would be manageable through the application of well proven and tested safeguards and adherence to site specific pollution prevention protocols for water quality and hazardous material procedures (refer to section 10.4.4 and section 10.7.4).

10.5.2.3 Impact on groundwater users

No substantial excavations would be required as part of the project that would result in dewatering or result in any water table drawdown in any of the existing aquifers. Therefore groundwater impacts on groundwater users including water supply users, GDEs, riparian areas or wetlands would not be expected.

10.5.3 Impacts during operation

The main potential groundwater impacts which have the potential to occur during operation relate to:

» Changes to aquifer permeability.
» Contamination of groundwater.

These impacts are discussed in greater detail in the following sections.

10.5.3.1 Changes to aquifer permeability

The project would involve increases to the impervious surface area (in some locations as described previously) to accommodate the project. Sealing the ground surface could reduce the amount of rainfall recharging the aquifers, leading to lowered groundwater levels and reduced access for bore owners or GDEs. Areas where this could occur include sections of light rail track that are not currently within existing paved road reserves, including:

» Within the Parramatta North Urban Transformation area.
» Within existing open space reserves including Robin Thomas Reserve.
» Along Tramway Avenue and parts of Grand Avenue North.
» Within the existing T6 Carlingford railway corridor.
» Parts of the stabling and maintenance facility at Camellia.

Increases to the non-pervable surface areas would have the potential to reduce recharge by rainfall infiltration to existing aquifers. However, as the area to be sealed for the project alignment are relatively small compared to the overall recharge areas of the existing aquifers, the risks to groundwater recharge are likely to be relatively low.

According to the NSW Aquifer Interference Policy (NSW Department of Primary Industries 2012), if more than a two metre decline in groundwater level at any water supply work is obtained, then ‘make good’ provisions (which could involve deepening a bore or drilling a new bore) should apply. A groundwater level decline of greater than two metres is unlikely as a result of changes to aquifer permeability.
Piling also has the potential to reduce the permeability of aquifers. As outlined in Chapter 6, piling would generally be required during the construction of overhead wiring, maintenance facility and piers for the new bridge structures which are proposed along the project alignment.

10.5.3.2 Contamination of groundwater

Accidental spills or leakages from the stabling and maintenance facility at Camellia have the potential to result in contamination to local aquifers during operation. Groundwater could become contaminated with hazardous materials (such as fuels, lubricants and hydraulic oils) during maintenance activities, resulting in the development of a contamination plume. As with the potential impact identified during construction, a decline in water quality or the contamination of groundwater could be problematic for groundwater users and sensitive receiving environments.

This impact would be largely avoided and/or managed through the application of adequate water quality and hazardous material procedures (refer to section 10.4.4 and section 10.7.4).

10.5.4 Management and mitigation

Excavation associated with light rail is expected to be too shallow to intercept the groundwater table. However, the management measures summarised in Table 10.21 to Table 10.23 would be implemented to manage potential water level and water quality and contamination issues associated with potential groundwater impacts.

### Table 10.21 Management and mitigation measures - groundwater impacts (detailed design)

<table>
<thead>
<tr>
<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GW-1</td>
<td>The design of embankments would incorporate adequate drainage to reduce compaction and/or sealing of the underlying aquifer.</td>
<td>All precincts</td>
</tr>
<tr>
<td>GW-2</td>
<td>Adequate drainage and runoff management would be incorporated into the design of the stabling and maintenance facility.</td>
<td>Rosehill and Camellia</td>
</tr>
<tr>
<td>GW-3</td>
<td>A condition assessment of existing buildings and infrastructure would be carried out to monitor the risk of settlement from groundwater drawdown.</td>
<td>All precincts</td>
</tr>
</tbody>
</table>

### Table 10.22 Management and mitigation measures - groundwater impacts (construction)

<table>
<thead>
<tr>
<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GW-4</td>
<td>Excavation techniques would be adopted to minimise impacts on aquifers.</td>
<td>All precincts</td>
</tr>
<tr>
<td>GW-5</td>
<td>Any groundwater encountered during the construction of the project would be managed and disposed of in accordance with the Waste Classification Guidelines (DECC 2009) and Transport for NSW’s (2012) Water Discharge and Re-use Guideline.</td>
<td>All precincts</td>
</tr>
<tr>
<td>GW-6</td>
<td>Hazardous material procedures (including procedures for managing spills and refuelling and maintaining construction vehicles/equipment) would be developed and implemented as part of the CEMP to minimise potential for groundwater quality impacts due to chemical spills.</td>
<td>All precincts</td>
</tr>
<tr>
<td>GW-7</td>
<td>No new wells would be drilled to extract water for construction use.</td>
<td>All precincts</td>
</tr>
</tbody>
</table>
Other regional environmental impacts

Table 10.23  Management and mitigation measures – groundwater impacts (operation)

<table>
<thead>
<tr>
<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GW-8</td>
<td>Hazardous material procedures (including procedures for managing spills, and the refuelling and maintenance of vehicles/equipment) would be developed and implemented during the operation of the project to minimise potential for groundwater quality impacts associated with chemical spills and leaks. These procedures would adequately address activities at the stabling and maintenance facility, as well as other general maintenance facilities that would occur along the project alignment.</td>
<td>All precincts</td>
</tr>
</tbody>
</table>

10.6 Soils and geology

10.6.1 Existing environment

10.6.1.1 Topography

The project corridor consists of a predominantly undulating landscape, with generally flat-lying areas across creek floodplains and the Parramatta CBD area. West of the Parramatta CBD, the project typically follows a low crest (typically about 20 to 25 metres above sea level) along Hawkesbury Road north of Westmead station and descends to cross the river and adjoining floodplain at the Cumberland Hospital. The project alignment traverses the edge of a low ridge spur and adjoining shale hillslopes descending towards Parramatta North and follows the spine of this spur along Church Street south to the river where it crosses Lennox Bridge.

The majority of the project corridor south of the river is located within a floodplain/low river terrace landscape less than 10 metres above sea level. A small section along Macquarie Street is slightly higher, positioned on the eastern edge of the low ridge system extending east from Westmead. The floodplain and associated terraces are narrower to the north of the river, constrained by abutting slopes descending from the Hornsby Plateau.

North of the proposed junction at Camellia, the project alignment would follow the existing heavy rail line north towards Carlingford, passing through a low swampy area associated with the outflow of Vineyard Creek and Subiaco Creek in the industrial western part of Rydalmere. The project alignment then ascends a ridge running north through Dundas and Telopea towards Carlingford. The steepest section along the project corridor rises from about 45 metres near the existing Dundas station to about 100 metres at Carlingford, equivalent to a grade of about 3.5 per cent.

Just south of Carlingford the alignment joins the higher ridgeline containing Pennant Hills Road and then follows a short descent of the upper slopes to terminate just north of the road at an elevation of about 100 metres.

10.6.1.2 Geology and soil landscapes

Geology

The project corridor is located towards the boundary of the Cumberland Plain, a large low-lying and gently undulating region of the western Sydney Basin. To the north and east, the project intersects the elevated and highly dissected Hornsby Plateau. The majority of the Cumberland Plain is underlain by late Triassic shales of the Wiannamatta Group. A large part of the project is located atop Ashfield shale, a dark grey to black claystone-siltstone and fine sandstone-siltstone laminate (refer to Figure 10.5). The higher ground of the Hornsby Plateau to the north and east is composed of Hawkesbury Sandstone, a medium to very coarse-grained quartz sandstone, with minor laminated mudstone and siltstone lenses.
More recent Quaternary fluvial deposits associated with the drowned valley estuary of the Parramatta River are also evident, particularly to the south of the channel around James Ruse Drive. These deposits comprise silty to peaty quartz sand, silt and clay. To the east of the Rosehill Gardens Racecourse, the project passes through an area mapped as manmade fill mixed with older estuarine deposits. Where the project alignment crosses to the north of the Parramatta River and diverts to the Carlingford branch line, there is a small area of saline swamp along the fringe of the Hawkesbury Sandstone associated with the outflow of Vineyard and Subiaco Creeks comprising organic mud, peat, clay, silt, marine sand and fluvial sand.

One of these fluvial deposits is associated with a terrace formation known as the Parramatta Sand Body (Figure 10.5). The river terrace extends from the relatively narrow floodplain along the banks of the river to the base of the adjoining shale slopes, wider on the southern side of the river channel. The sand body is present beneath much of modern Parramatta. A portion of the sand body is listed on the NSW State Heritage Register (refer to section 12.5 – Non-Aboriginal heritage) and contains significant Aboriginal archaeology (refer to section 10.3 (Aboriginal heritage)).

Four dykes have also been mapped in close proximity to the project alignment (within about two kilometres). The most significant of these intrusions is the Dundas Dyke, which is located in the suburb of Dundas Valley. The Dundas Dyke consists predominantly of basalt, intruding into the surrounding shale. The two remaining dykes are found relatively close to the border of the project area. The dykes all trend approximately north-east to south-west.

Soil landscapes

Soils landscapes along the project alignment are varied (Figure 10.6), reflecting the influence of the diverse underlying geologies and topography of the study area. A review of the Soil Landscape Series Sheets (Penrith and Sydney) covering the project corridor indicates that soil zones are likely to be highly erodible when exposed.

10.6.1.3 Acid sulfate soils

Acid sulfate soils (ASS) are soils and sediments that contain iron sulphides that when exposed to oxygen, generate sulphuric acid and toxic quantities of aluminium and other heavy metals. The sulphuric acid and heavy metals are produced in forms that can be readily released into the environment with potential adverse effects on the natural and built environment, as well as human health. The majority of ASS are formed by natural processes under specific environmental conditions, which generally limits its occurrence to low lying sections of coastal floodplains, rivers and creeks where surface elevations generally less than five metres above sea level.

A review of the acid sulfate soil mapping, obtained from Australian Soils Resource Information System and NSW Department of Land Water and Conservation identified a number of high risk areas for acid sulfate soils along the project alignment. High risk acid sulfate soils are present at the following locations:

» Parramatta River crossing at Lennox Bridge, Parramatta (Class 1 ASS).
» Parramatta River, Rydalmere (Class 1 ASS).

The mapping indicates that the remainder of the project generally occupies an area that is classed as either ‘Low Probability’ of encountering ASS or is overlain by ‘Disturbed Terrain’ (fill material). There are also localised areas of ‘High Probability’ outside the area of impact of the project to the east, notably around Powell’s Creek, Homebush Bay, Haslam’s Creek and Duck River, however these are in areas which would not be impacted by the project.

Overall risk of disturbing ASS is considered to be low. An ASS risk map for the site is provided in Figure 10.7.
Other regional environmental impacts

Parramatta Light Rail | Stage 1 – Westmead to Carlingford via Camellia
Environmental Impact Statement

Figure 10.5 Geology

- Light rail stop
- Light rail alignment
- Existing railway
- Stabling and maintenance facility

- Back to dark grey shale and laminate
- Fine to medium-grained quartz-lithic sandstone
- Man-made fill (dredged estuarine sand and mud, demolition rubble, industrial and household waste) overlying silty to peaty quartz sand, silt and clay with ferruginous & humic cementation in places and common shell layers
- Man-made fill and miocene estuarine deposit
- Man-made fill. Dredged estuarine sand and mud, demolition rubble, industrial and household waste
- Medium to coarse grained quartz sandstone, very minor shale and laminate lenses
- Shale, carbonaceous claystone, laminate, fine to medium-grained lithic sandstone, rare coal
- Silty to peaty quartz sand, silt, and clay, ferruginous and humic cementation in places. Common shell layers
Figure 10.6 | Soil landscapes
Figure 10.7 | Existing Acid sulfate soils
10.6.1.4 Soil salinity

Surface water and groundwater can dissolve and mobilise salts and cause their accumulation in other areas. Excessive concentrations of salts in such areas can affect plant growth, soil chemistry and cause weakening and degradation of construction materials such as masonry, concrete and bitumen. The assessment of salinity potential along the alignment was carried out using the map of the salinity potential in western Sydney (NSW Department of Infrastructure, Planning and Natural Resources 2002) which identified that a majority of the alignment occurs in areas of moderate salinity potential.

10.6.2 Impacts during construction

10.6.2.1 Geology and soil landscapes

Construction of the project would expose the natural ground surface and sub-surface through the removal of vegetation, overlying structures (such as buildings, roadways and footpaths) and excavation of disturbance footprint for stops, structures and foundations. As a substantial proportion of the project would be constructed in existing roadways, man-made fill is likely to be encountered. Material encountered within existing roadways during construction is likely to be more stable than fill in the area adjacent to the roadways. This is due to road fill material which is likely to have been selected, graded, and compacted to a standard suitable for road construction.

Outside of existing roadways, the identified geology and soils landscapes along remaining sections of the alignment indicate that some of the exposed soil zones are likely to be highly erodible when exposed. Impacts associated with soil erosion include 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. In addition, the disturbance of soils would also have potential impacts on reduced air quality due to dust generation from loose soils. Measures proposed to manage these impacts are discussed in section 10.4 (Hydrology, drainage and water quality) and section 10.8 (Air quality).

Earthworks and bank excavations, such as those required along the alignment between Camellia and Carlingford would be required along the rail corridor to accommodate the project and the active transport link. These works could cause the rail corridor embankments to become unstable. During detailed design, further geotechnical investigations would be carried out to determine the extent of earthworks, excavations and piling required. Embankment stabilisation treatments would then be determined to mitigate impacts.

Piling works would also be required to construct a number of new and modified bridge structures along the project alignment, requiring various foundation works and support structures. These works could impact on the underlying geology. In particular, impacts on groundwater and the water table might occur where these works are carried out near the Parramatta River, given its tidal nature. Management and mitigation measures to minimise impacts would be determined during detailed design.

Given the relatively small areas of surface disturbance anticipated during construction and the overall topography (generally slightly undulating), soil erosion would be adequately managed with standard management measures (refer to section 10.6.4).

10.6.2.2 Acid sulfate soils

Given the likelihood of encountering acid sulfate soils during construction, a range of management measures would be implemented throughout construction to identify, contain and monitor acid sulfate soils (if encountered) (refer to section 10.6.4).
10.6.3 Impacts during operation

Potential operational impacts on existing geology and soils across the project alignment would be limited. Some minor erosion may occur during the operation of the project due to increased runoff from new hard surfaces, namely in areas where the project is not within existing roadways or other hard stand areas (such as through existing parks or reserves, or where the active transport link is proposed to be located adjacent to the existing rail corridor) or as a result of the presence of exposed surfaces (such as new embankments).

Operation of the project also has the potential to result in contamination of soils and/or groundwater due to spills and leaks of fuel, oils and other hazardous materials from the LRVs, maintenance vehicles and other light rail infrastructure. Potential contamination impacts are described in greater detail in section 10.7 (Contamination). These impacts would be managed through site operational procedures (refer to section 10.7.4).

10.6.4 Management and mitigation

The management and mitigation measures that would be implemented to address potential geology and soil impacts during detailed design are listed in Table 10.24.

<table>
<thead>
<tr>
<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SG-1</td>
<td>A geotechnical investigation would be carried out to guide the detailed design and construction of the project.</td>
<td>All precincts</td>
</tr>
<tr>
<td>SG-2</td>
<td>Detailed design would consider the potential impacts on elements that are buried or in contact with identified ASS and determine management and mitigation measures for minimising impacts.</td>
<td>All precincts</td>
</tr>
</tbody>
</table>

The management and mitigation measures that would be implemented to address potential geology and soil impacts during construction are listed in Table 10.25.

<table>
<thead>
<tr>
<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SG-3</td>
<td>To manage potential impacts to geology and soils standard management measures would be implemented during construction, including (but not limited to):</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Erosion and sediment control plans would be prepared for each worksite in accordance with Volume 2D of Managing Urban Stormwater: Soils and Construction (Landcom, 2004). Due to the potential high erosivity of soils along the alignment, the erosion and sediment control plans would be established prior to the commencement of construction and be updated and managed throughout as relevant to the activities during construction.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Stabilised surfaces would be reinstated as quickly as practicable after construction.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» All stockpiled materials would be stored in bunded areas and kept away from waterways to avoid sediment entering the waterways.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Sediment would be prevented from moving off-site and sediment laden water prevented from entering any watercourse, drainage line or drainage inlet.</td>
<td>All precincts</td>
</tr>
</tbody>
</table>
Other regional environmental impacts

**Other regional environmental impacts**

### Parramatta Light Rail | Stage 1 – Westmead to Carlingford via Camellia

**Environmental Impact Statement**

#### REF: Mitigation Measure

- **Clean water would be diverted around the work site in accordance with Managing Urban Stormwater: Soils and Construction (Landcom, 2004).**
- **Erosion and sediment control measures would be regularly inspected (particularly following rainfall events) to ensure their ongoing functionality.**
- **Erosion and sediment control measures would be left in place until the works are complete and areas are stabilised.**

**SG-4** The presence of ASS along the project alignment would be confirmed through intrusive testing of soils in areas conducive to environments where ASS is likely to occur. Should ASS be identified during intrusive investigations at any section along the project, an ASS management plan would be required for construction of the project in these areas. The ASS management plan should outline procedures for the safe handling, treatment and transport of potential/actual acid sulfate soils excavated during construction or maintenance works and identify management measures, including:
  - **Excavation procedures**
  - **Spoil storage and treatment**
  - **Dewatering and groundwater management**
  - **Bunding and measures to protect surrounding areas and waterways from the potential risk of acid contamination.**

The objective of the ASS management plan would be to comply with all statutory requirements and implement all environmental controls to minimise and manage impacts on the environment from the disturbance of potential or actual ASS.

**All precincts**

The management and mitigation measures that would be implemented to address potential geology and soil impacts during operation are listed in Table 10.26.

**Table 10.26 Management and mitigation measures – geology and soil impacts (operation)**

<table>
<thead>
<tr>
<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SG-5</td>
<td>Should ASS be identified during intrusive investigations, an ASS management plans would be required for future maintenance works in these areas.</td>
<td>All precincts</td>
</tr>
<tr>
<td>SG-6</td>
<td>Embankments stabilisation treatments would require maintenance during the operation phase of the project to ensure functionality.</td>
<td>All precincts</td>
</tr>
</tbody>
</table>
10.7 Contamination

This section summarises the potential sources of contamination within and adjacent to the alignment, and the potential contamination risks to the project. This assessment comprised a desk-based search of relevant databases and historical records, a series of site inspections during April 2017 to assess the potential areas of concern, and consideration of the potential impacts on the project. Further details are provided in the Contaminated Land Assessment (Technical Paper 8, Volume 4).

10.7.1 Existing environment

10.7.1.1 Desktop searches

A search of the NSW Environment Protection Authority (EPA) record of notices under section 58 of the Contaminated Land Management Act 1997 (CLM Act) and notifications under section 60 of the CLM Act was carried out in April 2017. The search identified a total of 13 registered sites within 500 metres of the project that were either regulated or had been notified to the NSW EPA, as shown in Table 10.27. This includes three properties within the project disturbance footprint.

All properties are located outside of the disturbance footprint with the exception of the service station at Church Street, Parramatta, the Former James Hardie Factory at James Ruse Drive/Grand Avenue, Rosehill, and the Sandown Railway Line.

**Table 10.27 List of notified sites within 500 metres of the project**

<table>
<thead>
<tr>
<th>SITE NAME</th>
<th>SITE ADDRESS</th>
<th>NOTIFIED ACTIVITY</th>
<th>SITE STATUS</th>
<th>LOCATION IN RELATION TO THE PROJECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coleman Oval Embankment</td>
<td>Corner of Pitt Street and Macquarie Street, Parramatta</td>
<td>Unclassified</td>
<td>Regulation not required</td>
<td>Adjacent to the off-corridor area at Park Avenue, Westmead (Westmead precinct).</td>
</tr>
<tr>
<td>BP Service Station</td>
<td>435 Church Street, Parramatta</td>
<td>Service station</td>
<td>Under assessment</td>
<td>Within the project disturbance footprint (Fennel Street compound in the Parramatta North precinct).</td>
</tr>
<tr>
<td>Former James Hardie Factory (former, western portion)</td>
<td>181 James Ruse Drive, Rosehill</td>
<td>Other industry (vacant land)</td>
<td>Regulated under CLM Act</td>
<td>Within the project disturbance footprint (Paramatta River Bridge (South) compound in the Rosehill and Camellia precinct).</td>
</tr>
<tr>
<td>Former James Hardie Factory (former, eastern portion)</td>
<td>1 Grand Avenue, Camellia</td>
<td>Other Industry (vacant land)</td>
<td>Regulated under CLM Act</td>
<td>Within the project disturbance footprint (alignment and the Paramatta River Bridge (South) compound in the Rosehill and Camellia precinct).</td>
</tr>
<tr>
<td>Council Reserve</td>
<td>11B Grand Avenue, Camellia</td>
<td>Metal industry</td>
<td>Regulation not required</td>
<td>Adjacent to project disturbance footprint (the project alignment within the Rosehill and Camellia precinct).</td>
</tr>
</tbody>
</table>
Other regional environmental impacts

<table>
<thead>
<tr>
<th>SITE NAME</th>
<th>SITE ADDRESS</th>
<th>NOTIFIED ACTIVITY</th>
<th>SITE STATUS</th>
<th>LOCATION IN RELATION TO THE PROJECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wrigg</td>
<td>13 Grand Avenue, Camellia</td>
<td>Metal industry</td>
<td>Under assessment</td>
<td>Adjacent to project disturbance footprint (the project alignment within the Rosehill and Camellia precinct).</td>
</tr>
<tr>
<td>Maurie Foods</td>
<td>15 Grand Avenue, Camellia</td>
<td>Other industry</td>
<td>Regulation being finalised</td>
<td>Adjacent to project disturbance footprint (the project alignment within the Rosehill and Camellia precinct).</td>
</tr>
<tr>
<td>Railway Land (Sandown Line)</td>
<td>27 Grand Avenue, Camellia</td>
<td>Other industry</td>
<td>Regulation not required</td>
<td>Within the project disturbance footprint (the Sandown line within the Rosehill and Camellia precinct).</td>
</tr>
<tr>
<td>Former Akzo Nobel site</td>
<td>6 Grand Avenue, Camellia</td>
<td>Chemical industry</td>
<td>Regulated under CLM Act</td>
<td>Within the project disturbance footprint (the stabling and maintenance facility in the Rosehill and Camellia precinct).</td>
</tr>
<tr>
<td>James Hardie</td>
<td>Devon Street, Rosehill</td>
<td>Other industry</td>
<td>Regulated under CLM Act</td>
<td>Adjacent to the project disturbance footprint (adjacent to the stabling and maintenance facility in the Rosehill and Camellia precinct).</td>
</tr>
<tr>
<td>Rheem Australia</td>
<td>1 Alan Street, Rosehill</td>
<td>Other industry</td>
<td>Formerly regulated under CLM Act</td>
<td>Approximately 200 metres to the east of the project disturbance footprint in the Carlingford precinct.</td>
</tr>
<tr>
<td>BP Service Station</td>
<td>265 Victoria Road, Rydalmere</td>
<td>Service station</td>
<td>Under assessment</td>
<td>Approximately 350 metres to the east of the project disturbance footprint in the Carlingford precinct.</td>
</tr>
<tr>
<td>Former Service Station</td>
<td>262–272 Victoria Road, Rydalmere</td>
<td>Service station</td>
<td>Under assessment</td>
<td>Approximately 350 metres east of the project disturbance footprint in Carlingford precinct.</td>
</tr>
</tbody>
</table>

A search of the NSW EPA registered Environment Protection Licences (EPL), applications, notices, audits or pollution studies and reduction programs, under section 308 of the Protection of the Environment Operation Act 1997 (POEO Act) was carried out in April 2017 which identified the following:

» No EPLs were identified in relation to land within the construction boundary.

» One property located adjacent to the Rosehill and Camellia precinct, with an EPL for contaminated soil treatment within the former James Hardie factory site at 181 James Ruse Drive, Rosehill (EPL licence number 20687).
Other regional environmental impacts

Two properties located adjacent to the Rosehill and Camellia precinct, adjacent to the stabling and maintenance facility, with EPLs for the following:

- Concrete works at the CSR Building Products site located at 10 Grand Avenue, Rosehill (EPL licence number 2007).
- Cement and lime handling, concrete works, crushing, grinding and separating at the James Hardie site located at 10 Colquhoun Street, Rosehill (EPL licence number 602).

One property within an approximate 500 metre radius of the project operated by Rheem Australia Pty Limited for metal processing at 55 Brodie Street, Rydalmere (EPL licence number 6990).

A search of NSW EPA List of Former Gasworks was carried out in April 2017, which indicated that the Parramatta Gasworks was historically located in Parramatta on George Street. Discussions with the City of Parramatta Council revealed that the gasworks was located at the southern end of Gas Works Bridge (MacArthur Street) and included a portion of Queen’s Wharf Reserve on the southern bank of the Parramatta River. Queen’s Wharf Reserve is partially located within the Parramatta CBD precinct within the project boundary. The extent of the former gas works is unknown.

A search of the Geoscience Australia National Waste Management Database indicated that there are no known landfills, waste transfer stations or waste processing facilities within 500 metres of the project. However, it is noted that Development Approval was granted in July 2016 for a resource recovery facility proposed to the south of the Parramatta River at the eastern end of Grand Avenue within the Rosehill and Camellia precinct. This site is located approximately 900 metres east of the location of the stabling and maintenance facility.

10.7.1.2 Historical aerial photographs

Historical aerial photographs from the NSW Land and Property Management Authority (Land and Property Information Division) were reviewed for the years 1955, 1970 and 1994. A Google maps aerial image was also reviewed for the year 2005 (refer to the Contaminated Land Assessment). The photographs show that:

- Since the 1950s, the Westmead precinct has changed from predominantly low density residential land use to commercial and industrial uses.
- Development has also occurred within the Westmead precinct in relation to construction of the Westmead Hospital in the 1990s.
- Since the 1950s, the Paramatta North precinct has increasingly changed from predominantly low density residential land use to commercial and industrial uses, as well as demolition of some buildings in the Cumberland Hospital site.
- Some taller commercial and residential buildings have been constructed in the Paramatta CBD precinct over the years.
- Between the 1950s and 1990s, further industrial development has occurred within the Camellia precinct, in particular along Grand Avenue and in the central portion of the Rosehill and Camellia precinct. This includes the development of the refinery site in the southern and south-western portions of Camellia.
- The mangrove/swamp area at the western end of Camellia has been cleared over the years.
- Since the 1950s, significant industrial warehouses have been developed in the Rydalmere area within the Carlingford precinct. Residential developments have also occurred to the north of Rydalmere between the 1970s and 1990s.

10.7.1.3 Other studies and reports

The NSW Department of Planning and Environment (DP&E) published the Camellia Precinct Land Use and Infrastructure Analysis (NSW Department of Planning and Environment 2015), which
includes a high level contamination review of the Camellia industrial area, including land within and adjacent to the Rosehill and Camellia precinct. The report identified localised soil and groundwater contamination associated with the history of industrial activities within the area, with a range of contaminants identified including asbestos, hexavalent chromium, petroleum hydrocarbons, chlorinated hydrocarbons and arsenic. The report also identified the potential for more widespread contamination to be present across the precinct, including asbestos and hexavalent chromium. The majority of the area assessed as part of the report is identified as having a medium to high risk of being contaminated.

City of Parramatta Council (2015) released a discussion paper, *Camellia 21st Century Business, Industry & Entertainment Precinct*, which also identified significant contamination within the Camellia area associated with industrial uses as well as poor historic site management practices. Substantial filling of the area is also believed to have occurred but is largely undocumented. This fill material is known to include asbestos waste and chrome ore processing waste. A number of sites on the Camellia peninsula have been subject to remediation or investigation notices by the NSW EPA. A Contamination Information Sheet published by Veolia for 37 Grand Avenue, Camellia, confirmed the presence of elevated levels of hexavalent chromium in groundwater and soil across the Camellia peninsula where contaminated material was used as fill. The NSW EPA (2012) published a summary project report, *Regulation Project – James Hardie Asbestos Waste Contamination Legacy*, which presented a summary of asbestos impacted sites resulting from former operations of James Hardie Industries and related entities (James Hardie).

The location of the asbestos impacted sites inspected by the NSW EPA identified the following sites within 500 metres of the disturbance footprint for the project:

- Cumberland Oval (Parramatta Stadium) within the Parramatta North precinct
- Catt & Goldsmith Pty Ltd within the Parramatta North precinct
- Rosehill Bowling Club, located within the Rosehill and Camellia precinct
- Eastern side of Oatlands Golf Course within the Carlingford precinct.

A review of a number of Sydney Trains reports was also carried out, which identified a number of contamination sources associated with Sydney Trains areas of operation within and adjacent to the project as follows:

- Asbestos impacted soils (friable and non-friable asbestos) associated with the Sandown Line rail corridor and proposed alignment adjacent Grand Avenue within the Rosehill and Camellia precinct.
- Hydrocarbon impacted soil at the Rydalmere Station compound (east), within the Carlingford precinct.
- Suspected fragments of non-friable asbestos-containing material (ACM) at the Rydalmere Station compound (west), within the Carlingford precinct.
- Trace organochlorine compounds and metal impacted soil adjacent to the Carlingford compound within the Carlingford precinct.

The Site Wide Remedial Concept Plan, *Parramatta North Urban Transformation Area* (JBS&G 2016), prepared on behalf of UrbanGrowth NSW, included a review of previous environmental site assessments which identified areas of potential environmental concern. Key findings, as relevant to the project alignment in the Parramatta North Urban Transformation precinct are:

- Historical use of western sections of the development site for agricultural/market garden use (e.g. application of chemicals for pest control, weed control etc.).
- Former fuel storage and dispensing facilities (diesel, unleaded petrol) adjacent to the former Transport Department.
- Former vehicle and plant maintenance activities associated with the former Transport Department and the Artisans Workshops areas, including dangerous goods storage.
10.7.2 Impacts during construction

10.7.2.1 Potential to cause contamination

Construction activities have the potential to result in contamination of soils and/or groundwater due to spills and leaks of fuel, oils and other hazardous chemicals, particular in relation to their use and storage within compound sites. These impacts would be readily managed through the implementation of relevant mitigation measures as outlined in section 10.13 (Hazards and risks).

The demolition of buildings and structures also has the potential to result in the disturbance of hazardous building materials, including asbestos. Mishandling of hazardous material waste has the potential to contaminate soils and to create health risks. These potential risks would be managed through the implementation of appropriate management measures as outlined in section 10.12 (Waste, energy and resource management) and section 10.13.

Reuse of materials for fill or other suitable purposes along the alignment would be subject to appropriate testing in accordance with the relevant guidelines prior to their use, to avoid potential cross-contamination of soils. Where materials are deemed unsuitable for reuse, or where there is a surplus of reusable material (e.g. fill), this would need to be managed in accordance with the relevant waste management measures as detailed in section 10.12.

10.7.2.2 Management of pre-existing contamination

Based on a review of background information, there is potential for contamination to be encountered at a number of locations throughout the construction project footprint. In general, the contamination sources include:

- Land reclamation and other uncontrolled fill material (contaminants may include metals, hydrocarbons, pesticides and asbestos).
- Former and current industrial land uses (contaminants may include hydrocarbons, heavy metals, polychlorinated biphenyl (PCBs) and phenolics).
- Demolition of buildings (contaminants may include asbestos).
- Historical railway activities (contaminants may include heavy metals, hydrocarbons, herbicides, phenols and asbestos).
- Leaks and spills from fuel storage infrastructure (contaminants may include hydrocarbons and heavy metals).

Exposure or disturbance of contaminants during construction may have the following impacts:

- Mobilisation of contaminants with the potential to impact groundwater, surface water or soils.
- Migration of contaminants into surrounding areas via leaching, overland flow and/or subsurface flow (water and/or vapour) with the potential to impact on flora, fauna or groundwater dependent ecosystems.
- Risk of exposure to contaminants by site workers or site users.

Table 10.28 identifies each Area of Environmental Interest (AEI) based on the desk-based search of relevant databases and historical records. The table lists the contaminants of potential concern (CoPC), the environmental media which may be affected, the location of the AEI relative to the alignment, and the likelihood of contamination being present in the construction project footprint. The AEIs are also shown in Figure 10.8.
This information has been evaluated to identify the consequence of encountering any contamination, based on the extent of disturbance required during construction. The following aspects were considered when assessing the potential for contamination to pose a risk due to project activities:

» The proximity of potential contamination to the disturbance footprint.

» The primary environmental media that are likely to be contaminated (i.e. soils, groundwater, surface water).

» The extent of excavation and construction activities that are likely to take place for the project, and whether these could result in interaction with potentially contaminated media.

» Potential exposure pathways to contaminants during construction and operation (inhalation, dermal contact, ingestion).

The identified AEIs and associated qualitative risk ratings are summarised in Table 10.28. Mitigation and management measures to be adopted during detailed design, during construction, and during operation of the project are outlined in Table 10.29.

For some AEIs identified as medium risk, the assessment identified a need for further information to be obtained and reviewed in order to determine the most appropriate site-specific controls. These requirements have been captured as specific actions within in Table 10.29.
Other regional environmental impacts

Figure 10.8 Areas of environmental concern
### Table 10.28 Areas of environmental concern

<table>
<thead>
<tr>
<th>REF NO.</th>
<th>AEC ISSUES</th>
<th>COPC</th>
<th>LOCATION</th>
<th>RISK</th>
<th>APPLICABLE PRECINCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fill along existing roadways, road reserves and properties</td>
<td>Historical uncontrolled fill, potentially containing asbestos. Potential utility structures made of asbestos.</td>
<td>Asbestos</td>
<td>Within disturbance footprint</td>
<td>Medium</td>
</tr>
<tr>
<td>2</td>
<td>Fill within river banks adjacent to Parramatta River</td>
<td>Potential for Parramatta River banks to contain uncontrolled fill.</td>
<td>TRH, BTEX, PAH, OCP, OPP, PCB and asbestos</td>
<td>Within disturbance footprint</td>
<td>Medium</td>
</tr>
<tr>
<td>3</td>
<td>Westmead Hospital NSW</td>
<td>Potential contamination from current and use and fill material of unknown origin.</td>
<td>TRH, BTEX, PAH, metals, asbestos</td>
<td>Within disturbance footprint</td>
<td>Medium</td>
</tr>
<tr>
<td>4</td>
<td>The Children's Hospital at Westmead</td>
<td>Potential contamination from current land use and fill material of unknown origin.</td>
<td>TRH, BTEX, PAH and metals</td>
<td>Within disturbance footprint</td>
<td>Medium</td>
</tr>
<tr>
<td>5</td>
<td>Coleman Oval Embankment</td>
<td>Listed on the NSW EPA List of Notified Sites, though EPA considered that the contamination does not require regulation.</td>
<td>Unknown</td>
<td>Outside disturbance footprint</td>
<td>Low</td>
</tr>
<tr>
<td>6</td>
<td>Potentially contaminated sediments in Parramatta River</td>
<td>Migration and accumulation of potentially contaminated sediment from erosion and surface runoff during bridge works. Contamination, if present, may mobilise into the Parramatta River if sediments are disturbed.</td>
<td>Metals, TRH and PAH</td>
<td>Minor or no excavation activities</td>
<td>Low</td>
</tr>
<tr>
<td>7</td>
<td>Parramatta North Urban Transformation Area</td>
<td>Potential for contamination due to historical market gardens, former fuel storage and dispensing facilities, and former vehicle and plant maintenance activities.</td>
<td>TRH, heavy metals, VOCs/ SVOCs OCPs and herbicides</td>
<td>Within disturbance footprint</td>
<td>Medium</td>
</tr>
<tr>
<td>REF NO.</td>
<td>AEC</td>
<td>ISSUES</td>
<td>COPC</td>
<td>LOCATION</td>
<td>RISK</td>
</tr>
<tr>
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</tr>
<tr>
<td>8</td>
<td>St Patrick’s Cemetery (1 Pennant Hills Road, North Parramatta)</td>
<td>The potential for contamination associated with imported uncontrolled fill, leaching of toxic chemicals from coffins and use of pesticides, fertilizers, and use of pesticides.</td>
<td>TRH, BTEX, metals, PAH, OCP, OPP, herbicides, PCB and Formaldehyde</td>
<td>Partially within disturbance footprint</td>
<td>Medium</td>
</tr>
<tr>
<td>9</td>
<td>435 Church Street, Parramatta</td>
<td>Potential petroleum hydrocarbon impacts at this site due to use as a service station. A service station listed on the NSW EPA List of Notified Sites with status of contamination ‘under assessment’.</td>
<td>TRH, BTEX, PAH and lead</td>
<td>Within disturbance footprint</td>
<td>Medium</td>
</tr>
<tr>
<td>10</td>
<td>Victoria Road and Church Street intersection</td>
<td>Asbestos waste from James Hardie site.</td>
<td>Asbestos</td>
<td>Within disturbance footprint</td>
<td>Medium</td>
</tr>
<tr>
<td>11</td>
<td>Victoria Road and O’Connell Street intersection</td>
<td>Asbestos waste from James Hardie site.</td>
<td>Asbestos</td>
<td>Outside disturbance footprint</td>
<td>Low</td>
</tr>
<tr>
<td>12</td>
<td>88 Victoria Road, North Parramatta</td>
<td>Potential contamination from service station. Likely limited to groundwater impacts.</td>
<td>TRH, BTEX, PAH, lead</td>
<td>Well outside disturbance footprint</td>
<td>Low</td>
</tr>
<tr>
<td>13</td>
<td>1A Barrack Lane, Parramatta</td>
<td>Potential contamination associated with its former use as a substation and potential for imported uncontrolled fill. Substation has been decommissioned by Endeavour Energy.</td>
<td>TRH, BTEX, PAH, PCBs, metals and asbestos</td>
<td>Within disturbance footprint</td>
<td>Medium</td>
</tr>
<tr>
<td>14</td>
<td>142-154 Macquarie Street, Parramatta</td>
<td>Potential for contamination due to past historical land uses. The site is currently under redevelopment.</td>
<td>VOCs’sVOCs, TRH, BTEX, PAH and metals</td>
<td>Partially within disturbance footprint</td>
<td>Medium</td>
</tr>
</tbody>
</table>
### Other regional environmental impacts

<table>
<thead>
<tr>
<th>REF NO.</th>
<th>AEC</th>
<th>ISSUES</th>
<th>COPC</th>
<th>LOCATION</th>
<th>RISK</th>
<th>APPLICABLE PRECINCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td></td>
<td>Potential for contamination, if waste materials were left on site, or used as fill at the former gas works site, and if remediation was not carried out.</td>
<td>TRH, BTEX, PAHs, metals, VOCs, phenols, asbestos</td>
<td>Within disturbance footprint</td>
<td>High</td>
<td>Parramatta CBD</td>
</tr>
<tr>
<td>16</td>
<td>15</td>
<td>The property is used as an automotive workshop and service station.</td>
<td>TRH, BTEX, PAH, metals, phenols and VOCs</td>
<td>Partially within disturbance footprint</td>
<td>Medium</td>
<td>Rosehill and Camellia</td>
</tr>
<tr>
<td>17</td>
<td>16</td>
<td>The property is used for several automotive workshops.</td>
<td>TRH, BTEX, PAH, metals, phenols and VOCs</td>
<td>Adjacent to disturbance footprint</td>
<td>Medium</td>
<td>Rosehill and Camellia</td>
</tr>
<tr>
<td>18</td>
<td>17</td>
<td>The property is used as an automotive workshop.</td>
<td>TRH, BTEX, PAH, metals, phenols and VOCs</td>
<td>Adjacent to disturbance footprint</td>
<td>Medium</td>
<td>Rosehill and Camellia</td>
</tr>
<tr>
<td>19</td>
<td>18</td>
<td>Asbestos waste from James Hardie site.</td>
<td>Asbestos</td>
<td>Adjacent to disturbance footprint</td>
<td>Low</td>
<td>Rosehill and Camellia</td>
</tr>
<tr>
<td>20</td>
<td>19</td>
<td>The property is used as a service station.</td>
<td>TRH, BTEX, PAH, lead</td>
<td>Adjacent to disturbance footprint</td>
<td>Medium</td>
<td>Rosehill and Camellia</td>
</tr>
<tr>
<td>21</td>
<td>20</td>
<td>The former James Hardie Factory site, which was historically used for the manufacture of building products using asbestos, exists on either side of the existing T6 Carlingford Line. It is regulated by NSW EPA under the CLM Act.</td>
<td>Asbestos and arsenic in soil, Zinc, phenol and PAH in groundwater</td>
<td>Within disturbance footprint</td>
<td>Medium</td>
<td>Rosehill and Camellia</td>
</tr>
</tbody>
</table>
### Other Regional Environmental Impacts

<table>
<thead>
<tr>
<th>REF NO.</th>
<th>AEC</th>
<th>ISSUES</th>
<th>COPC</th>
<th>LOCATION</th>
<th>RISK</th>
<th>APPLICABLE PRECINCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>Existing rail corridor - Sandown Line, including 27 Grand Avenue, Camellia</td>
<td>Presence of capped non-friable and friable asbestos impacted soils within the rail corridor along the Sandown Line.</td>
<td>Asbestos</td>
<td>Within disturbance footprint</td>
<td>High</td>
<td>Rosehill and Camellia</td>
</tr>
<tr>
<td>24</td>
<td>Existing rail corridor - T6 Carlingford Line - Camellia to Parramatta Road</td>
<td>Potential for contamination due to fill materials associated with railway use.</td>
<td>Metals, TRH, BTEX, OCP, OPP, asbestos</td>
<td>Within disturbance footprint</td>
<td>Medium</td>
<td>Rosehill and Camellia</td>
</tr>
<tr>
<td>25</td>
<td>11B Grand Avenue, Rosehill</td>
<td>The property is used for metal processing and has been notified to the NSW EPA, however contamination was not significant enough to warrant regulation.</td>
<td>TRH, BTEX, VOCs, metals, asbestos</td>
<td>Outside disturbance footprint</td>
<td>Low</td>
<td>Rosehill and Camellia</td>
</tr>
<tr>
<td>26</td>
<td>13A Grand Avenue, Rosehill</td>
<td>Property was used as a scrap yard and land is likely to have been reclaimed by filling. Potential for chrome ore processing residue.</td>
<td>TRH, BTEX, PAH, metals, VOCs, phenols, metals VOCs, and asbestos</td>
<td>Within disturbance footprint</td>
<td>High</td>
<td>Rosehill and Camellia</td>
</tr>
<tr>
<td>27</td>
<td>6 Grand Avenue, Rosehill (former Akzo Nobel site)</td>
<td>This site is currently notified under the CLM Act. Soils and groundwater at the site are known to contain hexavalent chromium, volatile chlorinated hydrocarbons (VCHs) and asbestos due to historical industrial activities. The site would be remediated (subsurface) to a commercial/industrial land use under NSW EPA audit scheme prior to the commencement of construction of the stabling and maintenance facility (under a separate planning approval process).</td>
<td>TRH, BTEX, PAH, metals (including hexavalent chromium), VOCs and asbestos</td>
<td>Within disturbance footprint</td>
<td>Medium</td>
<td>Rosehill and Camellia</td>
</tr>
</tbody>
</table>
### Other regional environmental impacts

<table>
<thead>
<tr>
<th>REF NO.</th>
<th>AEC</th>
<th>ISSUES</th>
<th>COPC</th>
<th>LOCATION</th>
<th>RISK</th>
<th>APPLICABLE PRECINCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>28-29</td>
<td>13 and 15 Grand Avenue, Rosehill</td>
<td>Both properties are on the list of contaminated sites notified to the NSW EPA, and are either under assessment (13 Grand Avenue) or listed as regulation being finalised in the case of 15 Grand Avenue. These properties are likely to have been reclaimed by filling over the alluvial deposits. There is the potential for chromium impact on exist associated with chrome ore processing residue in fill at these properties.</td>
<td>Metals (including hexavalent chromium), TRH, BTEX, PAH and VOCs</td>
<td>Partially within disturbance footprint</td>
<td>Medium</td>
<td>Rosehill and Camellia</td>
</tr>
<tr>
<td>30</td>
<td>33A Grand Avenue, Rosehill</td>
<td>The property is used for metal processing and has been notified to the NSW EPA, however contamination was not significant enough to warrant regulation.</td>
<td>TRH, BTEX, VOCs, metals, asbestos</td>
<td>Adjacent to disturbance footprint</td>
<td>Low</td>
<td>Rosehill and Camellia</td>
</tr>
<tr>
<td>31</td>
<td>14 Thackeray Street, Rosehill</td>
<td>The property is used for metal processing and has been notified to the NSW EPA, however contamination was not significant enough to warrant regulation.</td>
<td>TRH, BTEX, VOCs, metals, asbestos</td>
<td>Well outside disturbance footprint</td>
<td>Low</td>
<td>Rosehill and Camellia</td>
</tr>
<tr>
<td>32</td>
<td>37 Grand Avenue, Rosehill</td>
<td>The property is used for metal processing and has been notified to the NSW EPA, however contamination was not significant enough to warrant regulation.</td>
<td>Hexavalent chromium and asbestos</td>
<td>Well outside disturbance footprint</td>
<td>Low</td>
<td>Rosehill and Camellia</td>
</tr>
<tr>
<td>33</td>
<td>39 Grand Avenue, Rosehill</td>
<td>Groundwater and stormwater contamination are currently regulated by the NSW EPA.</td>
<td>Hexavalent chromium and asbestos</td>
<td>Well outside disturbance footprint</td>
<td>Low</td>
<td>Rosehill and Camellia</td>
</tr>
<tr>
<td>34</td>
<td>12 Grand Avenue, Rosehill</td>
<td>Contamination is currently regulated by the NSW EPA.</td>
<td>TRH, BTEX, PAHs, metals, asbestos</td>
<td>Well outside disturbance footprint</td>
<td>Low</td>
<td>Rosehill and Camellia</td>
</tr>
<tr>
<td>REF NO.</td>
<td>AEC</td>
<td>ISSUES</td>
<td>COPC</td>
<td>LOCATION</td>
<td>RISK</td>
<td>APPLICABLE PRECINCT</td>
</tr>
<tr>
<td>--------</td>
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</tr>
<tr>
<td>35</td>
<td>10 Colquhoun Street, Rosehill</td>
<td>The property is listed on the NSW EPA List of Notified Sites. Contamination comprising buried asbestos waste is currently regulated by the NSW EPA under the CLM Act.</td>
<td>Asbestos</td>
<td>Outside disturbance footprint</td>
<td>Low</td>
<td>Rosehill and Camellia</td>
</tr>
<tr>
<td>36</td>
<td>Former Shell Clyde Refinery</td>
<td>The property is listed on the NSW EPA List of Notified Sites. Contamination and is currently regulated under the POEO Act 1997. Contamination is likely limited to groundwater within the disturbance area.</td>
<td>Hexavalent chromium, TRH, BTEX, PAH, asbestos</td>
<td>Outside disturbance footprint</td>
<td>Low</td>
<td>Rosehill and Camellia</td>
</tr>
<tr>
<td>37</td>
<td>Acid Sulfate Soils/Sediments within the Parramatta River</td>
<td>Review of ASS Risk Mapping indicates there is a high probability of occurrence of ASS within sediments of the Parramatta River.</td>
<td>Acid sulfate soils</td>
<td>Outside disturbance footprint</td>
<td>Low</td>
<td>Rosehill and Camellia</td>
</tr>
<tr>
<td>38</td>
<td>Potentially contaminated sediments in the Parramatta River</td>
<td>Potential for sediments within the Parramatta River to be contaminated.</td>
<td>Nutrients, Metals, TRH and PAH</td>
<td>Outside disturbance footprint</td>
<td>Low</td>
<td>Rosehill and Camellia</td>
</tr>
<tr>
<td>39</td>
<td>Existing rail corridor – T6 Carlingford Line</td>
<td>Potential for contamination due to fill materials for rail formation. Any contamination (if present) is typically localised and superficial.</td>
<td>Metals, TRH, BTEX, phenols, OCP, OPP, herbicides and asbestos</td>
<td>Within disturbance footprint</td>
<td>Medium</td>
<td>Carlingford</td>
</tr>
<tr>
<td>40</td>
<td>1 Alan Street, Rydalmere</td>
<td>The property is listed on the NSW EPA List of Notified Sites as having contamination which is formerly regulated under the CLM Act.</td>
<td>TRH, BTEX, asbestos</td>
<td>Outside disturbance footprint</td>
<td>Low</td>
<td>Carlingford</td>
</tr>
<tr>
<td>41</td>
<td>2 Brodie Street, Rydalmere</td>
<td>Hydrocarbon impacted soil previously identified at the property associated with former use of the site as a truck and trailer yard. Potential for additional contamination due to current land use.</td>
<td>TRH, BTEX, PAH, metals, phenols and VOCs, asbestos</td>
<td>Outside disturbance footprint</td>
<td>Low</td>
<td>Carlingford</td>
</tr>
</tbody>
</table>
### Other regional environmental impacts

<table>
<thead>
<tr>
<th>REF NO.</th>
<th>AEC</th>
<th>ISSUES</th>
<th>COPC</th>
<th>LOCATION</th>
<th>RISK</th>
<th>APPLICABLE PRECINCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>42</td>
<td></td>
<td>Potential for uncontrolled fill within the banks of Vineyard Creek.</td>
<td>TRH, BTEX, PAH, OCP, OPP, PCB and asbestos</td>
<td>Within disturbance footprint</td>
<td>Medium</td>
<td>Carlingford</td>
</tr>
<tr>
<td>43</td>
<td>213</td>
<td>Suspected fragments of non-friable ACM identified on the ground surface and photographs indicate incineration of waste has occurred on open ground during redevelopment works.</td>
<td>TRH, BTEX, PAH, and asbestos</td>
<td>Adjacent to disturbance footprint</td>
<td>Low</td>
<td>Carlingford</td>
</tr>
<tr>
<td>44</td>
<td>265</td>
<td>The service stations are listed on the NSW EPA List of Notified Sites. The contamination status is listed as ‘under assessment’. Impacts are likely to be petroleum hydrocarbon based.</td>
<td>TRH, BTEX, PAH and lead</td>
<td>Well outside disturbance footprint</td>
<td>Low</td>
<td>Carlingford</td>
</tr>
<tr>
<td>46</td>
<td></td>
<td>Asbestos waste from James Hardie site.</td>
<td>Asbestos</td>
<td>Adjacent to disturbance footprint</td>
<td>Low</td>
<td>Carlingford</td>
</tr>
<tr>
<td>47</td>
<td>57</td>
<td>The property was used as a workshop and service station.</td>
<td>TRH, BTEX, PAH, metals, phenols, VOCs</td>
<td>Adjacent to disturbance footprint</td>
<td>Medium</td>
<td>Carlingford</td>
</tr>
</tbody>
</table>

**Former Producers Co-Op site, off Thalon Street, Carlingford**

Presence of trace organochlorine compounds and metal impacted soil have been identified previously. There are also reports of historical underground storage tanks (USTs which, if leaked, present potential petroleum hydrocarbons groundwater contamination risks.

<table>
<thead>
<tr>
<th>REF NO.</th>
<th>AEC</th>
<th>ISSUES</th>
<th>COPC</th>
<th>LOCATION</th>
<th>RISK</th>
<th>APPLICABLE PRECINCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
<td></td>
<td></td>
<td>TRH, BTEX, PAH and lead</td>
<td>Adjacent to disturbance footprint</td>
<td>Medium</td>
<td>Carlingford</td>
</tr>
</tbody>
</table>
10.7.3 Impacts during operation

Operational impacts on the environment resulting from contamination are anticipated to be restricted to those arising from accidental spills or leakage, primarily from activities at the stabling and maintenance facility within the Rosehill and Camellia precinct. These impacts would be readily managed through the implementation of relevant mitigation measures as outlined in section 10.13 (Hazards and risks).

10.7.4 Management and mitigation

Limited contamination investigations are currently underway along the alignment in conjunction with geotechnical investigations. Information and data collected from these investigations will assist in refining the requirements for more targeted investigation or remediation works, as described below.

Areas of the alignment identified as low risk would be managed through normal construction practices including soil and water management techniques as documented within the Construction Environmental Management Plan (CEMP).

Areas identified as medium risk would be managed in the same manner as low risk locations. Additionally, visual inspections would be performed during excavation activities to monitor for indicators of contamination such as the presence of fill materials, stained soils, odours or asbestos-containing materials (ACM). If suspected contamination is encountered, the materials would be subject to sampling and analysis in accordance with the processes within section 10.12 (Resource management and waste minimisation) to determine management requirements and suitability for reuse, recycling or remediation.

Areas identified as high risk would be subject to the controls above, and would have targeted site investigations performed prior to the commencement of construction. Investigations will be performed in accordance with the National Environment Protection (Assessment of Site Contamination) Measure 1999 (amended 2013) and relevant guidelines made or endorsed by NSW EPA. The targeted investigations may take the form of Tier 1, 2 or 3 assessments (as discussed in the Technical Paper No.8 – Contaminated Land Assessment) depending on the complexity of the issue and the availability of data already gathered through the early contamination investigations.

The outcomes of site assessments would be evaluated against trigger levels in relevant guidelines to determine the need, or otherwise, for remediation of contamination. Where remediation is required, the works will be performed in accordance with the hierarchy of preferred strategies in the NSW DECCW Guidelines for the NSW Site Auditor Scheme (DECCW 2006) including:

» On-site treatment of soil so that the contaminant is either destroyed or the associated hazard is reduced to an acceptable level.

» Off-site treatment of the soil so that the contaminant is either destroyed or the associated hazard is reduced to an acceptable level, after which the soil is returned to site.

» Removal of contaminated material to an approved site or facility, followed where necessary by replacement with clean fill.

» Consolidation and isolation of the soil on site by containment with a properly designed barrier.

The specific methodologies available for remediation are detailed within the Technical Paper No.8 – Contaminated Land Assessment.

The management and mitigation measures that would be implemented to address potential contamination impacts, in particular during detailed design are listed in Table 10.29.
### Table 10.29 Management and mitigation measures – contamination impacts (detailed design)

<table>
<thead>
<tr>
<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
</tr>
</thead>
</table>
| CM-1 | During detailed design, a desktop risk assessment would be carried out for the following Areas of Environmental Interest (AEI) to confirm high or medium risk of contamination:  
» 435 Church Street, Parramatta (AEI 9)  
» 1A Barrack Lane, Parramatta (AEI 13)  
» 142-154 Macquarie Street, Parramatta (AEI 14)  
» 127 Alfred Street Parramatta (AEI 16)  
» Former James Hardie Property at 181 James Ruse Drive, Rosehill and 1 Grand Avenue, Rosehill (AEI 21 and AEI 22)  
» 6 Grand Avenue, Rosehill (former Akzo Nobel site) (AEI 27).  
This would involve a review of available data, collaboration with stakeholders and consideration of the extent of disturbance by the project in the vicinity of the AEI.  
Based on the results of this assessment:  
» Mitigation measure CM-2 would apply to AEIs classified as high risk  
» Mitigation CM-4 would apply to AEIs classified as medium risk. | North Parramatta Parramatta CBD Rosehill and Camellia |

| CM-2 | Prior to the commencement of construction in the vicinity of these sites, site investigations would be carried out at the following high risk Area of Environmental Interest (AEI):  
» Former gas works at Queens Wharf Reserve (AEI 15)  
» 13A Grand Avenue, Camellia (AEI 21)  
The results from the site investigations would be assessed against criteria contained within the National Environment Protection (Assessment of Site Contamination) Measure 1999 (2013) to determine any need for remediation.  
Remediation works would be performed in accordance with the hierarchy of preferred strategies in the Guidelines for the NSW Site Auditor Scheme (DECCW 2006). Where practical, remediation works would be integrated with excavation and development works performed during construction. | Parramatta CBD Rosehill and Camellia |

The management and mitigation measures that would be implemented to address potential contamination impacts, in particular during construction are listed in Table 10.30.

### Table 10.30 Management and mitigation measures – contamination impacts (construction)

<table>
<thead>
<tr>
<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
</tr>
</thead>
</table>
| CM-3 | For low and medium risk sites, environmental management measures would be applied as detailed in a Construction Contaminated Land Management Plan (CCLMP), as a sub-plan to the Construction Environmental Management Plan (CEMP).  
The measures would be tailored to address any specific locations where contamination is identified through the current contaminated land investigations. This includes worker health and safety measures. | All precincts |
Other regional environmental impacts

<table>
<thead>
<tr>
<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM-4</td>
<td>Visual inspections and monitoring will be performed during excavation activities at medium risk Areas of Environmental Interest (AEIs) to identify potential indicators of contamination. If suspected contamination is encountered, the materials will be subject to sampling and analysis to determine management requirements and suitability for reuse, recycling or remediation.</td>
<td>All precincts</td>
</tr>
<tr>
<td>CM-5</td>
<td>Construction activities within AEI 23 (Sandown Line, including 27 Grand Avenue, Camellia) would be carried out under asbestos control and removal conditions by an appropriately licensed asbestos contractor.</td>
<td>Rosehill and Camellia</td>
</tr>
<tr>
<td>CM-6</td>
<td>An unexpected finds procedure would be developed and implemented as part of the project CCLMP, outlining a set of potential contamination issues which could be encountered, and detailing the corrective actions to be implemented.</td>
<td>All precincts</td>
</tr>
</tbody>
</table>

The management and mitigation measures that would be implemented to address potential contamination impacts, in particular during operation are listed in Table 10.31.

Table 10.31  Management and mitigation measures - contamination impacts (operation)

<table>
<thead>
<tr>
<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM-7</td>
<td>Ongoing management and monitoring measures would be implemented for any areas where minor, residual contamination remains following construction.</td>
<td>All precincts</td>
</tr>
</tbody>
</table>

10.8  Air quality

The following sections provide a summary of a desktop air quality assessment that was carried out for the project. The full assessment is provided in the Air Quality Impact Assessment (Technical Paper 9, Volume 4).

10.8.1  Existing environment

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

10.8.1.1  Local emission sources

A search of the Commonwealth Department of the Environment’s National Pollutant Inventory and a desktop review of land uses surrounding the project alignment identified a number of air pollution sources which are likely to influence local air quality.
These sources include:

- Commercial and industrial facilities at North Parramatta, Rosehill and Camellia that reported air emissions (under the National Pollutant Inventory reporting program). These facilities include:
  - A commercial laundry (at North Rocks).
  - Hot mix asphalt manufacturing (at Rosehill and Camellia).
  - Cement, lime, plaster and concrete product manufacturing (at Camellia and Rosehill).
  - Food product manufacturing (at Camellia and Emington).
  - Soft drink manufacturing (at Northmead).
  - Mineral, metal and chemical wholesaling (at Camellia).
  - Waste treatment, disposal storage and remediation services (at Camellia, Clyde, Silverwater and Rosehill).
  - Recycling (at Camellia).
  - Petroleum product storage (at Silverwater and Rosehill).
  - Manufacture of home and personal care products (at North Rocks).
- Vehicle exhaust emissions from the existing road network.
- Other light industrial activities.
- Commercial businesses, such as service stations and smash repairs.
- Domestic activities, such as wood-fired home heaters.
- Other construction projects.

Regional air quality can also be influenced by naturally occurring events such as bushfires and dust storms. The primary contributor to air pollutant levels in the vicinity of the project is expected to be emissions from motor vehicles along the road network.

Ambient concentrations of pollutants along the project alignment are expected to be primarily dependent on local and regional weather conditions and overall regional air quality.

### 10.8.1.2 Background air quality

The NSW OEH uses a standardised measurement known as the air quality index to characterise air quality at a location and compare it in relative terms with other locations throughout NSW.

The NSW OEH developed a metric known as the ‘air quality index’ to provide an indication of the overall air quality. The metric considers pollutant data measurements for ozone ($O_3$), nitrogen dioxide ($NO_2$), carbon monoxide ($CO$), sulphur dioxide ($SO_2$) and particulates (such as $PM_{10}$ and $PM_{2.5}$), as well as visibility against criteria presented in the Variation to the National Environment Protection (Ambient Air Quality) Measure and OEH standard for visibility. Air quality index values measured at the nearest NSW OEH ambient air quality monitoring stations at Chullora and Prospect were generally recorded to be ‘good’ with occasional days of ‘fair’ to ‘poor’ air quality or worse, usually driven by particulate matter concentrations. These conditions are considered to be representative of those around Parramatta.

### 10.8.1.3 Background concentrations

The primary pollutants of concern during construction and operation are $NO_2$, $CO$, particulate matter ($PM_{10}$, $PM_{2.5}$ being particulate matter with an equivalent diameter less than 10 microns and less than 2.5 microns respectively), $SO_2$, and volatile organic compounds (VOCs). A summary of the ambient concentrations of $PM_{10}$, $PM_{2.5}$, $NO_2$, $SO_2$ and $CO$ measured at the two reference stations (Chullora and Prospect) between 2013 and 2016 is shown below and taken from Table 4.5 of Technical Paper 9.
Considering the results of the measured ambient data, Table 10.32 outlines the key observations which can be made regarding the background concentrations for each key pollutant of interest.

**Table 10.32 Summary of ambient air quality and background concentrations**

<table>
<thead>
<tr>
<th>Pollutant Type</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulate matter (PM(_{10}))</td>
<td>100th percentile (maximum) 24 hour averaged PM(<em>{10}) background concentrations were found to exceed the criterion of 50 µg/m(^3) at both monitoring locations in 2013, 2015 and 2016, but were below this criterion in 2014. 95th percentile values of 24 hour averaged concentrations ranged from 29 to 34 µg/m(^3), with the highest value recorded at Prospect in 2016. Annually averaged PM(</em>{10}) background concentrations were consistently 18 to 19 µg/m(^3) across all years considered. These levels are below the assessment criterion (25 µg/m(^3)).</td>
</tr>
<tr>
<td>Particulate matter (PM(_{2.5}))</td>
<td>100th percentile (maximum) 24 hour averaged PM(<em>{2.5}) background concentrations were generally measured above the criterion of 25 µg/m(^3), but 95th percentile 24 hour averaged PM(</em>{2.5}) concentrations were below this value, ranging from 14 to 18 µg/m(^3). Annually averaged PM(_{2.5}) background concentrations (8.0 µg/m(^3) to 9.0 µg/m(^3)) were measured to already be at or exceeding the assessment criterion of 8 µg/m(^3).</td>
</tr>
<tr>
<td>Nitrogen dioxide (NO(_2))</td>
<td>100th percentile one hour averaged NO(_2) background concentrations were measured to be well below the assessment criterion (246 µg/m(^3)) with a maximum value of 120 µg/m(^3) recorded at Chullora in 2014. Annually averaged NO(_2) background concentrations were recorded below the assessment criterion (62 µg/m(^3)) during all measurements considered.</td>
</tr>
<tr>
<td>Sulfur dioxide (SO(_2))</td>
<td>100th percentile one hour averaged SO(_2) background concentrations were found to be well below the criterion of 570 µg/m(^3), with the highest recorded value being 71 µg/m(^3) at Prospect in 2015. Annually averaged SO(_2) background concentrations were measured well below the 60 µg/m(^3) criterion.</td>
</tr>
<tr>
<td>Carbon monoxide (CO)</td>
<td>100th percentile eight hour averaged CO concentrations were well below the assessment criterion (10 µg/m(^3)) during all measurements considered.</td>
</tr>
</tbody>
</table>
| Volatile organic compounds (VOCs) | VOCs are not presently measured at any NSW OEH air quality monitoring stations. Two historical studies have previously been completed by the NSW EPA to investigate baseline concentrations of air toxics:  
  » Air Toxics Monitoring Program involving the collection of 24 hour averaged measurements at the Sydney CBD, Rozelle, St Marys and Blacktown from 1996 to 2001  
  » Ambient Air Quality Monitoring and Fuel Quality Testing Project where 24 hour averaged measurements were collected from October 2008 to October 2009 at Turrella and Rozelle.  
During the Air Toxics Monitoring Program study, annual and 24 hour averaged benzene concentrations of 1.4 µg/m\(^3\) and 4.2 µg/m\(^3\) were measured at St Marys respectively. Annual benzene concentrations of 1.4 µg/m\(^3\) were measured at Turrella during the Ambient Air Quality Monitoring and Fuel Quality Testing Project.  
Using the formula provided in the AUSPLUME Gaussian Plume Dispersion Model Technical User Manual, (Victorian Environment Protection Authority 2000) for estimating sub-hourly concentrations from hourly data, an approximate one hour averaged background concentration of 7.9 µg/m\(^3\) was estimated. This is well below the criterion of 29 µg/m\(^3\). |
10.8.1.4 Sensitive land uses and receivers

The project alignment would traverse a well-established urban environment that contains a wide range of sensitive receivers including residential properties, community facilities (such as a number of schools, university campuses, childcare centres, places of worship and health and medical facilities – including the Westmead health precinct), recreational areas and commercial and retail premises. A number of these receivers are located immediately adjacent to the project alignment.

A detailed description of the existing land use patterns and sensitive receivers surrounding the project alignment (including potential social and community infrastructure) is provided in the local impacts sections of this Environmental Impact Statement in Part D.

10.8.2 Impacts during construction

During construction, potential air quality impacts would be primarily associated with the generation of dust and emissions from the operation of on-site machinery, excavation works, materials handling and material storage. Vehicle movements within the project disturbance footprint would also contribute to emission loads.

Potential indirect air quality issues as a result of electricity use during construction of the project are addressed in section 10.10 Greenhouse gases.

10.8.2.1 Dust (including asbestos fibres and other hazardous materials)

During construction, the primary risk to local air quality would be the generation of dust. Airborne particulate matter has the potential to cause adverse health (such as potential respiratory effects) or nuisance impacts if not properly managed. Due to the existing urban setting, there is also potential for dust emissions to contain:

» Contaminants mobilised through the disturbance of contaminated soils.

» Other hazardous materials, such as asbestos fibres or other hazardous material mobilised through the demolition of existing buildings or structures. These issues would however be managed to avoid any potential impacts through appropriate construction techniques and use of qualified material removal specialists (refer to section 10.7 (Contamination) for further details).

The primary sources of dust and dust-generating activities as a result of the project are anticipated to include:

» Earthworks activities during enabling road and service reconfigurations, light rail civil works and construction of the stabling and maintenance facility.

» Storage, handling and management of excavated spoil and imported fill materials within the disturbance footprint and at the temporary construction compound areas.

» Remediation of excavated materials.

» Demolition activities.

» Ballast screening, crushing and recycling activities within the Sandown line.

Without the implementation of standard management and mitigation measures, dust emissions from the above activities could result dust deposition leading to reduced local air quality around the nearest receiver locations.

Dust generation would primarily be limited to construction activities as they progress along the project alignment and would be expected to increase where higher dust generating activities are carried out. Dust emissions would also be expected to increase during unfavourable weather, such as dry windy conditions.

In addition to construction activities, wind erosion from exposed surfaces would also generate dust emissions. Erosion rates (generating dust) from exposed surfaces would vary with wind gusts, threshold wind speeds, precipitation events, silt loadings and the number of disturbances that
Other regional environmental impacts

restore the erosion potential. The dispersion of particulate matter would depend on the meteorological conditions present during the works. It is expected that these particulate levels would drop significantly with distance. During unfavourable meteorological conditions, such as dry and windy conditions, particulate emissions may be higher and would require specific corrective measures.

Recycling of ballast from the T6 Carlingford Line would also potentially result in some dust and air quality impacts.

Overall, dust emissions would be comparable to other similar infrastructure projects and the risk of dust impacting on receivers would be readily manageable through standard management and mitigation measures, such as wetting stockpiles and exposed surfaces and minimising dust generating works during adverse weather conditions (refer to section 10.8.4). The risk of mobilising hazardous materials (including contaminants, asbestos fibres or other hazardous materials) would also be adequately managed through standard air quality management planning as detailed in section 10.8.4.

10.8.2.2 Gaseous emissions

Vehicle emissions

Emissions from vehicles would be associated with the combustion of fuel (diesel and petrol) in construction plant, vehicles and machinery. These sources would generate emissions of particulate matter, CO, oxides of nitrogen (NOₓ), SO₂ and trace amounts of non-combustible hydrocarbons. The rates of emission and potential impact on surrounding land uses would depend on the number and power output of the combustion engines, the quality of the fuel used, the condition of the engines and the intensity of use.

An indicative list of the types of construction plant, vehicles and equipment that would be used during various construction activities is provided in section 6.15, while average daily heavy vehicle movements estimated during the construction are outlined in section 6.13. As outlined in section 6.13, average daily heavy vehicle movements of between around 30 and 40 movements per day (including movements to and from the worksite) are predicted across the main part of the project alignment during construction (increasing to around 100 movements at the stabling and maintenance facility site). Gaseous emissions from plant and equipment along the works corridor would be intermittent and transient in nature. Short-term peaks in pollutant loads would be expected as works progress.

Given the anticipated duration of works at any given location, the likely number of emission sources, the staging of construction, and scheduling of activities (i.e. not all machinery would be operating in the same location simultaneously), gaseous emissions would be adequately manageable through the implementation of standard management measures.

Fugitive emissions

Fugitive emissions would be expected from fuel and chemicals stored at construction compounds (e.g. LPG, diesel, lubricant oils, cleaning chemicals). These emissions are anticipated to be minor and would be readily manageable through the application of standard management and mitigation measures.

10.8.3 Impacts during operation

During operation, potential air quality impacts would be primarily associated with the generation of particulate emissions from the operation and maintenance of the LRV, reduced gaseous emissions due to the associated reduction in bus and car exhaust emissions, and fugitive emissions from fuel and chemicals stored at the proposed stabling and maintenance facility.

Potential indirect air quality issues as a result of electricity use during construction of the project are addressed in section 10.10 (Greenhouse gases).
10.8.3.1 Particulate emissions

Operation of the project would generate minor particulate matter emissions, which would be mainly caused by:

» Emissions associated with train braking and wheel and rail wear — Braking and wear from wheels on rails would cause very low levels of emissions of metal particulates as the wheels and rail wear with use. These particulate emissions are expected to be minimal and would not significantly contribute to ambient PM$_{10}$ concentrations beyond the light rail corridor.

» Rail traction sanding works — This involves the deposition of sand between the LRV wheels and the rails to provide additional grip. Examples of when this may be required include stopping during wet weather and travelling up steep sections of the track. Modern LRV sanding systems include a targeted application of sand at the wheel and rail contact point to maximise traction and minimise excessive sand deposits.

» Fugitive particulate matter re-entrainment (lift-off) as a result of air flows associated with the light rail — These emissions would be dependent on particulate loading, meteorological conditions and LRV speeds.

» Maintenance activities — Emissions to air as a result of combustion from the operation of plant and equipment at the stabling and maintenance facility.

These minor particulate emissions are expected to be relatively minor and would not significantly affect local air quality along the project alignment.

10.8.3.2 Gaseous emissions

The project is expected to result in a net benefit to local air quality due to associated reductions in bus and car combustion engine emissions (including CO$_2$, oxides of nitrogen and SO$_2$). By delivering an attractive alternative mode of public transport, the project is expected to result in assisting to create a mode shift from road to light rail. This has the potential to reduce air pollution emissions from road transport and congestion within the Greater Parramatta to the Olympic Peninsula (GPOP) priority growth area (when compared to the emissions that would otherwise occur if the project were not delivered).

Notwithstanding the anticipated reductions in air pollution emissions from reduced bus and car emissions, the maintenance of project infrastructure and activities at the stabling and maintenance facility would generate some minor gaseous emissions. These emissions would be associated with the combustion of fuel (diesel and petrol) in construction plant, vehicles and machinery. These sources would generate emissions of CO, oxides of nitrogen (NO$_x$), SO$_2$ and trace amounts of non-combustible hydrocarbons. Gaseous emissions from maintenance vehicles and equipment would be intermittent and transient in nature, and would be manageable through the application of standard management and mitigation measures.

Overall, the project would be expected to have a positive net benefit (both economic and social) due to the reduction in bus and car exhaust emissions in the GPOP priority growth area.

10.8.3.3 Fugitive emissions

Fugitive emissions would be expected from fuel and chemicals stored at the proposed stabling and maintenance facility (e.g. liquid petroleum LPG, diesel, lubricant oils, cleaning chemicals). These emissions are anticipated to be minor and would be readily manageable through the application of standard management and mitigation measures.
10.8.4 Management and mitigation

The management and mitigation measures that would be implemented to address potential air quality impacts during construction are listed in Table 10.33.

Table 10.33 Management and mitigation measures – air quality impacts (construction)

<table>
<thead>
<tr>
<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AQ-1</td>
<td>A dust management plan would be developed and implemented as part of the CEMP. This plan would identify triggers and procedures for dealing with significant dust generating activities, with the aim of minimising impacts on surrounding sensitive receivers. Dust management measures that would be identified in the CEMP would include:</td>
<td>All precincts</td>
</tr>
<tr>
<td></td>
<td>» Apply wheel-wash or rumble grid facilities as appropriate to remove loose material and prevent the tracking of spoil debris onto local roads.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Clean loose materials and debris from the tailgate of vehicles unloading materials to stockpiles prior to departure from site.</td>
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</tr>
<tr>
<td></td>
<td>» Conduct routine servicing and maintenance, and subsequent inspections to ensure that equipment continues to operate efficiently.</td>
<td></td>
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<tr>
<td></td>
<td>» Ensure that all loads are covered when materials are being hauled to and from site.</td>
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<tr>
<td></td>
<td>» Ensure that compound area surfaces are well compacted or sealed to limit the potential for dust generation.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Ensure that structures are inspected by a suitably qualified person to confirm that they do not contain any hazardous materials (e.g. asbestos) which could be broken and mobilised during demolition. Where such materials are identified, adhere to the requirements for removal and disposal listed in the Work Health and Safety Act 2011, and Work health and Safety Regulation 2011.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Impose low speed limits around compound sites to limit the generation of dust from vehicle movements.</td>
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<tr>
<td></td>
<td>» Install dust monitoring devices to quantify dust levels and determine whether control measures are adequate or whether further actions are required.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Installation of perimeter screening around areas where there is a potential to generate emissions to air and around long-term compound and stockpile locations.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Plan activities and avoid weather conditions which may result in the generation of off-site dust impacts.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Position stockpiling areas as far as possible from surrounding receivers.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Regularly water exposed and disturbed areas and stockpiles especially during inclement weather conditions.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Water demolition areas as necessary to minimise the generation of dust.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Wherever possible and practical, limit the amount of materials stockpiled, extent of disturbed and exposed surfaces. Restoration of cleared areas to occur as soon as possible.</td>
<td></td>
</tr>
</tbody>
</table>
### Other regional environmental impacts

#### Parramatta Light Rail | Stage 1 – Westmead to Carlingford via Camellia

Environmental Impact Statement

**Mitigation Measures for Air Quality**

<table>
<thead>
<tr>
<th>REF</th>
<th>Mitigation Measure</th>
<th>Applicable Precinct(s)</th>
</tr>
</thead>
</table>
| AQ-2 | Air quality management measures would be developed and implemented during the construction of the project as part of the CEMP. These measures would include the following:  
» Apply odour suppressing agents to materials as necessary to minimise related impacts should any contaminated or hazardous materials be uncovered during the works.  
» Construction plant and equipment would be well maintained and regularly serviced so that vehicular emissions remain within relevant air quality guidelines and standards.  
» All vehicles used on site, for transporting materials to or from site, or for any other activities associated with the project, shall be maintained to avoid the emission of excessive air impurities in accordance with Part 5.8 of the Protection of the Environment Operations Act 1997 and the Protection of the Environment Operations (Clean Air) Regulation 2010.  
» All on-road trucks would comply with the relevant Australian emission standards.  
» All chemicals and fuels would be stored in sealed containers as per appropriate regulations and guidelines.  
» The on-site storage of fuel would be kept to a minimum.  
» Unloading of fuels (diesel or liquefied nitrogen gas (LNG)) would be vented via return hoses that recirculate vapours from delivery to receiver.  
» On dry days unsurfaced haul roads will be watered to aid dust suppression.  
» Stockpiles left for extended periods will be grassed or covered with appropriate material.  
» Chemical/fuel storage tanks would be fitted with a conservation vent (to prevent air inflow and vapour escape until a pre-set vacuum or pressure develops). | All precincts |

The management and mitigation measures that would be implemented to address potential air quality impacts during operation are listed in Table 10.34.

**Table 10.34  Management and mitigation measures – air quality impacts (operation)**

<table>
<thead>
<tr>
<th>REF</th>
<th>Mitigation Measure</th>
<th>Applicable Precinct(s)</th>
</tr>
</thead>
</table>
| AQ-3 | Potential air quality impacts associated with the operation of the project would be managed through the implementation of the following environmental management measures:  
» Conduct routine maintenance to clear debris and loose materials from around the light rail operating area.  
» Plan and co-ordinate sanding maintenance works to avoid inclement weather conditions which may result in emissions being blown towards nearby receivers.  
» Inspect plant/equipment prior to commencement of maintenance activities to ensure that equipment continues to operate efficiently.  
» Conduct routine servicing and maintenance, and subsequent inspections to ensure that the light rail transport infrastructure continues to operate efficiently (such as replacing any wearing parts). | All precincts |
10.9 Utilities and services

10.9.1 Assessment methodology

Utilities within the vicinity of the project have a substantial footprint and interface with the existing road and rail infrastructure. As such, protection and/or relocation would require detailed management. Utility information within the project corridor and surrounding environment have been identified using desktop dial-before-you-dig (DBYD) enquiries, consultation and data collection from utility service providers, as well as limited visual inspections and ground survey. A utilities site investigation commenced in February 2017 to inform subsequent stages of design for the project.

10.9.2 Existing utilities

Key utilities which have been identified within the project corridor which have the potential to be affected by and/or affect the project include:

» Electricity (Endeavour Energy and Ausgrid).
» Telecommunications (Telstra, Optus, NBN Co, Vocus, TPG, Verizon, Nextgen and Aarnet).
» Water (Sydney Water).
» Sewer (Sydney Water).
» Stormwater and drainage (Sydney Water and City of Parramatta).
» High and low pressure gas mains (Jemena).
» High pressure petroleum pipelines along Grand Avenue and adjacent to the existing Carlingford heavy rail line between Grand Avenue and the Western Sydney University (Parramatta) (Hunter Pipeline operated by Caltex).
» Rail infrastructure (Sydney Trains).
» NSW Roads and Maritime traffic signals.
» City of Parramatta street lighting.

For most utilities, no depth information is currently available. If the existing utilities were to be installed to current standards, they would typically be within about 0.5 to 1.5 metres below the existing surface. However, due to the age of some of the existing utilities and the surface works that have occurred over the years (such as road resurfacing), some utilities could be quite shallow, potentially sitting just under the pavement in some locations.

Further detailed utility investigations and consultations with utility providers are currently in progress to refine the identification of existing utilities and inform the ongoing design development for the project.
10.9.3 Planned utilities

In addition to known/existing utilities, future planned utilities may be impacted by, or impact on the design and construction of the project. Based on current discussions with utilities providers, works that would involve potential major future utilities or utility adjustments include:

- Redevelopment of Westmead Health Precinct.
- Parramatta North Urban Transformation area.
- Redevelopment of the existing industrial land at Camellia.
- Ongoing development of the National Broadband Network (NBN).

As described in Chapter 4 – Community and stakeholder consultation, consultations with utility and service providers are currently in progress and would continue during detailed design to determine details of existing and planned future utilities with the potential to affect or be affected by the construction or operation of the project.

10.9.4 Interaction with existing and proposed services and utilities

Utility relocations and/or protection would form a critical and complex part of the project construction process. The details of the proposed relocations/protections are currently being developed as both the design and consultations with utility and service provider’s progress.

Ongoing access arrangements for public and private utilities and services along the project alignment would also be a key issue for utility providers for maintenance and future development needs. This is also a key issue for the delivery of the project such that construction and operation of the project is not significantly disrupted.

Interface agreements with relevant utility providers are currently being developed by Transport for NSW. Once finalised, all agreements would be incorporated into the design and delivery of the project. Securing active cooperation from all affected utility providers would enable relocation and/or protection of utilities to be designed, agreed and constructed in an efficient manner. It would also establish agreed ongoing maintenance and access arrangements for the construction and operation phases.

10.9.5 Potential utility impacts and requirements

10.9.5.1 Construction

Potential construction impacts on services and utilities could include temporary disruption and/or damage as well as injury to persons (construction workers or the community) in the event that cables, mains or pipelines are accidentally damaged during excavation, plant movement or general civil works.

Given the historic nature of the wider Parramatta region, the project also has the potential to impact on some heritage infrastructure utilities. This includes potential impacts on currently known heritage infrastructure within the Cumberland Hospital site (the ‘Grose Street Drain’) and the Parramatta CBD (‘The Town Drain’ located in Macquarie Street, Smith Street and Barrack Lane). Further details regarding the potential impacts on these heritage utilities is provided in section 12.5 and section 13.5 respectively, in addition to the Non-Aboriginal Archaeological Assessment (Technical Paper 11).

Ongoing investigations, risk assessment and safe work protocols would be carried out during all phases of project development and construction such that appropriate measures are in place to address the potential risks to existing utilities and services prior to commencement of construction works.
Specific care would need to be taken when working in proximity to high risk assets. These include:

- High voltage power lines (both above and belowground) located throughout the alignment.
- High pressure gas mains located throughout the alignment.
- The existing Hunter Pipeline high pressure petroleum pipeline that extends along Grand Avenue and adjacent to the existing T6 Carlingford Line between Grand Avenue and the Western Sydney University. Three potential areas of interaction have been identified between the project and the pipeline, including two sites associated with the track junction at Camellia and one location where the track crosses Grand Avenue to access the stabling and maintenance facility. These locations would be designed to comply with relevant standards, including AS 2885 Pipelines – Gas and Liquid Petroleum.

Risk assessments and hazard logs would be developed and specific management plans put in place if deemed necessary to mitigate the risk of personal safety incidents and asset integrity damage (refer to section 10.13 (Hazards and risks) for additional discussion).

10.9.5.2 Operation

Electrical and communications

The operation of the project would require additional electrical power to run the LRVs and electrical equipment at each of the stops (such as lighting and emergency help points). New infrastructure required would include:

- Overhead catenary cabling for power distribution to the project – refer details in Chapter 6 – Project description – construction.
- Communications cabling that would be installed in ducts within the proposed track-bed footprint – refer Chapter 6 – Project description – construction.
- Installation of approximately eight substations across the alignment. These would augment the local power systems and provide the required additional level of power required to operate the light rail network extension. The location and design of these substations are described in Chapter 5 – Project description – Infrastructure and operation.

Leakage of stray currents from the running rails into surrounding earth can potentially cause electrolysis corrosion of nearby buried metallic assets. This would be mitigated through the design of the track structure to ensure that the rails are well insulated from earth.

Water, sewer and drainage

As part of the Westmead and Carlingford termini, driver amenities and facilities would be connected to the water and sewer system. Additionally connections to the local water and sewer system would be required for the stabling and maintenance facility. It is anticipated that the existing services at these locations would have sufficient capacity to meet the minimal requirements associated with the project.

Similarly, additional stormwater drainage would be provided to augment/supplement the existing City of Parramatta Council stormwater drainage system. The final scope of the stormwater system would be determined during detailed design. As a minimum, the proposed drainage network would be such that it would not result in exacerbation of existing stormwater or flooding impacts. Further details regarding potential stormwater and flooding impacts is provided in section 10.4 (Hydrology, drainage and surface water) and section 10.11 (Climate change adaptation) of this Environmental Impact Statement.

Opportunities for incorporation of water sensitive urban design opportunities as part of future water and drainage requirements during operation of the project would also be considered during detailed design.
10.9.6 Management and mitigation

The project would aim to minimise and manage any potential hazards or risks of working in close proximity to existing utilities. In addition to current investigations into the location of buried utilities in the vicinity of the project, the construction contractor(s) would be required to check the locations of existing underground utilities and services prior to commencing construction works.

In order to manage potential utility and service impacts during detailed design, a series of management and mitigation measures would be implemented, as provided in Table 10.35.

**Table 10.35 Management and mitigation measures - utilities (detailed design)**

<table>
<thead>
<tr>
<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UT-1</td>
<td>Dial before you dig searches and non-destructive digging (including pot-holing and/or hand-digging) would be carried out to identify the presence of underground utilities prior to commencement of construction in accordance with guidelines provided by the relevant utility authority.</td>
<td>All precincts</td>
</tr>
</tbody>
</table>
| UT-2 | Consultation with utility service providers would be carried out during detailed design to ensure that appropriate measures are taken regarding the potential integration of future utilities requirements along the project alignment and to ensure that the project does not preclude the development or installation of these proposed utilities. A Basis of Design Manual would be developed for each utility owner which would:  
  » Outline relocation or protection rules for each utility  
  » Identify design approval process(es) and indicative timeframes  
  » Identify construction requirements, including provisions for standby support.  
  » Indicate future proofing spares requirements.  
  » Identify interfacing projects to consider during project construction.                                                                                           | All precincts          |
| UT-3 | A strategy for the management of utilities would be developed during detailed design. The strategy for the preferred hierarchy of utilities treatment would be as follows:  
  » Avoid/Do nothing - avoid impact on utilities where possible  
  » Protect - protect utilities in their existing locations where feasible  
  » Relocate - utilities to be relocated only where no other options are feasible or acceptable.                                                                 | All precincts          |
| UT-4 | Risk assessments and hazard logs would be developed and specific management plans put in place if deemed necessary to mitigate the risk of personal safety incidents and asset integrity damage.                                                                 | All precincts          |
| UT-5 | Opportunities for incorporation of water sensitive urban design opportunities as part of future water and drainage requirements during operation of the project would also be considered during detailed design.                                                                 | All precincts          |
| UT-6 | The design of the project and construction activities would comply with the requirements of AS 2885 Pipelines – Gas and Liquid Petroleum, to ensure that existing utilities are protected.                                                                 | All precincts          |
In order to manage potential utility and service impacts during construction, a series of management and mitigation measures would be implemented, as provided in Table 10.36.

Table 10.36 Management and mitigation measures – utilities (construction)

<table>
<thead>
<tr>
<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UT-7</td>
<td>When working in the vicinity of utilities during construction, a review of the proposed works at these location(s) would be carried out by the construction contractor in consultation with the relevant service provider(s). The review would consider service provider and project requirements in terms of safety, network integrity and constructability. Safe working method statements and appropriate management plans must be implemented to minimise the risk of striking nearby utilities.</td>
<td>All precincts</td>
</tr>
</tbody>
</table>

10.10 Greenhouse gases

This section provides an estimate of greenhouse gas emissions (Scope 1, 2 and 3 emissions) that would be generated during the construction and operation of the project, and identifies opportunities (mitigation measures) that may be implemented to reduce the greenhouse gas emissions associated with the project.

The greenhouse gas assessment has been prepared based on current design information and available information from construction staging (as described in Chapters 5 and 6). At this stage in design, there is a level of uncertainty associated with the assessment as outlined in this chapter, the outcomes of which should be considered a preliminary estimate.

A summary of the methodology for this assessment has been provided in Chapter 7 – Approach to this Environmental Impact Statement. A more detailed greenhouse gas assessment would be carried out (involving an inventory of Scope 1, 2 and 3 emissions) throughout design development as more information becomes available.

10.10.1 Greenhouse gas sources for construction and operation

Greenhouse gas emissions are reported as tonnes of carbon dioxide equivalent (tCO₂-e) and categorised into one of three categories or ‘scopes’. This helps delineate between direct emissions from sources that are owned or controlled by the project and indirect emissions that are a consequence of project activities but occur at sources owned or controlled by another entity. Definitions for the three scopes are provided below:

» **Scope 1 emissions** – Direct emissions arising from activities by the project (for example, the consumption of diesel fuel in construction vehicles).

» **Scope 2 emissions** – Referred to as indirect emissions – Emissions are generated outside of a project’s boundaries to provide energy to the project (for example, purchasing electricity from the grid).

» **Scope 3 emissions** – All indirect emissions (not included in Scope 2) due to upstream or downstream activities. For example, indirect upstream emissions associated with the extraction and production of purchased construction materials and fuels; transport-related activities and waste disposal.

10.10.2 Emissions during construction

Greenhouse gas emissions would be generated during the construction of the project. Substantial energy consuming activities are anticipated to occur over the construction period and greenhouse gas emissions would predominantly be generated by the activities identified in Table 10.37.
Table 10.37  Greenhouse gas sources by scope for the project (construction)

<table>
<thead>
<tr>
<th>SCOPE DESCRIPTION</th>
<th>GREENHOUSE GAS SOURCES - CONSTRUCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scope 1</strong></td>
<td></td>
</tr>
</tbody>
</table>
| Direct greenhouse emissions associated with emissions generated on site | Removal of vegetation (loss of carbon sink) – vegetation absorbs carbon dioxide from the atmosphere (by photosynthesis). Where vegetation is removed, the ability for the vegetation to act as a carbon sink would be lost.  
Construction equipment – most construction equipment would be operated by the burning of fossil fuels, typically diesel, which would create greenhouse gas emissions.  
Generator use – some small equipment and lighting for out-of-hours work would require the use of an on-site generator, typically powered by diesel, which creates greenhouse gas emissions. |
| **Scope 2**       |                                      |
| Indirect greenhouse gas emissions associated with electricity used on-site for lighting construction sites, where actual emissions are generated elsewhere (generally at the source of the electricity generation) | Electricity would also be used at construction compounds and work sites for lighting and security. |
| **Scope 3**       |                                      |
| Other indirect emissions such as the extraction and production of purchased materials and fuels, transport-related activities and disposal | Construction materials – different construction materials contain varying levels of embodied emissions. For example, high strength concrete contains a greater proportion of cement (which has a high level of embodied emissions), compared to concrete for lower strength applications that contain fly-ash (which has a lower level of embodied emissions).  
Construction waste – decomposition of cleared vegetation, disposal of contaminated soil and wood material from the demolition of acquired properties would create greenhouse gases, as the breakdown of organic matter as waste material directly releases stored carbon dioxide to the atmosphere.  
Construction transport – all construction-related transport would create greenhouse gas emissions from the consumption and burning of fossil fuels. |

The amount of greenhouse gas emissions generated during construction is dependent on a number of factors including:

» quantity and type of construction materials used
» construction plant and equipment efficiency
» fuels used
» construction programming and techniques
An estimated greenhouse gas footprint of direct (Scope 1) and indirect (Scope 2 and 3) emissions is summarised in Table 10.38. This estimate has been based on the concept design to date and an assumed proposed construction period as outlined in Chapter 6.

As outlined in Table 10.38, the construction of the project is estimated to generate about 63,800 tonnes of CO₂-e, (including embodied emissions). This is considered comparable with other similar projects, such as the CBD and South East Light Rail project which estimated a similar generation of total emissions during construction. Construction related greenhouse gas emissions and energy use would be mitigated where possible through construction and procurement actions. These are summarised in section 10.10.4.

**Table 10.38 Estimated greenhouse gas emissions from the construction of the project**

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>TOTAL CARBON EMISSIONS (TCO₂-E)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scope 1 emissions</strong></td>
<td></td>
</tr>
<tr>
<td>Construction plant and equipment (generators)</td>
<td>1,036.44</td>
</tr>
<tr>
<td>Construction plant and equipment (heavy equipment)</td>
<td>21,395.67</td>
</tr>
<tr>
<td><strong>Scope 2 emissions</strong></td>
<td></td>
</tr>
<tr>
<td>Electricity generated off-site</td>
<td>3,831.13</td>
</tr>
<tr>
<td><strong>Scope 3 emissions</strong></td>
<td></td>
</tr>
<tr>
<td>Embodied emissions of construction materials</td>
<td>26,664.80</td>
</tr>
<tr>
<td>Delivery of materials to site</td>
<td>7,954.40</td>
</tr>
<tr>
<td>Upstream fuel extraction for construction plant and equipment</td>
<td>2243.20</td>
</tr>
<tr>
<td>Construction waste transport</td>
<td>385.55</td>
</tr>
<tr>
<td>Wastewater disposal at municipal plant</td>
<td>50</td>
</tr>
<tr>
<td>Waste from construction workers</td>
<td>252</td>
</tr>
<tr>
<td><strong>Total estimate during construction</strong></td>
<td>63,813.20</td>
</tr>
</tbody>
</table>

Note: Direct (Scope 1) greenhouse gas emissions associated with removal of street trees, while not included in Table 10.38, are likely to be minimal, when compared to the total greenhouse gas emissions associated with energy (fuel and electricity) consumption.

### 10.10.3 Emissions during operation

Operational greenhouse gas emissions are expected to be primarily associated with the operation and maintenance of LRVs and associated infrastructure. Greenhouse gas emissions would predominantly be generated by the following activities:

- Electricity consumption to power LRVs, signalling, lighting, closed-circuit television and communications systems and other activities carried out at stops, as well as the stabling maintenance facility (Scope 2).
- Combustion of fuel in maintenance plant, equipment and vehicles (direct emissions occurring on-site).
Other regional environmental impacts

- Disposal of general waste from LRVs/customers (e.g. from bins) and the maintenance and stabling facility (indirect emissions from the decomposition of waste material, occurring off-site and waste disposal facilities (Scope 3)).
- Embodied energy (and associated greenhouse gas emissions) in materials used in the maintenance of light rail infrastructure (Scope 3).

Initial estimates of the likely annual indirect (Scope 2) greenhouse gas emissions during the operational phase of the project is summarised in Table 10.39.

Other operational related greenhouse gas emissions related to maintenance equipment use, maintenance transport, minor vegetation removal (pruning), waste generation and materials used for maintenance are considered to be low to negligible in scale when compared with electrical consumption and therefore not included in the operational greenhouse gas assessment.

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>TOTAL CARBON EMISSIONS (TCO$_2$-E)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scope 2 emissions</strong></td>
<td></td>
</tr>
<tr>
<td>Energy use at the stabling maintenance facility use (including wastewater treatment)</td>
<td>471</td>
</tr>
<tr>
<td>Energy use at all stops</td>
<td>628</td>
</tr>
<tr>
<td>Energy use for light rail operations</td>
<td>6,124</td>
</tr>
<tr>
<td><strong>Total estimate during operational lifecycle</strong></td>
<td><strong>7,223</strong></td>
</tr>
</tbody>
</table>

As outlined in Table 10.39, operation of the project is estimated to generate approximately 7,223 tCO$_2$e per annum. Over a 100 year operational lifecycle, this equates to a total of 722,300 tonnes of CO$_2$-e. Consumption of electricity to power LRVs and associated infrastructure accounts for around 85 per cent of these emissions. The project is aiming to offset 100 per cent of greenhouse gas emissions generated by electricity consumption during operations.

The operation of light rail services would result in some indirect emissions (through increased electricity use). However, this increase is expected to be relatively small on a per capita basis (i.e. the amount of electricity consumed relative to the number of passengers using the light rail services) compared to the current transport mode of private vehicles.

The project is expected to generate a modal shift from private vehicles to public transport, with the project removing around 25,000 cars from the road network by 2041, resulting in 188,000 fewer car kilometres each day. This would result in a reduction of around 71 CO$_2$-e per day or the equivalent of around 23,793 CO$_2$-e per year. Consequently the increase in emissions is likely to be offset by a reduction in greenhouse gas emissions from private motor vehicles and the use of more energy efficient modes of transport such as buses. The successful delivery of an active transport link between Carlingford and Arthur Street, Parramatta is also expected to reduce private vehicle use through promoting walking and cycling.

Emissions generated as a result of construction of the project are also likely to be offset during operation of the project based on the emissions reductions as outlined above, with an estimated payback period of just over two and half years.
10.10.4 Management and mitigation

A number of management and mitigation measures would be considered for the project to reduce potential greenhouse gas, and would be documented in an energy and greenhouse gas strategy, guided by the NSW Government Resource Efficiency Policy (Office of Environment and Heritage, 2014) and ISCA requirements. Underpinning this strategy would be the application of a carbon emissions management hierarchy as follows:

» Avoid or reduce emissions – for example, minimising the weight of rolling stock to reduce the energy required to operate vehicles, or procuring low energy embodied materials.

» Improve efficiency – for example, using energy efficient lighting.

» Source low carbon energy (on-site) – for example, incorporating solar voltaic cells on large buildings at the stabling and maintenance facilities.

» Source low carbon energy (offsite) – for example, purchasing renewable energy to offset construction and operational energy consumption impacts throughout the life of the project.

Regular reviews would also be carried out of the proposed measures to ensure new practices and technologies are considered as they emerge over time.

The management and mitigation measures that would be implemented to address greenhouse gas impacts during detailed design, construction and operation are listed in Table 10.40, Table 10.41 and Table 10.42 respectively. Additional mitigation measures are also recommended in section 10.12.4 (Resource management and waste minimisation) which would further contribute to the reduction in greenhouse gas emissions during construction and operation.

Table 10.40 Management and mitigation measures - greenhouse gas management (detailed design)

<table>
<thead>
<tr>
<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GG-1</td>
<td>During detailed design, an energy and greenhouse gas strategy would be developed that documents the greenhouse reduction targets for the construction and operational stages of the project. The strategy would be prepared in line with ISCA and GREP requirements, and would identify the key initiatives that would be explored further to meet these targets in accordance with the carbon emissions management hierarchy. It would be continually reviewed throughout the project lifecycle. Performance would be measured in terms of a percentage reduction target in greenhouse gas emissions from a defined reference footprint as documented in the energy and greenhouse gas strategy.</td>
<td>All precincts</td>
</tr>
<tr>
<td>GG-2</td>
<td>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 during construction and operational stages of the project. Evaluation and reporting on the feasibility of identified opportunities would also be carried out during detailed design.</td>
<td>All precincts</td>
</tr>
</tbody>
</table>
### Opportunities to reduce operational greenhouse gas emissions

<table>
<thead>
<tr>
<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GG-3</td>
<td>Opportunities to reduce operational greenhouse gas emissions would be investigated during detailed design including:</td>
<td>All precincts</td>
</tr>
<tr>
<td></td>
<td>» Purchasing electricity derived from a renewable energy source (where available).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» The use of regenerative braking on rolling stock.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Promoting the selection of energy efficient rolling stock (such as air conditioning, ventilation fans with smart temperature set points, insulation and weight considerations for rolling stock).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Selection of energy efficient maintenance vehicles.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Selection of energy efficient electrical equipment as per GREP.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Energy efficient design of buildings within the stabling and maintenance facility (such as natural ventilation designs and use of insulation).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Achieving the minimum improvement for operational energy for buildings as per the GREP.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» The use of photovoltaic cells at the stabling and maintenance facility.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Use of low embodied energy and recycled materials at light rail stops.</td>
<td></td>
</tr>
</tbody>
</table>

Evaluation and reporting on the feasibility of identified opportunities would also be carried out during detailed design and would be documented in an energy and greenhouse gas strategy.

### Table 10.41 Management and mitigation measures - greenhouse gas management (construction)

<table>
<thead>
<tr>
<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GG-4</td>
<td>Management of emissions would be incorporated into site inductions, training and pre-start talks.</td>
<td>All precincts</td>
</tr>
<tr>
<td>GG-5</td>
<td>Activities with the potential to cause substantial emissions (such as material delivery and loading and bulk earthworks) would be identified in the energy and greenhouse gas emissions strategy. Emissions management actions would be investigated and applied where reasonable and feasible. These would potentially include:</td>
<td>All precincts</td>
</tr>
<tr>
<td></td>
<td>» The use of biodiesel and other low carbon fuels in vehicles and equipment.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» The use of fuel-efficient construction equipment.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» The use of energy efficient construction practices.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Use of energy efficient or solar powered lighting for temporary construction facilities.</td>
<td></td>
</tr>
<tr>
<td>GG-6</td>
<td>Procurement of construction services and materials locally (where feasible and cost effective) to reduce fuel consumption for transport.</td>
<td>All precincts</td>
</tr>
<tr>
<td>GG-7</td>
<td>During construction planning, and where practical ensure that deliveries are managed in an efficient manner to minimise the number of trips required and therefore reduce the amount of emissions.</td>
<td>All precincts</td>
</tr>
</tbody>
</table>
10.11 Climate change adaptation

As a major infrastructure provider in NSW, Transport for NSW aims to provide a world class sustainable transport system. The Transport for NSW Climate Risk Assessment Guidelines (March 2016), recognise that the impacts of climate change pose a significant risk to its infrastructure assets, its core business and the communities it serves. In response to this, there is a commitment to building climate resilience across its network of current and future projects. The Climate Risk Assessment Guidelines recommend a Climate Change Pre-Screening process to identify areas of exposure and impact. This builds an understanding of the key risks which require further exploration through a climate change risk assessment. The following sections provide a summary of a climate change risk assessment that was carried out for the project as part of this Environmental Impact Statement.

10.11.1 Existing climate

Historically, the region of Greater Parramatta has a humid sub-tropical climate, with mild to cool winters and warm, hot summers. Daily temperatures generally range on average between about 17ºC and 28ºC during summer (with extreme events recorded up to around 45ºC in 2013) and between about 7ºC and 18ºC in winter (with the lowest temperatures recorded at -1.0 ºC in July 2002). Rainfall is typically spread evenly throughout the year with between about 200 and 300 millimetres per season (about 970 millimetres annually). Parramatta is slightly warmer than the Sydney CBD area. The distance to the coast means that the area does not benefit from the cooling effect of coastal sea breezes, and local temperatures are influenced by urban heat island effects (localised warming due to large areas of paved and dark coloured surfaces, such as roads, buildings, car parks, as well as low tree coverage).

The Parramatta region has also been experiencing more regular heat waves, with five significant heatwaves recorded since January 2013. Heatwaves experienced in May 2014 and March 2016 suggests that changing weather patterns are now leading to heat events outside the traditional summer months. Over the past 20 months, four severe storms have also caused significant damage.
Other regional environmental impacts

to the Parramatta region. There has been no observed pattern to these events, and the severity and impact on infrastructure is increasing.

The location of the project within this type of climate, with little influence from coastal areas and likelihood of more extremes in weather makes it more vulnerable to climate change impacts.

10.11.2 Climate change trends and projections

Most of the asset components for the project would be likely to have a design life of between 15 and 50 years, with structural elements typically designed for a 100 year life span. Therefore two time periods, 2030 and 2090, were selected to establish climate scenarios that represent the near-term and long-term design life of the assets components associated with the project.

To understand the future climate of the local area, the majority of the climate projection data was sourced from the CSIRO’s Australian Climate Futures online tool, an interactive online tool that provides projections for four plausible climate futures (or scenarios) representing different projections of global greenhouse gas emissions. The scenario selected for this assessment (RCP8.5) represents a scenario where global annual greenhouse gas emissions will continue to rise throughout the 21st century, and reflects a precautionary approach to climate change adaptation for the project. The Climate Futures data was selected over NSW and ACT Regional Climate Modelling (NARCliM) data due to the preferred time intervals and more detailed projections. The exception was data for the number of days that would exceed 35ºC, which was sourced from NSW and ACT Regional Climate Modelling (NARCliM) as this was not available from the Climate Futures online tool.

Relevant climate change projections which would have the potential to impact on the project are summarised in Table 10.43.

Table 10.43 Climate change projections

<table>
<thead>
<tr>
<th>CLIMATE VARIABLE</th>
<th>2030</th>
<th>2090</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum daily temperatures (ºC)</td>
<td>Increases in maximum daily temperatures by around between about 1ºC and 1.6ºC</td>
<td>Increases in maximum daily temperatures by around between about 3.4ºC and 4.2ºC</td>
</tr>
<tr>
<td>Minimum daily temperatures (ºC)</td>
<td>Increases in minimum daily temperatures by about one per cent</td>
<td>Increases in minimum daily temperatures by around 4.1 to 4.5 per cent</td>
</tr>
<tr>
<td>Average total rainfall (millimetres)</td>
<td>Decreases in overall average rainfall 3.0 per cent and 27.5 per cent</td>
<td>Decreases in overall average rainfall between about 6.5 per cent and 25.5 per cent</td>
</tr>
<tr>
<td>Average wind speeds (kilometres per hour)</td>
<td>Increases in overall average wind speeds by about 0.2 per cent</td>
<td>Increases in overall average wind speeds by about 6.4 per cent</td>
</tr>
<tr>
<td>Extreme winds (annual occurrence)</td>
<td>Increase of between 5 to 10 per cent</td>
<td>Increase greater than three per cent</td>
</tr>
<tr>
<td>Extreme Temperature (days per year, Sydney)</td>
<td>Increase in around 3.5 days per year</td>
<td>Increase in around 7.4 days per year</td>
</tr>
</tbody>
</table>

In summary, temperatures in Parramatta are expected to become warmer, with more hot days and fewer cold nights, and an increase in the frequency of extreme temperature conditions (hot days above 40ºC). The need to consider appropriate adaptation to enable resilience and ensure less disruptions to operations, provide a quality customer experience, and to ensure the physical components of the network maintain longevity, becomes critical with a future changing climate.
10.11.3 Sea level rise and rainfall intensity

In 2012, the NSW Government announced as part of the coastal management reforms that councils would have the flexibility to determine their own sea level rise projections to suit local conditions.

The City of Parramatta Council’s Climate Extremes Risk Assessment and Adaptation Plan (Parsons Brinckerhoff, 2011) references the sea level risk projections from the NSW Sea Level Rise Policy Statement. (November 2012). While this statement is no longer current NSW government policy, no alternative sea level risk projections have been publicly released by City of Parramatta Council. As such, the following projections (relative to the 1990 mean sea level) have been considered for this assessment:

» A 10 per cent increase in rainfall intensity and a 400 millimetre rise in sea level by 2050 (as a lower bound).
» A 30 per cent increase in rainfall intensity and a 400 millimetre rise in sea level by 2100 (as an upper bound).

The impact of these projections on operation of the project in relation to flood behaviour is discussed in section 10.4.4.

10.11.4 Climate change risk assessment

Key components of the project have a design life of between 50 and 100 years. Therefore, there is the potential for climate change to affect the operational phase of the project. The climate change risk assessment was carried out in accordance with the Transport for NSW Climate Risk Assessment Guidelines (March 2016). The climate change risk assessment has also been carried out in accordance with:

» Australian Standard 2013, AS 5334 – 2013 Climate change adaption for settlements and infrastructure – A risk based approach.
» Green Buildings Council of Australia 2015, Green Star Communities v1 Submission Guidelines: Credit 04: Adaptation and Resilience.

The Climate Risk Assessment Guidelines identify five steps to undertaking a climate risk assessment which have been applied to the assessment of the project in the following sections. The steps include:

» Assessing risk exposure
» Developing risk statements
» Undertaking risk assessment
» Identifying adaptation initiatives (management and mitigation measures)
» Reassessing the mitigated risks.

Current and future climate variables can have potential negative impact on the project. For example, increased frequency and severity of extreme rainfall events can result in increased incidence of flooding across project infrastructure, including the potential for new flooded areas as a result of the project and potential overtopping of existing embankments and bridge crossings. The vulnerability of the project to climate change would be dependent on its exposure to a
particular climate change variable (e.g. increased frequency, severity and duration of extreme temperatures); the capacity of the light rail operator to adapt/respond to these changes; and the extent to which the change is able to be managed through upfront design (i.e. infrastructure designed to be resilient to projected extreme weather events).

Construction-related climate change risks (e.g. the potential for increased frequency and severity of extreme rainfall events placing increased pressure on construction water quality control measures) would generally be considered during the development of environmental management measures as part of the CEMP.

A climate change risk assessment was carried out for the project as part of the concept design development. The purpose of the risk assessment was to identify initial risk areas and associated consequences due to projected climate change. Potential management and mitigation measures and/or potential design responses to address such risks were also identified as part of the climate change risk assessment. Risks identified in the climate change risk assessment are monitored and reviewed throughout the various stages of the project lifecycle.

10.11.4.1 Potential climate change impacts

A number of key climate impacts relevant to the project have been identified including:

- Infrastructure/track issues associated with extreme heat conditions.
- Inundation of track areas/stops, the stabling and maintenance facility or other flood related impacts of civil infrastructure systems (stormwater drains) associated with higher occurrence and extremes of rainfall events.
- Damage associated with high wind events.
- Increased bushfire risk to areas within and surrounding the alignment.
- Passenger comfort at stops during hot or wet weather periods.
- Increased operation and maintenance costs associated with climate hazards and risks.

Initial, relevant climate related risks were identified by the project team and documented for relevant climate change variables and their associated project hazards. Risk ratings were determined for both 2030 and 2090 projection periods. Following the discussion and adoption of feasible and practicable adaptation measures, residual risks were re-assessed for the projection periods. Risks were identified for the current design and will be reviewed as design progresses.

In relation to flooding, climate change risks were assessed by increasing design rainfall intensities in the flood model of between 10 and 30 per cent. An allowance for sea level rise was also factored into the model by adopting the NSW benchmarks of 0.4 metres above 1990 mean sea levels by 2050 and 0.9 metres by 2100. This assessment considered compounded risks associated with rainfall, sea level rise and tides.

Table 10.44 provides a summary of the initial climate change related risks identified for the project. For the purpose of the Environmental Impact Statement, only those risks identified as being ‘medium’ and ‘high’ climate change risks to the project have been identified (based on the anticipated likelihood and consequences of the risks).
### Table 10.44 Climate change risks identified for the project

<table>
<thead>
<tr>
<th>RISK IDENTIFIED</th>
<th>CLIMATE RISK STATEMENT</th>
<th>RISK TREATMENT STRATEGIES</th>
<th>RISK RATING (2030 PROJECTION)</th>
<th>RISK RATING (2090 PROJECTION)</th>
</tr>
</thead>
</table>
| **Increased frequency, severity and duration of extreme temperatures (days exceeding 35ºC)** | Buckling of ballasted track or cracking and movement of embedded track causing:  
  » Potential derailment of LRVs  
  » Disruption to services  
  » Increased travel times due to speed restrictions  
  » Increased operation and capital expenditure.                                                                                                       | Ensure design of the project infrastructure meets relevant RailCorp Standards Track (ESC 200) temperature ranges (-10ºC to 75ºC) and operating ranges (-10ºC to 45ºC).  
  Reduction of thermal mass to avoid ambient temperature build up on hot days.  
  Consideration of steel at junctions to support track stability.  
  Regular inspection and maintenance of light rail track would be carried out during operation of the project. | Medium                         | Medium                         |
| **Extreme heat causing discomfort in trains and/or failure of high voltage systems (including substations) resulting in:** | Extreme heat causing discomfort in trains and/or failure of high voltage systems (including substations) resulting in:  
  » Impacts on ability to run services  
  » Ill health & passengers discomfort  
  » Reduced patronage  
  » Air conditioning units on trains failing  
  » Driver discomfort – health impacts  
  » Potential financial losses through reduced reliability. Heat in carriages may be exacerbated by urban heat island effects. | LRVs designed for 30 year life expectancy and to include equipment such as air conditioners for passenger comfort.  
  Increased maintenance/ inspections of LRV electrical systems during prolonged extreme temperatures.  
  Retirement of trains if electrical system is in failure.  
  Improved glazing specifications for LRVs or consideration of passenger controlled doors (avoid all doors opening at every stop).  
  Regular inspection and maintenance of electrical systems and infrastructure would be carried out during operation of the project. | Medium                         | Medium                         |
<table>
<thead>
<tr>
<th>Risk Identified</th>
<th>Climate Risk Statement</th>
<th>Risk Treatment Strategies</th>
<th>Risk Rating (2030 Projection)</th>
<th>Risk Rating (2090 Projection)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disruption of electricity supply from the base power supply network as a result of demand or equipment failure. This may lead to more frequent and prolonged brownouts/blackouts resulting in disruption to light rail services and impacts on the broader transport network.</td>
<td>Stringent maintenance, inspection and safety protocols would be developed to enable rail systems to be managed efficiently and effectively during extreme hot weather events. Infrastructure to be designed to allow for system contingency (i.e. if one substation fails the system will still have electricity supply from other substations). Substation equipment would be designed for ambient temperatures of up to 50-60°C where feasible.</td>
<td>Medium</td>
<td>Medium</td>
<td></td>
</tr>
</tbody>
</table>
| Direct failure of electrical equipment or reduced lifespan (such as signalling, overhead wiring, etc.) due to heat stress. This may result in:  
  » Safety and operational impacts  
  » Passenger service delays  
  » Increased maintenance and capital expenditure. | Overhead wiring would be designed for ambient temperatures of up to 60 to 65°C. The overhead wiring system would be double insulated. Maintenance and inspection regimes to assure conditions of wiring, etc. Regulated tension wiring and safety screens would take account of temperature-related sag. | Medium | Medium |
| Passenger discomfort and health risk at stops from sun, heat exposure or dehydration during extreme heat events resulting in:  
  » Health and safety risk to passengers  
  » Reduced patronage. | Consideration of shading in stop canopy design. | Medium | High |
<table>
<thead>
<tr>
<th>RISK IDENTIFIED</th>
<th>CLIMATE RISK STATEMENT</th>
<th>RISK TREATMENT STRATEGIES</th>
<th>RISK RATING (2030 PROJECTION)</th>
<th>RISK RATING (2090 PROJECTION)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased frequency and severity of extreme rainfall events</td>
<td>Flooding of tracks (including wash out of ballast track), pavement and foundations from extreme rainfall, blockage or incapacity of drainage to cope with flow. Additional impact from overland flow from other locations resulting in disruption to services and damage to infrastructure.</td>
<td>The environmental management measures documented in section 10.4 would be implemented. Track level and track drainage systems designed for increase in rainfall intensity (i.e. increased pipe size to cater for increased runoff).</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td>Flooding or inundation causing damage and disruption to electrical systems such as OHW, signalling, substation systems and track sensors.</td>
<td></td>
<td>All drainage systems would be designed according to specific design lives and predicted flood levels, which correlate with the manageable level of acceptable risk.</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Flooding or water ingress into electrical substations causing system failure.</td>
<td></td>
<td>Allowance for increased rainfall intensity to be included in detailed drainage design where nominated standards have not already made an allowance for climate change related rainfall.</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Light rail drainage and stormwater systems may become blocked or be unable to manage flow during heavy rainfall events leading to flooding or inundation of neighbouring property/facilities or track and stop infrastructure.</td>
<td></td>
<td>Equipment to be raised where possible. Sensitive equipment to be protected from rain/flood exposure. Substations to be located appropriately in consideration of known flood prone areas. Stabling and maintenance facility site to be raised and made flood tolerant (e.g. all electrical equipment raised/put in control room above stabling yard). Locations to be identified on the light rail network where LRV could be parked in event of stabling yard flooding.</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td>RISK IDENTIFIED</td>
<td>CLIMATE RISK STATEMENT</td>
<td>RISK TREATMENT STRATEGIES</td>
<td>RISK RATING (2030 PROJECTION)</td>
<td>RISK RATING (2090 PROJECTION)</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>----------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------</td>
<td>-------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>Reduced comfort or drop in patronage</td>
<td>Reduced comfort or drop in patronage through inadequate protection from rainfall at stops.</td>
<td>Stop shelters designs to provide sufficient coverage for passengers.</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Increased severity of extreme wind events</td>
<td>Extreme wind events leading to debris, fallen trees and branches creating obstacles or damage to track, overhead lines or associated infrastructure causing disruption and delay to services.</td>
<td>Consideration of tree species and planning locations to take into account potential future impacts. Adequate clearances between vegetation and structures would be adopted to reduce the risk of debris, fallen trees and branches damaging overhead wiring, including ongoing maintenance of existing vegetation along the project alignment.</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td>High wind events (over 130 km/h) leading to cessation of operations causing delays or transport disruption to the broader network due to derailment.</td>
<td>High wind events (over 130 km/h) leading to cessation of operations causing delays or transport disruption to the broader network due to derailment.</td>
<td>Risk would be manageable through the application of standard Management and mitigation measures (e.g. design standards for light rail vehicles).</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>High wind events leading to LRVs blowing over</td>
<td>High wind events leading to LRVs blowing over</td>
<td>Proposed system shut down when wind speeds reach above 130 km/h.</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Wind events (high wind, wind with rainfall, cold days, hot days) leading to impacts on customer comfort at stops resulting in passenger discomfort or drop in patronage.</td>
<td>Wind events (high wind, wind with rainfall, cold days, hot days) leading to impacts on customer comfort at stops resulting in passenger discomfort or drop in patronage.</td>
<td>Stop shelters design to provide sufficient coverage for passengers.</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Increased frequency of lightning events</td>
<td>Increased lightning causing damage or outage of electrical systems resulting in safety risks and disruption to services.</td>
<td>Infrastructure design to allow for surge arrestors to be installed at intersections with cables and OHW.</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td>Risk Identified</td>
<td>Climate Risk Statement</td>
<td>Risk Treatment Strategies</td>
<td>Risk Rating (2030 Projection)</td>
<td>Risk Rating (2090 Projection)</td>
</tr>
<tr>
<td>----------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------</td>
<td>-------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>Increased annual average ultraviolet (UV) radiation</td>
<td>Increased UV causing passenger discomfort at stops including heat stress and sun burn.</td>
<td>Consideration of shading in stop canopy design.</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Increased solar radiation leading to accelerated degradation of external materials on stops and other structures.</td>
<td>Structures designed to standards, which provide for a range of weather conditions.</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Increased UV potentially impacting driver comfort/health.</td>
<td>LRVs to be designed to appropriate standards.</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td>Incremental sea level rise and increased frequency and severity of storm surge events</td>
<td>Sea level rise and storm surge leading to flooding of track and critical infrastructure resulting in damage to track, critical infrastructure and disruption of services.</td>
<td>The environmental management measures documented in section 10.4 would be implemented.</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Scouring of structures such as bridge footings and embankments from rising water levels.</td>
<td>Electrical cables would be protected, insulated and have fail-safe mechanisms to manage safety risks associated with electrical discharges. Electrical circuitry would operate autonomously, such that one failure would not result in the failure of entire system. Location of electrical equipment (with the exception of cables) above the one per cent AEP (where feasible) to minimise damage and to allow prompt resumption of services when water recedes. Structures designed to appropriate standards for required durability.</td>
<td>Low</td>
<td>Medium</td>
</tr>
</tbody>
</table>
10.11.5 Management and mitigation measures

Adaptation measures for significant risks have been proposed to mitigate these to an acceptable level. The adaptation measures can be categorised into one of the following:

» Avoiding the risk through strategic planning and delivery.
» Acceptance of risk and continue to manage and budget for risk, including consideration of appropriate insurance cover.
» Engineered or technical solutions.
» Education, awareness and advocacy programs.
» Changes to internal systems and procedures, including adaptive management which allows for incremental change in design over time as technology and circumstances change.

The management and mitigation measures proposed to address potential climate change risks during detailed design are listed in Table 10.45.

Table 10.45 Management and mitigation measures – climate change impacts (detailed design)

<table>
<thead>
<tr>
<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
</tr>
</thead>
</table>
| CC-1 | Climate change risk treatments would be incorporated into the detailed design of the project and supported by an updated climate change risk assessment and a cost-benefit analysis. Treatments could include adaptation strategies as identified in Table 10.44 and the following additional strategies to respond to identified high risks:  
  » Consideration of stop orientation, appropriate materials selection and passenger amenity (e.g. inclusion of water bubblers and misting fans).  
  » Refurbishment of shelters every 10 years and adapted to changing climate conditions as required.                                                                                                                                                                                                 | All precincts          |

The management and mitigation measures that would be implemented to address potential climate change impacts during construction are listed in Table 10.46.

Table 10.46 Management and mitigation measures – climate change impacts (construction)

<table>
<thead>
<tr>
<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CC-2</td>
<td>Construction-related climate change risks (e.g. increased frequency and severity of extreme rainfall events placing increased pressure on construction water quality control measures) would be considered during the development of environmental management measures as part of the CEMP.</td>
<td>All precincts</td>
</tr>
</tbody>
</table>

The environmental management measures documented in Table 10.47 would be implemented (where appropriate) to reduce climate change risks to the project during operation.

Table 10.47 Management and mitigation measures – climate change impacts (operation)

<table>
<thead>
<tr>
<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CC-3</td>
<td>Operational procedures would be developed and implemented to enable the light rail system to be maintained and managed efficiently in order to appropriately respond to extreme climate events (temperature, winds or rainfall), as identified in the updated climate change risk assessment.</td>
<td>All precincts</td>
</tr>
</tbody>
</table>
10.12 Resource management and waste minimisation

This section describes the construction and operational resources and materials that would be required during the construction and operation of the project. In addition, this section also provides a description of each waste stream, expected waste quantities (where known) and applicable waste management strategies.

Resource consumption and waste generated by the project would also contribute to the emission of greenhouse gas during construction and operation. The consideration of this impact and potential emission reduction opportunities are discussed in section 10.10 (Greenhouse gases).

10.12.1 Introduction


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:

1. Avoidance of unnecessary waste and resource consumption – the first priority in waste management includes actions to reduce the amount of waste generated.
2. 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.
3. 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.

To support the NSW Government’s commitment to minimising the consumption of materials and the use of resources, and waste minimisation, the following key policies and strategies have been implemented:

» The NSW Waste Avoidance and Resource Recovery Strategy 2014–21 (Environment Protection Authority, 2014a), which provides a framework and targets for waste management and recycling in NSW to 2021–22. Relevant key targets set by the strategy include:
  • Avoiding and reducing the amount of waste generated per person in NSW.
  • Increasing recycling rates to 70 per cent for municipal solid waste; 70 per cent for commercial and industrial waste; and 80 per cent for construction and demolition waste.
  • Increasing waste diverted from landfill to 75 per cent.
  • Managing problem wastes better, and establishing 86 drop-off facilities and services across NSW.
  • Reducing litter, with 40 per cent fewer items (compared to 2012) by 2017.

» The NSW Government Resource Efficiency Policy (Office of Environment and Heritage, 2014), which aims to reduce the NSW Government’s operating costs and lead by example in increasing the efficiency of the resources it uses. The policy ensures NSW Government agencies meet the challenge of rising costs for energy, water, clean air and waste management and use purchasing power to drive down the cost of resource efficient technologies and services. The GREP includes measures, targets and minimum standards to drive efficiency in energy and water use, waste reporting and improvements to air quality.
Transport for NSW, as a NSW Government agency, has a general responsibility to support these targets by:

» Complying with relevant regulations and policies (like the NSW Government Resource Efficiency Policy).

» Implementing complementary policies and programs, including sustainable procurement.

» Incorporating resource recovery and waste reduction objectives into its operations, including a range of sustainability initiatives as detailed in Chapter 16 – Project Sustainability of this Environmental Impact Statement.

Transport for NSW is committed to minimising the consumption of materials and the use of resources (such as potable water and energy), and minimising waste generation throughout the lifecycle of the project. In the development of the project, Transport for NSW has considered the requirements of a number of other relevant sustainability policies which include measures to reduce resource use, materials consumption and waste such as Transport for NSW’s Sustainable Design Guidelines, Infrastructure Sustainability Council of Australia (ISCA) requirements, and the NSW Government Resource Efficiency Policy. This is discussed further in the following sections and Chapter 16 – Project Sustainability of this Environmental Impact Statement.

### 10.12.2 Impacts during construction

#### 10.12.2.1 Materials consumption

The construction of the project would require the use of materials such as (but not limited to):

» Steel rails, structural steel and steel reinforcement.

» Prefabricated steel furniture and signage.

» Liquid fuel (diesel and petrol).

» Lubricating oil.

» Premix concrete.

» Road sub-base and road base.

» Timber/plywood.

» Rock gabions.

» Asphalt and bitumen.

» Bentonite.

» Concrete, sand and cement.

» Precast concrete pipes and conduits.

» Paving stones.

» Pvc conduit.

» Paint.

» Sleepers and ballast.

» Structural fill (where existing subgrade material is not suitable).

Other resources required for tracks, signals and for the construction of the new light rail stops and the stabling and maintenance facility would be determined during detailed design.

Considering the current number of large infrastructure construction activities being carried out within the Sydney or greater regional area, the construction of the project would potentially result in
Some increased demand and availability on local and regional resources. It is not anticipated that the project would result in any resource becoming scarce or in short supply.

A key initiative of the project to reduce materials consumption is the reuse of ballast from the T6 Carlingford Line for the designated rail corridor, where suitable (refer to section 6.6.3). Additional initiatives to reduce materials consumption have been identified and would be explored further during detailed design (refer to section 10.12.4 and Chapter 16 - Project Sustainability).

10.12.2.2 Water
The use of water during construction would be required for (but not limited to):
» Dust suppression.
» Road pavement works, including compaction of pavement.
» Site office and amenities.

The anticipated demand on water sources would alter throughout the construction, depending on the stage of construction.

Water would be primarily sourced from the Sydney water mains (potable water). Opportunities to access non-potable water sources (i.e. recycled water networks) during construction would be explored during detailed design. Further mitigation strategies are detailed in section 10.12.4 and Chapter 16 - Project Sustainability.

10.12.2.3 Energy
The construction of the project would require the use of energy for a number of construction activities. Fuel would be used for machinery (such as cranes and excavators), vehicles (such as trucks and staff vehicles), equipment and generators. Electricity would be required at the construction compounds and worksites.

Energy consumption would be approached during construction according to the following hierarchy:
» Avoid or reduce energy use.
» Improve energy efficiency.
» Source low energy (on or off-site) (i.e. renewable energy).
» Offset carbon energy.

As detailed in the section 10.10 (Greenhouse gases), Transport for NSW would identify an offsetting target for energy consumption during construction and identify approaches to minimise energy consumption during detailed design to meet the project’s energy and carbon objectives.

10.12.2.4 Waste
Waste generating activities during the construction of the project would include earthworks, demolition of existing structures, removal of existing road pavements and utilities, vegetation clearing, wash-down and maintenance of equipment, and on-site office activities. The key waste streams generated during these activities would include:
» Green waste from vegetation clearing (e.g. removal of street trees and stripping of grassed areas).
» Concrete, asphalt, bricks, steel and other general construction waste from the demolition of existing buildings, structures and road pavements.
» Redundant conduits, pipes and cables from excavation.
Other regional environmental impacts

» Potential asbestos containing materials from excavation and the demolition of existing buildings or structures.
» Excess spoil from excavations where cut/fill balance may not be achieved.
» Rock fragments from excavation activities.
» Excess concrete and asphalt, such as from the stabling and maintenance facility at Camellia.
» Domestic waste from construction material packaging and site personnel including food scraps, glass and plastic bottles, paper and plastic containers.
» Liquid wastes such as oils and used chemicals from equipment maintenance.
» Site sewage and other wastewater runoff including water utilised for dust suppression.
» Contaminated/unsuitable spoil material, such as excavated materials from the existing (and former) rail corridors or industrial areas.
» Waste materials generated as a result of potential ballast recycling or crushing of existing ballast materials along the Carlingford line and Sandown freight corridors.

Potential waste management issues associated with these waste streams during construction would include:

» Waste being directed to landfill due to the inadequate collection, classification and disposal of waste, which would increase the demand for landfill capacity within the Sydney region.
» Contamination of soil, surface and/or groundwater from the inappropriate storage, transport and disposal of liquid and solid wastes.
» An increase in vermin from the incorrect storage, handling and disposal of putrescible waste from construction sites.
» Incorrect classification and/or disposal of waste, including the incorrect storage, handling and disposal of contaminated spoil and other hazardous materials (for example, asbestos from building demolition).
» Excessive amounts of materials being ordered, resulting in a large amount of unused resources.
» Lack of identification of feasible options for recycling or re-use of resources.

The overall volumes of typical construction waste streams are expected to be comparable to other similar infrastructure projects (such as the CBD and South East Light Rail project, which is currently under construction). These construction wastes would be manageable through the application of standard waste management strategies (addressing waste generation, storage, disposal and re-use).

Any hazardous waste arising from the construction of the project (such as contaminated ground spoil or asbestos containing materials present within demolished building/structures) would be removed and disposed of in accordance with the relevant legislation and guidelines, including the Waste Avoidance and Recovery Act 2001, Work Health and Safety Regulation 2011, and Waste Classification Guidelines (Office of Environment and Heritage, 2009).

Opportunities to reuse construction waste or spoil generated by the project, if it can be safety used for another purpose, would be explored during detailed design and during construction. This includes (but is not limited to) excavated natural material, excavated road material, asphalt pavement and ballast (as discussed further in section 10.12.4 and Chapter 16 – Project Sustainability).
10.12.3 Impacts during operational

10.12.3.1 Materials consumption

The operation of the project would involve the ongoing consumption of materials as part of maintenance and stabling activities, and ongoing refurbishment of infrastructure throughout the project lifecycle. This would include, replacement of LRVs and stop furniture, LRVs maintenance materials (cleaning chemicals, oils, lubricants, and degreasers), and for traction sanding devices in LRVs, and asphalt and concrete for track maintenance. The anticipated demand for these resources would be determined during detailed design as outlined in section 10.12.4 and Chapter 16 – Project Sustainability.

Operational requirements such as component replacement for LRVs and associated project infrastructure would also acknowledge the need to consider sustainability with respect to ongoing demands on available resources.

10.12.3.2 Water

An integrated approach to water management for the stabling and maintenance facility would be carried out to minimise the use of potable water for maintenance and train wash activities. The stabling and maintenance facility would also include a series of sustainability measures to minimise waste (in particular wastewater) including of a series of stormwater tanks, a recycled water network and the use of recycled water for the train wash facility.

While the operation of the project would increase demand on local and regional resources, it is unlikely that the project alone would result in any resource becoming scarce or in short supply.

10.12.3.3 Energy

The operation of the project would require electricity for LRVs, stops, stabling and maintenance facility, lighting and the operation of signalling equipment. Sustainability initiatives that could be adopted to reduce the amount of energy that the project would consume during operations are documented in section 12.10.4 and Chapter 16 – Project sustainability, and would follow the general hierarchy:

» Avoid or reduce energy use.

» Improve energy efficiency.

» Source low energy (on or off-site) (i.e. renewable energy).

» Offset carbon energy.

As detailed in the section 10.10 (Greenhouse gases), the project is aiming to offset 100 per cent of the project’s electricity consumption during operation. As identified in section 10.10.4, an energy and greenhouse gas strategy would be developed and reviewed and updated throughout project delivery. This strategy would include identification of opportunities to achieve the offset target, in addition to the selection of energy efficient building design, and energy efficient equipment and maintenance vehicles.

10.12.3.4 Waste

Only a relatively small quantity of waste would be generated by the project and would primarily relate to the maintenance and repair activities. Waste generating activities during operation would include maintenance of light rail vehicles, stops, track and associated infrastructure, use of the light rail stops by commuters (e.g. domestic waste in stop bins), and office/administration operations at the proposed stabling and maintenance facilities.
Other regional environmental impacts

Operational and maintenance waste streams would include:

» General non-recyclable and putrescible waste (such as food waste from station rubbish bins), recyclable wastes such as plastics and aluminium cans, office waste including paper and plastics associated with the disposal of general litter in station bins and cleaning activities associated with stops and other infrastructure.

» Cable and conduit off-cuts from maintenance of electrical infrastructure, solvents, paints, adhesives, cleaning fluids, greases, acids and alkali materials, and spent spill kit absorbent materials used to clean up accidental spills during maintenance associated with ongoing infrastructure maintenance.

» Potential hazardous chemicals, wastewater and other chemicals associated with ballast cleaning and replacement (as required along the section of the project between Camellia and Carlingford).

» Sand from LRVs along the alignment (only used for traction control and to improve emergency braking performance).

» Some wastes would also be generated from periodic replacement of light rail tracks. Replacement of tracks would not occur on a frequent basis (replacement would be on an as-required basis only) and would generate some levels of wastes including excess metals (where tracks are cut to length) and small amounts of asphalt or concrete where tracks are replaced within existing road surfaces.

» Waste streams from the stabling and maintenance facility would include:
  • Sewage, wastewater and general office waste from staff.
  • Wastewater generated from the washing of light rail vehicles. This would be treated and recycled (where possible) or disposed of via the sewer under a trade waste licence (if required).
  • Oils, grease, chemicals and other waste materials (such as LRV brake pads) associated with the servicing of LRVs at the Camellia stabling and maintenance facility.
  • General non-recyclable and putrescible waste (such as food waste), recyclable wastes such as plastics and aluminium cans, office waste including paper and plastics associated with the disposal of general litter and cleaning activities associated with LRVs.

Minimal waste streams would be generated at each of the light rail stops. This would be limited to general rubbish from commuters. Some minor amounts of waste may also be generated from the maintenance of the proposed shared paths. This would likely include small amounts of vegetation where this is required to be trimmed on either side of the shared paths on a periodic basis in order to maintain an appropriately cleared corridor for pedestrians and cyclists. This would be managed by City of Parramatta Council.

Waste quantities generated during the project operation are estimated to be considerably lower than those generated during construction. This is typical of similar projects such as the currently operating Inner West Light Rail and future operation of the CBD and South East Light Rail. Operational waste would be manageable through the application of standard waste management strategies (outlined in section 10.11.4).

Overall, the project would seek to achieve the following with respect to waste management:

» A diversion rate for construction waste from landfill of at least 90 per cent of waste by volume, with a target of 95 per cent of waste by volume (this may not be achievable given the amount of contamination in the area).

» Reuse of 100 per cent of paving and other reusable materials or facilitate reuse of such materials (these targets may not be possible, given the amount of contamination in the area).
10.12.4 Management and mitigation measures

The management and mitigation measures that would be implemented to address potential waste, energy and resource management during detailed design, construction and operation are listed in Table 10.48, Table 10.49 and Table 10.50.

Additional mitigation measures are also recommended in section 10.10.4 (Greenhouse gases) and Chapter 16 – Project Sustainability which would further contribute to the reduction in resource and materials use, and waste generation during construction and operation of the project.

**Table 10.48 Management and mitigation measures – resource management and waste minimisation (detailed design)**

<table>
<thead>
<tr>
<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WM-1</td>
<td>During detailed design and detailed construction planning, the following resource and material minimisation initiatives would be explored, and if determined to be reasonable and feasible, implemented:</td>
<td>All precincts</td>
</tr>
<tr>
<td></td>
<td>» Use of recycled materials, such as the maximum permitted recycled content for asphalt and concrete (including use of fly ash and blast furnace slag).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Use of modular, prefabricated and precast structural and finishing materials.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Use of recycled materials and local low embodied energy materials for light rail stops.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Use of waste water or recycled water to reduce potable water demand during construction and operation.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Design track components, structures and stops for disassembly to enable readily separation of parts for recovery and recycling.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Water efficient fixtures and fittings at the stabling and maintenance facility, including the LRV wash facility.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Rainwater harvesting infrastructure at the stabling and maintenance facility to provide non-potable water for operational uses.</td>
<td></td>
</tr>
</tbody>
</table>
Table 10.49 Management and mitigation measures - resource management and waste minimisation (construction)

<table>
<thead>
<tr>
<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
</tr>
</thead>
</table>
| WM-2 | Construction waste would be managed through the waste hierarchy established under the Waste Avoidance and Recovery Act 2001. Resource recovery would be applied to the management of construction waste and would include (but is not limited to):  
» Classification of waste during construction in accordance with the current guidelines.  
» Segregation of waste into stockpiles of spoil, concrete, steel, timber, paper and cardboard and vegetation to make it easier to recycle components and prevent cross contamination.  
» Procurement of materials would be carried out on an ‘as needed’ basis to reduce over-ordering and wastage, and exploring opportunities to reuse materials, where applicable.                                                                 | All precincts          |
| WM-3 | A Construction Waste, Reuse, Recycling and Energy plan would be prepared as part of the CEMP. It would ensure resource and materials use, waste disposal and energy use is minimised by tracking and reporting performance, and applying corrective action as required.                                                                 | All precincts          |
| WM-4 | Prior to disposal/removal or reuse off-site, all wastes would be classified in accordance with the waste classification guidelines to ensure the most appropriate disposal or reuse option.                                                                                                                          | All precincts          |
| WM-5 | The project would achieve a diversion rate for construction waste from landfill of a minimum of 90 per cent of waste by volume, with a target of 95 per cent. The project would also reuse 100 per cent of paving and other reusable materials or facilitate reuse of such materials. Contaminated waste which cannot be diverted from landfill would be excluded from this calculation. Where targets cannot be achieved, the project must demonstrate all feasible measures have been taken to achieve as close to the targets as possible. | All precincts          |
| WM-6 | Construction waste would be segregated and stockpiled on site, with materials such as bricks and tiles, timber, plastic, metals and existing track materials (such as rail and ballast materials) being separated where practicable and sent to a waste facility with recycling capabilities.                                                                           | All precincts          |
| WM-7 | Wastes would be managed (classified, handled and stored) in accordance with relevant State legislation and government policies (including the Waste Classification Guidelines (Office of Environment and Heritage, 2009) and Waste Avoidance and Resource Recovery Strategy 2014-2021 (EPA, 2014)). All waste to be disposed of would be directed to a waste management facility that is lawfully permitted to accept that type of waste. | All precincts          |
| WM-8 | The disturbance, movement and disposal of asbestos containing materials would be carried out in accordance with the Work Health and Safety Regulation 2011 and other relevant guidelines.                                                                                                                                                                       | All precincts          |
| WM-9 | Where possible and fit for purpose, spoil would be beneficially reused within the project before off-site reuse or disposal options are pursued.                                                                                                                                                                                                  | All precincts          |
10.13 Hazards and risks

10.13.1 Assessment methodology

A desktop preliminary hazard assessment was carried out to identify potential environmental hazards and other risks that could arise during construction and operation of the project. This assessment also identified a series of management measures to address the potential issues identified. The preliminary hazard assessment considered potential hazards and risks which might result in potentially hazardous incidents or which may adversely affect the quality of the surrounding environment, land uses and communities.

The desktop assessment was carried out with consideration of a series of relevant guidelines including:

- NSW Department of Planning and Environment Hazardous Industry Planning Advisory Papers (HIPAPs) (Department of Planning 2011a).
- Storage and Handling of Dangerous Goods Code of Practice (WorkCover, 2005)

A summary of the key hazards and risks associated with the construction and operation of the project is provided in the following sections.
10.13.2 Hazards and risks during construction

Hazards and risks associated with the construction phase of the project can be broadly categorised into the following:

» Environmental hazards and risks – including discharge of potentially contaminated and/or hazardous materials to the environment.

» Occupational health and safety hazards and risks – including any activity or outcome that may affect the health and/or safety of construction personnel or the community, due to the failure of health and safety procedures.

» Construction hazards and risks – including operation and maintenance of plant and machinery, and use/stockpiling of materials required for construction in addition to risks associated with potential interactions with the Hunter Pipeline (Caltex fuel line) and natural gas pipelines, potentially leading to hazardous incidents.

Further discussion on the above hazards and risks is provided in the following sections.

10.13.2.1 Environmental hazards and risks

Environmental hazards and risks associated with construction of the project could arise during the transport, use and storage of hazardous materials on-site, as well as the discovery of contaminated soils/groundwater and their subsequent disposal during construction activities.

During construction, potentially hazardous materials would be stored and used on-site at the proposed construction compounds, laydown areas and other ancillary work areas (refer to Figure 6.2a to Figure 6.2g). The refuelling and maintenance of construction plant and equipment would be carried out within designated areas at these construction sites, and would typically be done by specialised refuelling contractors equipped with appropriate spillage response equipment and training.

All cylinders, small containers and drums containing potentially hazardous materials would be consolidated in designated areas. Gas cylinders would be stored securely upright. Potentially hazardous liquid containers would be stored on drip trays.

Potentially hazardous materials would be transported to and from construction sites on public roads. Potential risks would be manageable through the use of delivery contractors who are certified to transport those potentially hazardous materials and have adequate environmental management procedures to address risks associated with spills and leaks during transportation.

As described in section 10.7 (Contamination), a number of potential sources of contamination exist along the project alignment. Construction activities, if not managed correctly, would have the potential to result in the release of these contaminants into the wider environment. For example, the contamination of land and waterways outside of the project area could occur due to inadequate management of runoff, dust generation, or due to spills or accidents during the transportation of contaminated materials within or from the construction site.

Potential sensitive environmental receivers that could be affected by spills and leaks of hazardous materials or the unearthing of contaminated soils/groundwater (and their subsequent disposal) include:

» Surface waterways, including Parramatta River, Vineyard Creek, Clay Cliff Creek and Subiaco Creek. Further discussion on potential impacts on surface waterways is provided in section 10.4 (Hydrology, drainage and surface water).

» Groundwater aquifers and associated sensitive groundwater receptors, including registered bore users and groundwater dependent ecosystems. Further discussion on potential groundwater impacts is provided in section 10.5 (Groundwater).

» Recreation areas (e.g. parkland), including Parramatta Park, Prince Alfred Square, Robin Thomas Reserve, Queen’s Wharf Reserve and Rosehill Racecourse.
Flora and fauna, including existing street trees which are proposed to be retained along the project alignment and fauna species currently using the area for foraging and/or roosting habitat. Further discussion on potential impacts on flora and fauna is provided in section 10.2 (Biodiversity).

Members of the public and construction, operation and maintenance personnel.

Environmental hazards and risks associated with the construction of the project would be managed through the development and implementation of environmental management measures as part of the CEMP to address the following issues described previously:

- Surface water quality.
- Groundwater quality.
- Disposal of contaminated groundwater.
- Chemical spills and leaks and disposal of contaminated materials.

10.13.2.2 Construction hazards and risks

A series of hazards and risks would have the potential to occur during construction of the project. These include:

- Occupational health and safety hazards and risks.
- Risks associated with the demolition of existing structures.
- Hazards and risks associated with impacts on existing utilities.

Each of these risks are summarised below.

**Occupational health and safety**

Occupational health and safety hazards could arise throughout construction, where inadequate hazard/risk identification, reporting and monitoring systems are not implemented and/or maintained. Hazards and risks that could arise during the construction of the project include:

- Undertaking construction works close to publicly accessible/highly trafficked areas (such as within/adjacent to Westmead Hospital, pedestrian footpaths within the Parramatta CBD, Rosehill Racecourse, the University of Western Sydney, existing parks, etc.).
- Undertaking construction works close to sensitive community facilities (e.g. schools, childcare centres, Western Sydney University, Westmead Health Precinct and Cumberland Hospital).
- Undertaking construction works within or adjacent to major arterial and regional roads (including Hawkesbury Road, Church Street, Kissing Point Road and James Ruse Drive).
- Undertaking construction works in the vicinity of existing services and utilities (refer to construction hazards below).
- Failure to shut down/isolate services and utilities proposed to be relocated as part of the project (e.g. electricity cables and gas mains).
- Undertaking construction works close to existing buildings and vibration sensitive structures.
- Encountering contaminated land and other potentially hazardous materials during construction and associated risks relating to the handling, stockpiling, transporting and disposal of such material.
- The use and storage of hazardous materials.
- The use of heavy machinery.
- Works which may impact or restrict emergency access from existing building and/or emergency vehicles, including Westmead Hospital.
Other regional environmental impacts

The above hazards and risks would be managed through the development and implementation of standard management and mitigation measures, which would be developed as part of the CEMP (and associated sub-plans such as the traffic management plan and occupational health and safety plan) prior to construction. These are outlined in section 10.13.4.

Demolition of existing structures

The demolition of existing structures along the alignment (refer to Chapter 6) would pose construction risks to site workers and the community, if inadequate demolition technique and/or working clearances are adopted. The demolition of existing buildings and structures could also involve the removal of asbestos. This activity would be carried out only by licenced contractors that have current WorkCover NSW accreditation in asbestos removal and would be carried out in accordance with relevant guidelines, including OEH’s Waste Classification Guidelines (DECCW 2009). A hazardous materials survey would also be carried out during detailed design to determine the presence of contaminated materials on-site.

Impacts on existing utilities

Overhead wires and subsurface utilities could also pose construction hazards to site workers and the environment. As outlined in section 10.9 (Utilities and services), a number of above and underground utilities have been identified in the vicinity of the project, a number of which would potentially require protection or relocation as part of the project. Key utilities which would present a potential hazard or risk during construction would include:

- High voltage power lines (both above and below ground) located throughout the alignment.
- High pressure gas mains located throughout the alignment, including the Jemena Secondary Mains which the project crosses and runs parallel to at various locations along the alignment.
- The existing Hunter Pipeline high pressure petroleum pipeline that extends along Grand Avenue and adjacent to the existing T6 Carlingford Line between Grand Avenue and the Western Sydney University (Parramatta) campus, including a small section under Parramatta River.

With respect to the potential impacts on the identified high pressure gas mains and fuel pipeline (Hunter Pipeline), the use of heavy machinery within the vicinity of these services could result in a defect to these pipelines (service stricken) leading to a loss of containment of the either fuel or gas (leading potentially to the potential for a fire/explosion, corrosion or material failure). The fire and explosion consequence scenarios would have the potential to result in possible fatality, asset damage and/or disruption to light rail operations. Other activities that may impact on these services would be from vibrating machinery, the crossing of pipelines by heavy construction machinery and vehicles and the use of boring and trenching equipment which may result in potential rupturing of these services.

The potential impacts and proposed management and mitigation of utilities and services are discussed in section 10.9 of this Environmental Impact Statement.

10.13.3 Hazards and risks during operation

Hazards and risks associated with the operation of the project would primarily be due to:

- The movement of LRVs through highly pedestrianised areas such as within the vicinity of the Westmead Health Precinct and the Parramatta CBD (including the section of Church Street which is proposed to become a light rail and pedestrian zone), resulting in the potential for collisions/accidents.
- Potential collisions between road vehicles and LRVs at signalised crossings and locations where road traffic would be adjacent to the project.
- Accidental interactions with the overhead wiring (including during maintenance of project infrastructure).
Other regional environmental impacts

» The handling, storage, use and disposal of chemicals and other potentially hazardous materials at the stabling and maintenance facility at Camellia and at other locations along the project alignment (e.g. use of herbicides on landscaping).

» Injury to maintenance staff from activities occurring within the proposed stabling and maintenance facility, or at other locations along the project alignment (e.g. collision with motor vehicles while undertaking maintenance work adjacent to traffic).

» Damage to project infrastructure caused by falling tree branches (particularly overhead wiring).

» Utility failure (power or communication system failure).

» Electromagnetic fields which may potentially occur along the project corridor (such as from LRV passbys, proposed electrical substations and overhead wiring) and the resultant potential electromagnetic interference (EMI) issues that may arise between the project and neighbouring sensitive equipment.

» Risks associated with explosions from nearby hazardous industries (known fuel storage pipelines).

» Other events such as external events (i.e. events occurring at adjacent facilities); natural events (including flooding and extreme weather events).

The above hazards and risks are considered to be manageable during operations through design (e.g. incorporating adequate safety provisions into the design of project infrastructure), the application of community education programs (e.g. advertisement of potential project related safety risks - such as the risk of injury to pedestrians moving within the project corridor - to build community awareness of and resilience to such risks), and standard management and mitigation measures and plans (e.g. emergency response plans). Further discussion on potential hazards/risks associated with collisions and EMI from electricity infrastructure is provided in the following sections.

10.13.3.1 Collisions with pedestrians and road vehicles and cyclists

The project would result in the potential risk of collisions between LRVs and pedestrians, or LRVs and road traffic, particularly where the alignment must cross roads carrying vehicular traffic or where pedestrians would cross or interact with the project alignment.

As described in Chapter 5 - Project description - Infrastructure and operation, a section of the project alignment is proposed to accommodate a shared light rail and pedestrian zone along Church Street between Market Street and Macquarie Street and along Macquarie Street between Horwood Place and Smith Street.

LRVs would be fitted with warning bells that are used on approach to and departure from each stop, except at night when they are used only where the driver considers there is a danger to public safety. The detailed design of the project would be subject to detailed safety reviews to identify requirements for mitigation to manage and reduce the risk of incidents arising from collisions during operation.

Hazards associated with the movement of LRVs through the existing road network and highly pedestrianised areas have been managed in some major states (such as Strasbourg, France and Linz, Austria, Melbourne and Sydney) through widespread and targeted educational programs and detailed design considerations for the vehicles and stops. A similar approach would be applied to managing potential hazards or risks associated with the project.

10.13.3.2 Electromagnetic interference

Electromagnetic interference (EMI) is a degradation of the performance of electrical equipment or a transmission channel or system caused by interference by electric and magnetic fields.

Types of EMI associated with light rail systems include high frequency emissions and low frequency electromagnetic emissions. The dominant electromagnetic disturbance from the project would be associated with the electric and magnetic fields generated by the direct current (DC) used to
power LRVs around the alignment (including overhead wiring and running rails), and the movement of the LRVs themselves.

Disturbances from the operation of the project may result in disruption to the operation of equipment sensitive to EMI (such as electronics/electrical equipment or information technology devices). Malfunctioning of these devices can result in adverse results or damage to this equipment.

Sensitive receivers to EMI that are known or are likely to exist along the project alignment include the following facilities or institutions:

» Hospitals and medical specialist clinics (such as Magnetic Resonance Imaging (MRI) machines or other medical equipment), such as facilities within the Westmead Health Precinct (including a number of research buildings).

» Medical, technological and engineering research facilities (such as electron microscopes).

» Sciences, health or engineering university facilities.

» Existing utilities such as powerlines (such as Endeavour Energy) or telecommunications equipment (such as Telstra infrastructure).

Heavy rail corridors (such as signalling and communications equipment) can also be sensitive to EMI. However, EMI from light rail systems are of a lesser magnitude than that emitted by heavy rail systems, and are not considered as a risk to heavy rail.

The project would be designed to comply with appropriate standards thereby minimising the risks associated with electromagnetic exposure. These include:

» EN 50121 Standards series, Railway applications – Electromagnetic compatibility.

» ACMA mandatory Electromagnetic Compatibility (EMC) standards under section 162 of the Radio Communications Act 1992 as part of the ACMA's EMC Regulatory Arrangement.

» ARPANSA Radiation Protection Standard for Maximum Exposure Levels to Radio Frequency Fields – 3 kHz to 300 GHz (Radiation Protection Series 3).

In particular, the project would be designed such that electromagnetic emissions from the project would meet limits for human exposure as specified in the ARPANSA standard noted above and AS7722 – EMC management. Therefore the light rail causes no impact over above the ambient conditions from everyday equipment.

The key potential impact due to EMI generated by the project would be associated with the very low frequency emissions which can be problematic for very sensitive imaging and research equipment. This type of equipment is known or is highly likely to occur along the alignment, given presence of health facilities, research and university facilities in Westmead, Parramatta CBD and Rydalmere.

The project has been designed with consideration of EMI risk to these particular sensitive receivers along the alignment. For example, the alignment has been located along the centre line of Hawkesbury Road to maximise possible distances to known medical and research facilities in Westmead.

The level of residual EMI risk would be dependent on the proximity of the receiver (or equipment) to the EMI sources from the project and the level of tolerance or sensitivity of the equipment to EMI from the project. This means that each sensitive receiver needs to be identified and treated on a case by case basis.

To address this issue Transport for NSW has commenced targeted consultation with potentially affected businesses and organisations identified along the alignment following a preliminary risk assessment. Transport for NSW would continue to work with these businesses and organisations to ascertain if electromagnetic fields emitted by the project are likely to affect the proper operation of equipment.
Further analysis would be carried out during detailed design. If any unacceptable impacts are identified, mitigation strategies would be implemented. Examples include:

» Minimisation of electromagnetic fields through applying good design engineering and installation mitigation techniques.

» Earthing and bonding.

» Increasing the separation distance between the source and the equipment.

» Applying shielding mitigations to reduce the interaction between the source and the receiver.

If mitigation is required at the receiver (building or the equipment itself), Transport for NSW would work with the operator/owner to resolve the potential impact.

Low frequency EMI can also be considered a potential health hazard with long term exposure if the emission levels are high. The possibility of adverse health effects due to the EMFs associated with electrical equipment has been the subject of extensive research throughout the world. To date, adverse health effects have not been established, but the possibility that they may exist has not been ruled out.

10.13.3.3 Stray currents

Stray leakage of currents from the running rails into surrounding earth would be minimised, to avoid electrolysis corrosion of nearby buried metalwork. The project design would incorporate running rails (tracks) which are encased within insulating material and bonded where required, ensuring this issue is mitigated.

10.13.3.4 Potentially hazardous incidents

There are a number of hazardous installations (gas mains, fuel pipelines and storage areas) in close proximity to the project alignment, which would potential pose safety risks to the project (refer to section 10.9 (Utilities) for details).

A series of secondary gas mains, including the Jemena Secondary Mains, have been identified along various sections of the project alignment including near the Children’s Hospital at Westmead, the Cumberland Hospital, along Church Street, and within the Rosehill and Camellia precinct. Within the Rosehill and Camellia and Carlingford precincts an existing high pressure petroleum pipeline (Hunter Pipeline) has also been identified which extends underground along Grand Avenue and adjacent to the existing T6 Carlingford Line between Grand Avenue and the Western Sydney University. In addition, a number of fuel storage tanks are located to the east and south of the stabling and maintenance facility within the Viva Energy site.

The primary risk associated with the identified gas and fuel utilities would be the potential for a loss of containment (or break) of these pipelines leading to a fire or explosion scenario. The causes of the breaches (also known as threat scenarios) would include corrosion, impact (such as from a derailed LRV) and leaks from fittings.

A fire or explosion scenarios could potentially result in serious impacts on the project including injury to passengers (on LRVs or waiting at stops) or staff (such as those working at the stabling and maintenance facility), asset damage and disruption to light rail operations. Potentially hazardous incidents may include ignition of gases or fuels resulting in flash fires, pool fires resulting from leaks of flammable fuels, or vapour cloud explosion following vaporisation of fuel and delayed ignition of the vapour cloud.

Consideration of these potential impacts included calculation of risks in accordance with the the Department of Planning and Environment’s Hazardous Industry Planning Advisory Papers (HIPAPs) (Department of Planning 2011a) and the relevant risk criteria identified in the HIPAPs. Both individual and societal risks were considered as part of the assessment.
Potential individual risk for passengers and LRV drivers were calculated at each point along the project alignment. Key features of the individual risk profile included:

» The potential risk was identified to be highest at the stops due to the longer period of time an LRV is stationary at a stop and a person waits for the LRV at a stop.

» The potential risk for LRV drivers was higher than for passengers when the LRV is moving since LRV drivers are exposed to the potential fire and explosion consequences for a longer total period of time due to the number of trips made each day.

» The potential risk for passengers is higher than for LRV drivers at the stops since passengers wait for an LRV at a stop.

» The potential risk for both passengers and drivers also peaks at points where the Jemena secondary mains pipeline crosses the track or runs parallel to the track a short distance away. This occurs near the Children’s Hospital at Westmead stop, the crossing at New Street, the crossing at Ross Street, and around the Camellia precinct.

» There is an increase in potential individual risk for both passengers and LRV drivers at about 110 metres from the Camellia stop. This is because this section of the project alignment is subject to the impact of almost all of the fire and explosion consequence scenarios from both identified fuel pipelines.

The assessment concluded that the project would result in a potential individual risk level that is more than an order of magnitude below the criteria for the most sensitive population groups as defined in HIPAP 4.

Potential societal risk for passengers and LRV drivers were also calculated for a range of population groups including:

» People inside the LRV while the LRV is moving.

» People inside the LRV while the LRV is at a stop.

» People waiting at the stop (outside).

» Workers in the stabling and maintenance facility.

The assessment concluded that all applicable scenarios considered identified a negligible impact in accordance with the relevant NSW planning criteria.

### 10.13.4 Management and mitigation measures

In order to manage potential hazard and risk impacts as a result of the project, the following management and mitigation measures would be implemented during detailed design, as provided in Table 10.51.

Table 10.51 Management and mitigation measures - hazard and risk (detailed design)

<table>
<thead>
<tr>
<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
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<tbody>
<tr>
<td>HR-1</td>
<td>All electronic and electrical equipment for the project would be designed and constructed to ensure its operation and functionalities are not degraded or malfunction due to EMI. Further opportunities to minimise potential electromagnetic impact would be investigated during detailed design including consideration of: Wire-free technology and on-board energy storage Reduction of the current-loop circuit created between the substation and LRVs.</td>
<td>All precincts</td>
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</table>
Other regional environmental impacts

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<th>APPLICABLE PRECINCT(S)</th>
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<tr>
<td>HR-2</td>
<td>The project would be designed to comply with appropriate standards for the management of EMI including the international European Standards EN 50121 Electromagnetic Compatibility and EN 61000-6-2 Generic Standards – Immunity Standard for Industrial Environment).</td>
<td>All precincts</td>
</tr>
<tr>
<td>HR-3</td>
<td>Targeted consultation with identified sensitive receivers for EMI (such as the Westmead Health Precinct and the Western Sydney University) would be carried out to inform the detailed design. Any issues identified would be resolved on a case by case basis with solutions such as monitoring and, if necessary, protective screening at the site of the sensitive equipment.</td>
<td>All precincts</td>
</tr>
<tr>
<td>HR-4</td>
<td>All project electronic and electrical equipment would comply with the limits such as defined in the Australian Radiation Protection and Nuclear Safety Agency Radiation Protection Standard for Maximum Exposure Levels to Radiofrequency Fields.</td>
<td>All precincts</td>
</tr>
</tbody>
</table>

Construction hazards and risks would be addressed through the development and implementation of standard management and mitigation measures, which would be developed as part of the CEMP and occupational health and safety plan prior to construction. These measures are listed in Table 10.52.

**Table 10.52 Management and mitigation measures - hazard and risk (construction)**

<table>
<thead>
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<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
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<tr>
<td>HR-5</td>
<td>Environmental management measures would be developed and implemented as part of the wider project CEMP. Measures to minimise hazards and risks identified in the CEMP would include (but not be limited to):</td>
<td>All precincts</td>
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<td></td>
<td>» Potential environmental hazards and risks associated with construction activities would be identified prior to construction.</td>
<td></td>
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<tr>
<td></td>
<td>» The storage of hazardous materials, and refuelling/maintenance of construction plant and equipment would be carried out in clearly marked and bunded areas within the construction site that are designed to contain spills and leaks in accordance with Australian Standards and DECCW guidelines.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Hazardous materials would not be stored below the five per cent AEP flood level.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Chemical spill kits would be readily available and accessible to construction workers. Kits would be kept at site compounds and on specific construction vehicles and all hazardous materials spills and leaks would be reported to site managers and actions would be immediately taken to remedy spills and leaks.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» Employees would be trained in the correct use of spill kits.</td>
<td></td>
</tr>
<tr>
<td>HR-6</td>
<td>A process for regularly reviewing work practices/procedures would be implemented throughout construction to identify, report and respond to any new environmental hazards/risks.</td>
<td>All precincts</td>
</tr>
</tbody>
</table>
Other regional environmental impacts

Operational hazards and risks would be addressed through design, the application of community education programs, and standard management and mitigation measures and plans (where required). These measures are listed in Table 10.53.

**Table 10.53  Management and mitigation measures - hazard and risk (operation)**

<table>
<thead>
<tr>
<th>REF</th>
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<tr>
<td>HR-7</td>
<td>Ongoing consultation would be carried out with high risk utility providers (including Caltex and Jemena) to identify appropriate construction methodologies which would apply to construction operations within the vicinity of the Hunter Pipeline and Jemena secondary gas mains.</td>
<td>All precincts</td>
</tr>
<tr>
<td>HR-8</td>
<td>Targeted safety campaigns to raise awareness around the operation of LRVs would be used in the lead up to the opening of the project and during operation to promote the safe operation of the project. This would focus on raising awareness and promoting safe behaviours around the project.</td>
<td>All precincts</td>
</tr>
<tr>
<td>HR-9</td>
<td>All cables would be buried within ducts and would adhere to all International and Australian electrical standards in terms of distances from surrounding cables (i.e. adjacent high voltage cables require minimum separation in accordance with industry standards).</td>
<td>All precincts</td>
</tr>
<tr>
<td>HR-10</td>
<td>Storage of chemicals associated with the operation and maintenance of the LRVs would be designed in line with the appropriate EPA guidelines and legislative requirements. All hazardous substances that may be required for operation would be stored and managed in accordance with the Storage and Handling of Dangerous Goods Code of Practice (WorkCover NSW, 2005) and Hazardous and Offensive Development Application Guidelines: Applying SEPP 33 (Department of Planning, 2011).</td>
<td>All precincts</td>
</tr>
<tr>
<td>HR-11</td>
<td>Hazardous material procedures (including procedures for managing spills, and the refuelling and maintenance of vehicles/equipment) would be developed and implemented during the operation of the project to minimise potential for impacts associated with chemical spills and leaks. These procedures would adequately address activities at the stabling and maintenance facility, as well as other general maintenance facilities that would occur along the project alignment.</td>
<td>All precincts</td>
</tr>
<tr>
<td>HR-12</td>
<td>An emergency response strategy would be developed for the operation of the light rail which would ensure risks to the project are minimised in event of possible explosion from the known high pressure petroleum pipeline that extends along Grand Avenue and adjacent to the existing T6 Carlingford Line between Grand Avenue and the Western Sydney University (Parramatta) campus.</td>
<td>Rosehill and Camellia and Carlingford precincts</td>
</tr>
</tbody>
</table>
10.14 Privacy impacts

10.14.1 Impacts during construction

The construction of the project may temporarily reduce privacy for surrounding residents and adjacent businesses due to:

» General construction activities within the disturbance footprint, such as vegetation clearing, and the general presence of construction workers along the project corridor.

» Use of temporary construction access points to access the site at construction compounds and other temporary construction access points.

» Construction vehicle movements, both within the disturbance footprint and along nominated haulage routes.

» Potential vehicle, pedestrian or cyclist diversions along routes during construction that do not currently have high levels of use.

» Increased light spill into adjoining properties during night works.

The impact of the project on individual sensitive receivers would depend on the construction stage, the receiver location and the design and location of construction hoarding (which would generally minimise privacy impacts but may have other impacts such as visual amenity impacts). Privacy impacts during the construction of the project would be greatest at locations where residential or other sensitive receivers have an unscreened view of the construction corridor or work sites, or where vegetation clearing opens a clear view of construction activities and therefore increased views towards these sensitive receivers.

Light spill impacts during construction are discussed in more detail in sections 11.4, 12.4, 13.4, 14.4 and 15.4.

10.14.2 Impacts during operation

A substantial portion of the alignment for the project is currently subject to existing public transport operations and public usage (i.e. existing roads or heavy rail use along the existing Carlingford heavy rail line, existing bus routes) which would exhibit similar potential privacy impacts on those arising from the project. In some cases where double deck rail operations occur along these routes, the single deck LRVs may result in reduced privacy impacts at these locations.

Potential additional privacy impacts that may occur during operation of the project would include:

» Potential privacy concerns for those in the immediate vicinity of each of the proposed stops. This could occur as a result of an increased number of people waiting within the vicinity of these properties, increasing the opportunity for people to look into private properties. Potential concerns may be greatest where stops are planned for areas which currently experience relatively low levels of pedestrian activity, including the:
  • Cumberland Hospital stop (within the current Cumberland Hospital site)
  • Factory Street stop
  • Fennell Street stop
  • Harris Street stop
  • Tramway Avenue stop.

» Privacy impacts associated with the active transport link between Carlingford and Camellia. Impacts would predominantly be associated with increased opportunities for the public to view into properties adjacent to the project along the existing Carlingford corridor at a much slower speed (i.e. walking speed compared to an existing train passby). The frequency of LRVs along the T6 Carlingford Line during operation of the light rail would also be greater than the existing
heavy rail services, leading to increased opportunities for views towards private properties. Additionally, there is potential for increased privacy impacts at stops along the Carlingford corridor as a result of modifications to existing single platforms to side platforms (e.g. Dundas).

- Increased light spill into adjoining properties as a result of additional lighting for safety and security purposes along the project alignment and required vegetation clearance.

- Potential increase to view into residential properties or businesses located within the vicinity of the light rail and active transport bridge over James Ruse Drive between Rosehill and Camellia (the James Ruse Drive Bridge).

At a number of locations along the project corridor, existing vegetation would continue to provide some screening between the project and adjoining sensitive receivers (in particular between Camellia and Carlingford). In addition, the alignment for a large portion of the project would be on road and follow the existing routes already followed by buses (such as along Hawkesbury Road, Church Street or Macquarie Street). In these locations, the impacts on existing privacy are not anticipated to change.

However, in areas along the project corridor where vegetation would be cleared to construct stops or the light rail alignment, the existing screening of some adjacent land uses may be reduced, with associated privacy impacts. Proposed areas of tree removal are described in detail in sections 11.4, 12.4, 13.4, 14.4 and 15.4. These areas include Hawkesbury Road, through the Parramatta North Urban Transformation area, George Street and some portions of the existing T6 Carlingford Line and Sandown Line where vegetation removal is required to accommodate the additional tracks.

### 10.14.3 Management and mitigation measures

Management and mitigation measures which would be implemented to reduce and manage potential adverse privacy impacts of the project during detailed design are provided in Table 10.54.

<table>
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<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
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<tr>
<td>PR-1</td>
<td>Detailed design would consider measures to minimise removal of existing vegetation where possible. Where the project corridor is located close to residential dwellings or other sensitive receivers, the detailed landscape design would consider how planting and other landscaping options can be used to create or maintain privacy.</td>
<td>All precincts</td>
</tr>
</tbody>
</table>
| PR-2 | Where landscaping is not able to mitigate privacy impacts, additional urban design elements such as fencing or other screening features would be considered so as to mitigate a reduction in the privacy of existing sensitive receivers (i.e. private residences and businesses). This is most likely to occur at receivers within the vicinity of stops and active transport links, in particular in areas which currently experience relatively low levels of pedestrian activity as follows:  
  » Cumberland Hospital stop (within the current Cumberland Hospital)  
  » The active transport link between Carlingford and Camellia  
  » The light rail and active transport bridge over James Ruse Drive between Rosehill and Camellia. The design of landscaping or privacy screening would also need to consider safety issues such as sightlines for LRVs and crime prevention through environmental design (CPTED) principles. | All precincts           |
Other regional environmental impacts

### Table 10.55 Management and mitigation measures - privacy (construction)

<table>
<thead>
<tr>
<th>REF</th>
<th>MITIGATION MEASURE</th>
<th>APPLICABLE PRECINCT(S)</th>
</tr>
</thead>
</table>
| PR-3| Detailed design of the active transport link would consider the potential privacy impacts on adjacent properties. Measures to be considered would include:  
  » Separation of levels between the active shared path and adjacent properties to lower the path, minimising opportunities for overlooking of existing fences.  
  » Provision of additional fencing or vegetation to provide screening. | Rosehill and Camellia and Carlingford precincts |
| PR-4| Lighting within the project corridor would be required to address safety and consider the potential privacy impacts of light spill to adjoining properties, including the use of fixtures that prevent light within the light rail corridor from spilling upwards and/or beyond the required area to be lit and into adjacent residences or sensitive environmental areas. Lighting would be designed by a specialist lighting consultant and would comply with relevant Australian Standards, including AS4282.1997 (Control of the obtrusive effects of outdoor lighting). | All precincts |
| PR-5| The design and placement of construction hoardings would consider opportunities to minimise privacy impacts on adjacent residents or other adjacent land uses sensitive to privacy concerns. | All precincts |

Management and mitigation measures which would be implemented to reduce and manage potential adverse privacy impacts of the project during construction are provided in Table 10.55.

Light spill mitigation measures during construction are discussed in more detail in Part D and contained in the consolidated mitigation measures in Chapter 17.