CHAPTER 7

PROJECT DESCRIPTION – CONSTRUCTION

7 PROJECT DESCRIPTION-CONSTRUCTION

7.1 Introduction

This chapter provides a description of the stations, rail infrastructure and systems construction works including a description of the construction sites, methodology and program associated with:

- Station fit-out, platforms, buildings and architectural aspects.
- Completion of the skytrain including architectural aspects.
- Rail infrastructure such as railway tracks, signalling systems, ventilation systems, overhead power supply and substations.w
- Transport interchanges, park-and-ride facilities, kiss-and-ride, bus stops, taxi ranks and bicycle facilities.
- Fit-out and construction of services facilities, buildings for the stabling and maintenance of the rolling stock.
- Access roads and landscaping.

EIS 1 provided a description of the major civil construction works for NWRL alignment as well as a detailed description of the construction sites, methodology and program for the following works:

- Site establishment.
- Excavation of tunnels and station boxes.
- Construction of above ground infrastructure, including skytrain, viaducts and bridges.
- Earthworks.
- Road and site access works would be required to varying degrees at each of the construction sites to facilitate construction access for both stage 1 construction and stage 2 construction related activities. These works have been defined in EIS 1. Other minor works are described in Chapter 9.

7.2 Director-General's Requirements, Conditions of Approval and Statement of Commitments

Table 7.1 sets out the Supplementary Director-General's Requirements, Concept Plan Approval Requirements and the Statement of Commitments as they relate to the construction methodology, and where these have been addressed within this chapter. Unless otherwise stated, references are to chapters of EIS 2 in relation to rail systems and stations construction works.

Table 7.1 Director-General's Requirements, Conditions of Approval and Statement of Commitments

Reference	Description	Addressed
Supplementary Director-General's Requirements		
Project Description	As part of the ancillary infrastructure components assessment, matters relating to safety and emergency access, and associated impacts.	Chapter 6
Concept Plan Approval Requirements		
Performance Standards		
2.7	The Proponent shall ensure that any floodplain topography and/or waterway affected by cut-and-cover construction methodology is re-instated and/or rehabilitated consistent with re-construction conditions.	No cut-and-cover construction is proposed within floodplains or through waterways.
Project Application and Specific Requirements		
3.1	a. a detailed project description including: i. confirmation of the alignment, station locations (including feasibility of any additional stations) and stabling arrangements; and ii. the design and location of ancillary infrastructure.	Project description of rail systems and stations, including the design of ancillary infrastructure in Chapter 6 and Sections 7.5 to 7.11. Project description of major civil construction works, including alignment, station locations, stabling facility and ancillary infrastructure was detailed in EIS 1. Feasibility of additional stations was also detailed in EIS 1.
Statement of Commitments		
4	A construction strategy would be developed confirming detailed construction activities and methodologies at each construction site for the construction of the tunnel.	Construction strategy for rail systems and stations in Sections 7.5 to 7.11. Construction strategy relating to major civil construction works was detailed in EIS 1.
5	Detailed construction methodologies at each construction site would be developed, including spoil management, with the aim of minimising environmental impacts and informing future impact assessment.	Construction strategy for rail systems and stations in Sections 7.5 to 7.11. Construction strategy relating to major civil construction works, including spoil management, was detailed in EIS 1.

7.3 Construction description

The proposed activities that would be undertaken for the rail systems and stations construction works for the NWRL include:

- Station construction and fit-out.
- Precinct works.
- Services facility construction and fit-out at Epping and Cheltenham.
- Stabling and maintenance facility construction and fit-out at Tallawong Road.
- Tunnel systems fit-out.
- At-grade surface and viaduct systems fit-out.
- Testing and commissioning.

The construction methodologies detailed in Section 7.5 to Section 7.11 provide an indicative description of how the project may be constructed.

A number of construction sites would be required as part of the rail systems and stations construction works. These would include areas to support linear works such as trackwork, signalling and overhead wiring, as well as at each of the future station, service facility and train stabling locations.

In order to describe the potential impacts and mitigation measures throughout this EIS, the alignment has been split into three distinct sections, being:

- Epping to Bella Vista Station – predominantly within tunnel.
- Bella Vista Station to Rouse Hill Station – predominantly on viaduct.
- Rouse Hill Station to Tallawong Road – predominantly at-grade or bridge structures.

Where more detail is required, the site terminology and numbering introduced within EIS 1, and detailed in **Table 7.2** will be used.

Table 7.2 shows the proposed construction sites and their uses during the rail systems and stations construction works.

Indicative site layouts for each of the construction sites are provided at the end of this chapter.

The key objectives of the construction strategy for the rail systems and stations construction works are to facilitate:

- Safe construction of the project for the workforce, stakeholders and members of the public.
- Efficient and timely delivery of the rail systems and stations works to enable timely completion of the construction of the NWRL project.
- Minimisation and management of impacts to the environment and community resulting from the construction activities.

Table 7.2 Construction site activities

Site	Area (m^2)	Station construction and fit-out	Station precinct works	Services facility construction and fit-out	Stabling facility construction and fit-out	Tunnel systems fit-out	At-grade surface and viaduct systems fit-out	Testing and commissioning
Epping to Bella Vista Station								
Epping Services Facility	12,000			•		•		•
Cheltenham Services Facility	9,750			•		•		•
Cherrybrook Station	75,000	•	•			•		•
Castle Hill Station	18,000	•	•			•		•
Showground Station	85,000	•	•			•		•
Norwest Station	21,000	•	•			•		•
Bella Vista Station	63,000	•	•			•		•
Bella Vista Station to Rouse Hill Station								
Balmoral Road	190,000						•	•
Memorial Avenue	120,000						•	•
Kellyville Station	100,000	•	•				•	•
Samantha Riley Drive to Windsor Road	50,000						•	•
Old Windsor Road to White Hart Drive	97,000						•	•
Rouse Hill Station	18,000	•	•				•	•
Rouse Hill Station to Tallawong Stabling Facility								
Windsor Road Viaduct	61,000						•	•
Windsor Road Viaduct to Cudgegong Road	83,000						•	•
Cudgegong Road Station to Tallawong Stabling Facility	590,000	•	•		•		•	•

Note: Site 2 described within EIS 1 was deleted as part of the EIS 1 preferred infrastructure report

7.4 Construction program

The rail systems and stations construction work component of the NWRL would commence in Q1 2016 as the sites are progressively handed over from contractors undertaking the Stage 1 major civil construction works (detailed in EIS 1). The major civil works contractor(s) would demobilise plant and equipment from the sites which would not be required by the subsequent Stage 2 rail systems and stations contractor(s) and hand over the site. Any sites which would not be required to undertake the stage 2 construction works would be rehabilitated and revegetated by the Stage 1 contractor as described in EIS 1.

The total period of rail systems and stations construction works is expected to be approximately four years. This program is shown in **Table 7.3**.

Indicative construction programs detailing the sequence and duration of works for each construction site are provided at the end of this chapter.

Table 7.3 Indicative construction program

Construction activities	Indicative construction timeframe																			
	2015				2016				2017				2018				2019			
Station construction, fit-out, ventilation and precinct works							●	●	●	●	●	●	●	●	●	●				
Epping Services Facility fit-out							●	●	●	●	●	●	●	●	●					
Cheltenham Services Facility fit-out						●	●	●	●	●										
Trackwork							●	●	●	●	●									
Tunnel systems fit-out							●	●	●	●	●	●	●							
Surface and viaduct systems fit-out							●	●	●	●	●	●								
Testing and commissioning											●	●	●	●	●					
Operational readiness													●	●	●	●	●	●	●	
Systems integration																●	●	●	●	●

7.5 Station construction and fit-out

7.5.1 Underground stations

Three stations are proposed to be located underground within the tunnelled component of the project, these being:

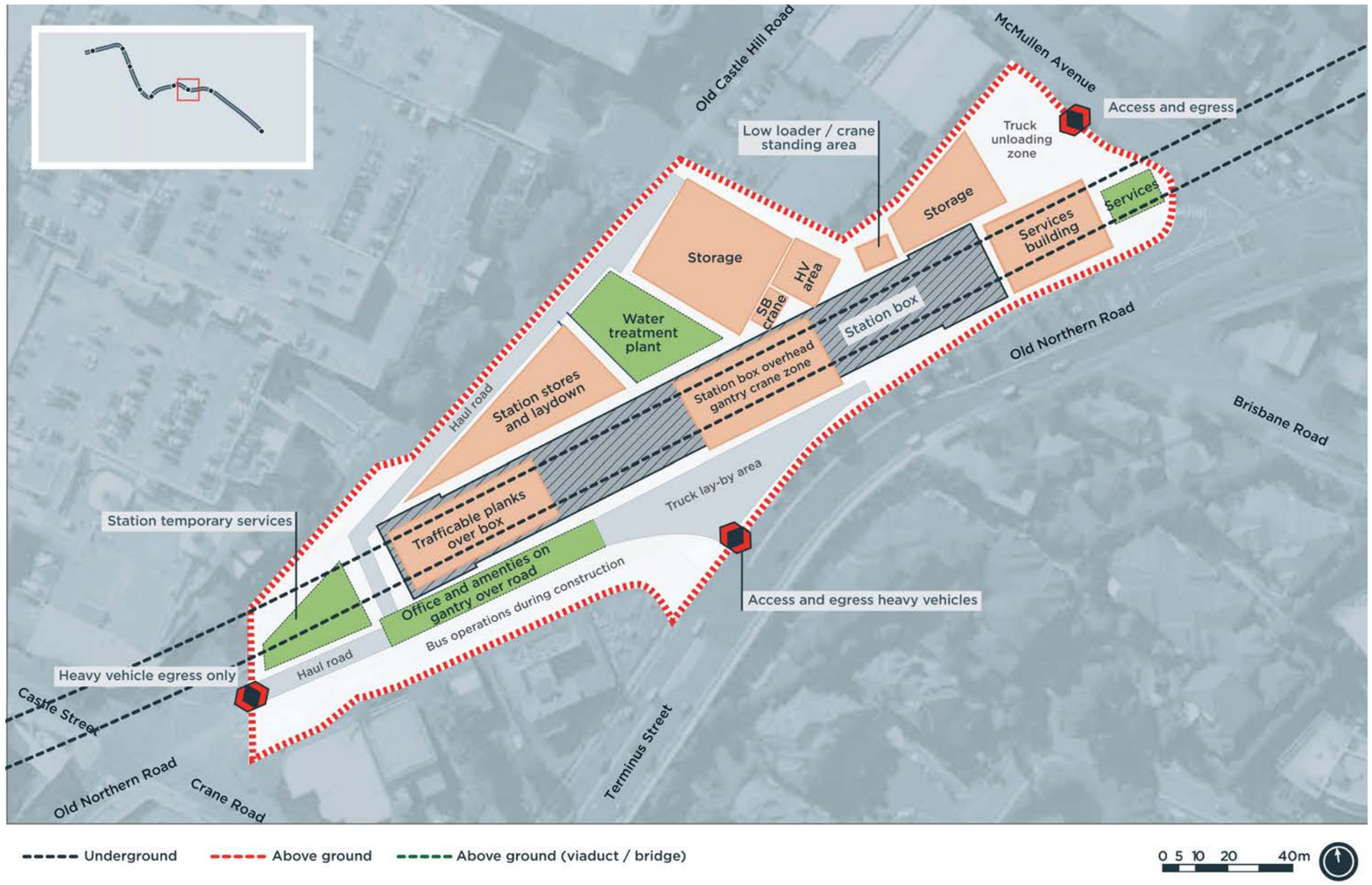
- Castle Hill – cut and cover.
- Showground – cut and cover.
- Norwest – cut and cover.

Indicative construction site layouts for Castle Hill, Showground and Norwest Stations are provided in **Figure 7.1**, **Figure 7.2** and **Figure 7.3**, with indicative construction site programs in **Table 7.4**, **Table 7.5** and **Table 7.6**.

Table 7.4 Castle Hill Station indicative program

Construction activities	Indicative construction timeframe																			
	2015				2016				2017				2018				2019			
Station structural works									•	•	•	•	•							
Internal walls and architectural finishes											•	•	•	•						
Mechanical and electrical fit-out											•	•	•	•						
Precinct works													•							
Testing and commissioning														•	•					

Figure 7.1 Castle Hill Station site layout



Underground Station Structural Works

The underground stations works would involve the construction of:

- Platforms.
- Vertical supports.
- Intermediate floors.
- Roof slabs (covering the station box for cut and cover stations, and covering the plant rooms for open cut stations).
- Platform canopies (for open cut stations).

Platform slab construction would involve the placement of formwork panels, followed by pouring of concrete into the panels using concrete pumps located on the surface. During platform construction, allowance would be made for the location of the vertical transportation elements (escalators and lifts).

Vertical supports would be generally constructed by installing pre-fabricated columns at the base slab level followed by a cast in-situ concrete edge beam connecting the column heads.

The construction of the intermediate floors would typically involve installing structural beams to span the full width of the station box, followed by secondary beams between the main beams. A concrete slab would then be poured in sections supported by the beams. Where large voids are required through the intermediate floors, ie for vertical transportation structures, longitudinal beams would be provided at the edge of the voids to support the slabs. This process would be repeated for each of the intermediate floors.

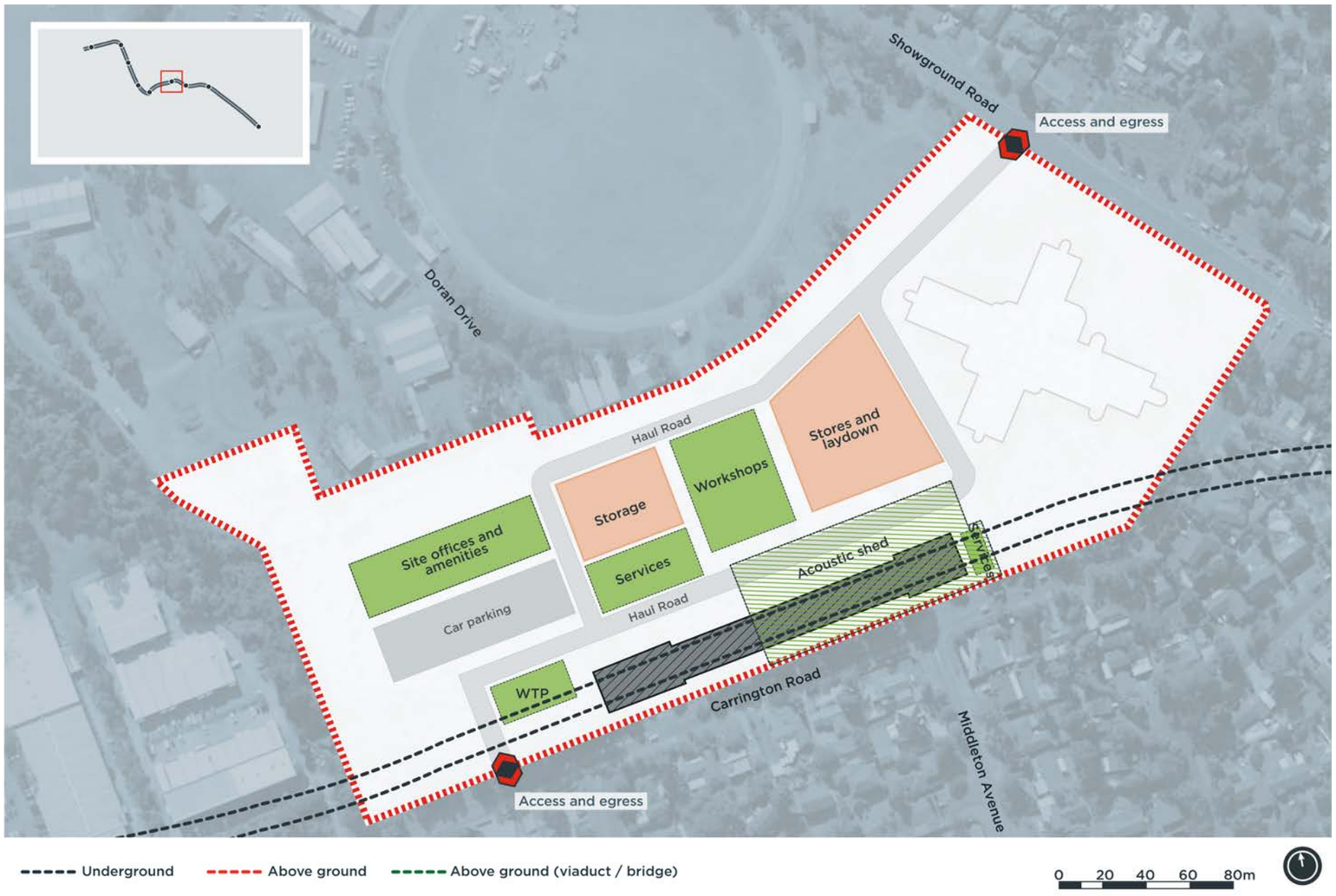
The roof slabs would consist of closely spaced pre-cast girders spanning the full width of the station box, placed on the piled wall capping beam (installed as part of stage 1 works). A concrete topping slab would be poured on the girders, followed by a waterproof membrane and a membrane concrete protection layer. The area would then be backfilled to the surface level.

The platform canopy components would likely be fabricated at an offsite location. The canopies would likely be assembled at ground level adjacent to the station platform then lifted into place as a single structure.

Table 7.5 Showground Station indicative program

Construction activities	Indicative construction timeframe																			
	2015				2016				2017				2018				2019			
Station structural works									•	•	•	•	•							
Internal walls and architectural finishes											•	•	•	•						
Mechanical and electrical fit-out											•	•	•	•	•					
Precinct works												•	•	•	•					
Testing and commissioning														•	•					

Figure 7.2 Showground Station site layout



Underground station fit-out works

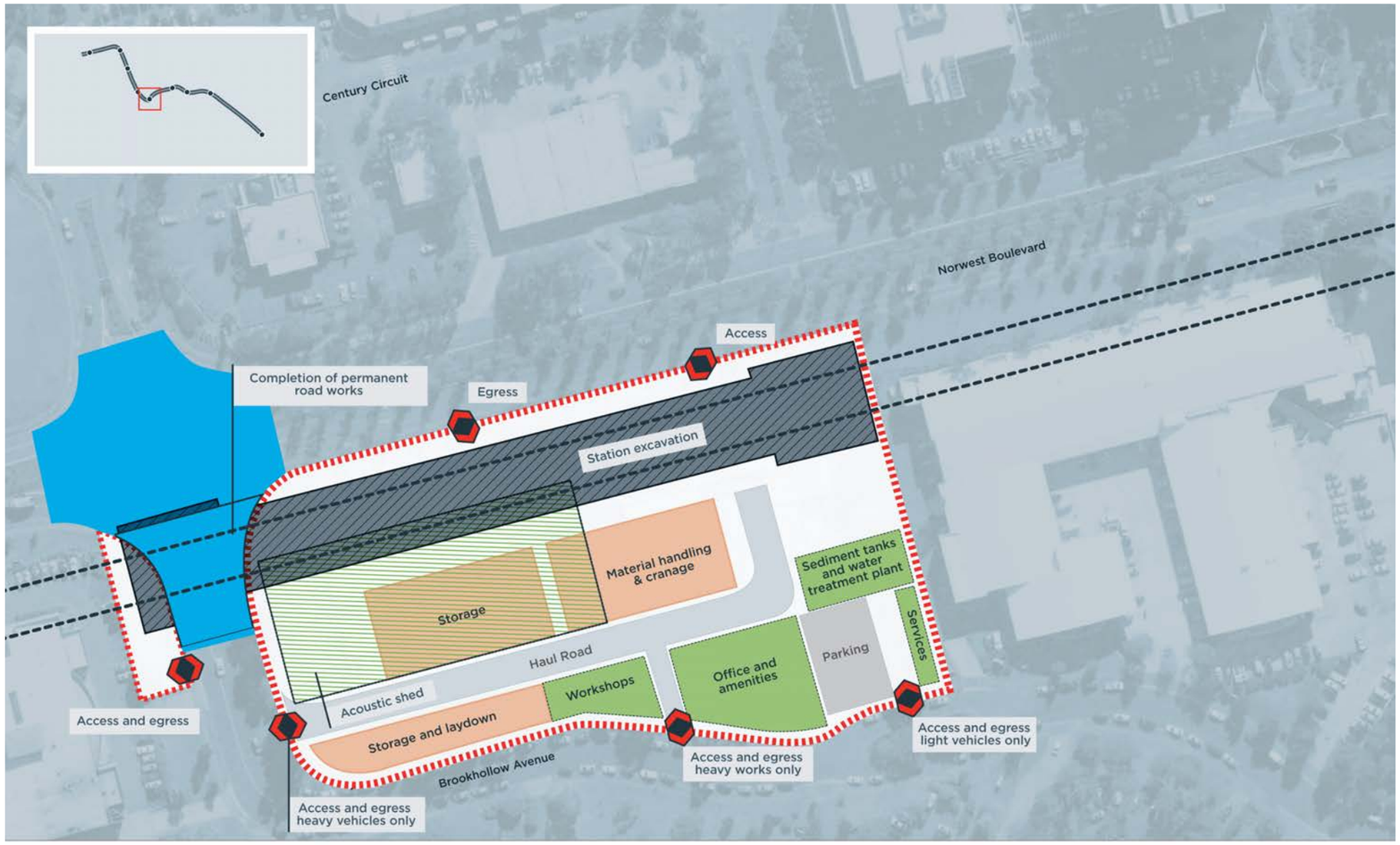
The mechanical and electrical fit-out of underground stations consists of two major elements, being the rail systems located at the stations and the services required for the function of the stations. The initial fit-out of mechanical and electrical services to the underground stations would occur concurrently with the structural works via openings left in the floors and roof structure. This would include the installation of large equipment such as ventilation fans. The final fit-out of mechanical and electrical services would occur after the completion of structural works and concurrently with the architectural fit-out.

The architectural fit-out of the underground stations would occur upon completion of the station structural works and involves the final finishes for the stations. The architectural fit-out would include elements such as glazing, wall and ceiling cladding, and floor finishes.

Table 7.6 Norwest Station indicative program

Construction activities	Indicative construction timeframe																			
	2015				2016				2017				2018				2019			
Station structural works							•	•	•	•	•									
Internal walls and architectural finishes								•	•	•	•									
Mechanical and electrical fit-out								•	•	•	•	•								
Precinct works											•	•								
Testing and commissioning												•	•							

Figure 7.3 Norwest Station site layout



7.5.2 Elevated stations

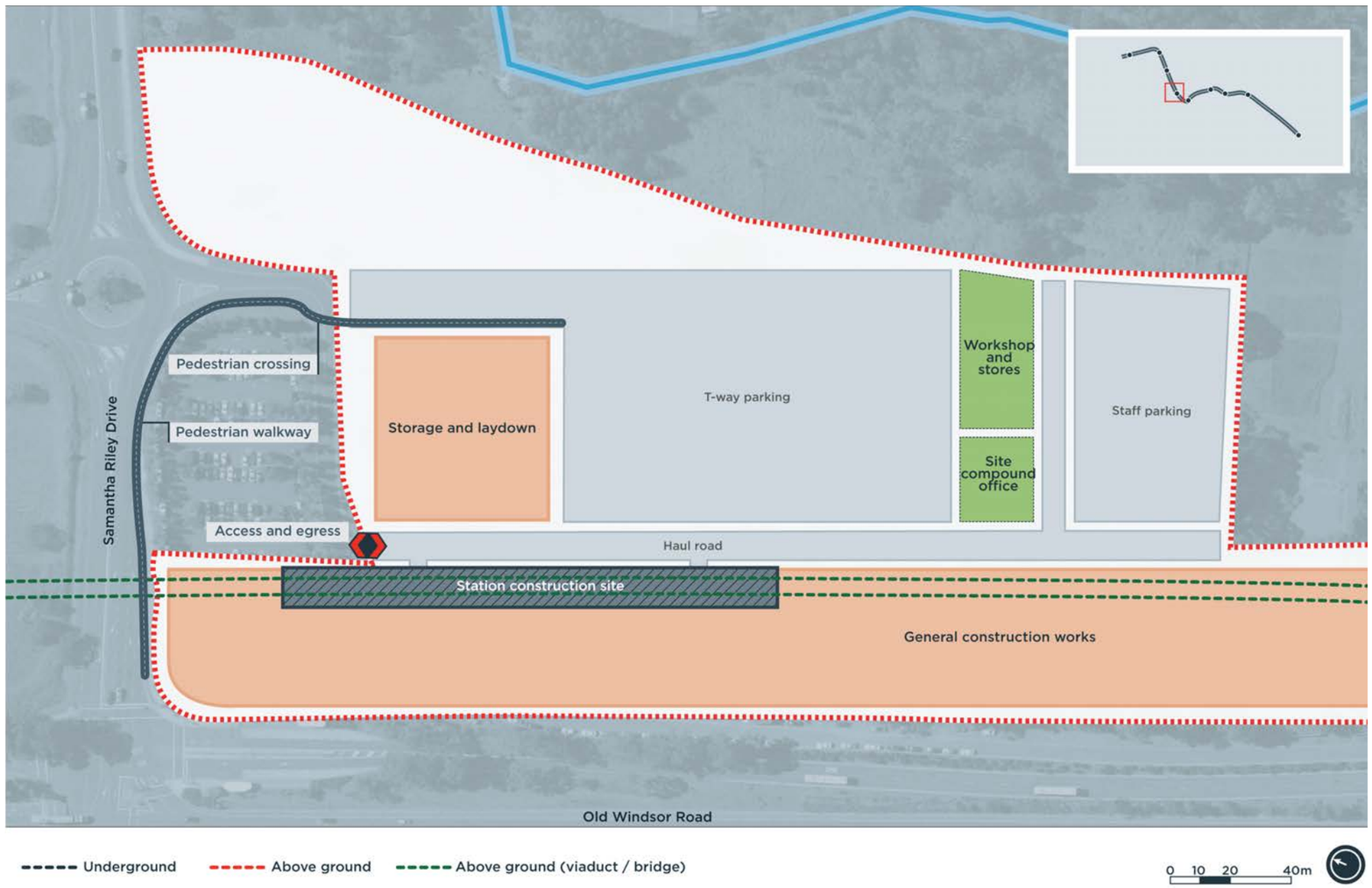
Two stations, Kellyville and Rouse Hill, are proposed to be on the viaduct structure. The construction of the viaduct structure would have been completed during Stage 1 major civil construction works (described within EIS 1). The construction works for the stations on the viaduct are described below.

Indicative construction site layouts for Kellyville and Rouse Hill Stations are provided in **Figure 7.4** and **Figure 7.5**, with indicative construction site programs in **Table 7.7** and **Table 7.8**.

Table 7.7 Kellyville Station indicative program

Construction activities	Indicative construction timeframe																			
	2015				2016				2017				2018				2019			
Station structural works								•	•	•										
Internal walls and architectural finishes									•	•	•	•								
Mechanical and electrical fit-out									•	•	•	•								
Precinct works											•	•	•	•						
Testing and commissioning												•	•							

Figure 7.4 Kellyville Station site layout



Elevated station structural works

The construction of the elevated stations would include:

- Support columns and foundations for the station structure.
- Emergency egress stairs.
- The platform structure.
- The vertical transport structure.
- The platform canopy.
- The station buildings.

The structures for the emergency stairs would be constructed through the erection of formwork followed by in-situ concrete pours.

The platforms would be typically formed by the placement of pre-cast concrete structures.

The vertical transportation structures (for example, stairs, escalators and lifts) would typically be pre-fabricated, assembled at ground level then lifted into place by cranes.

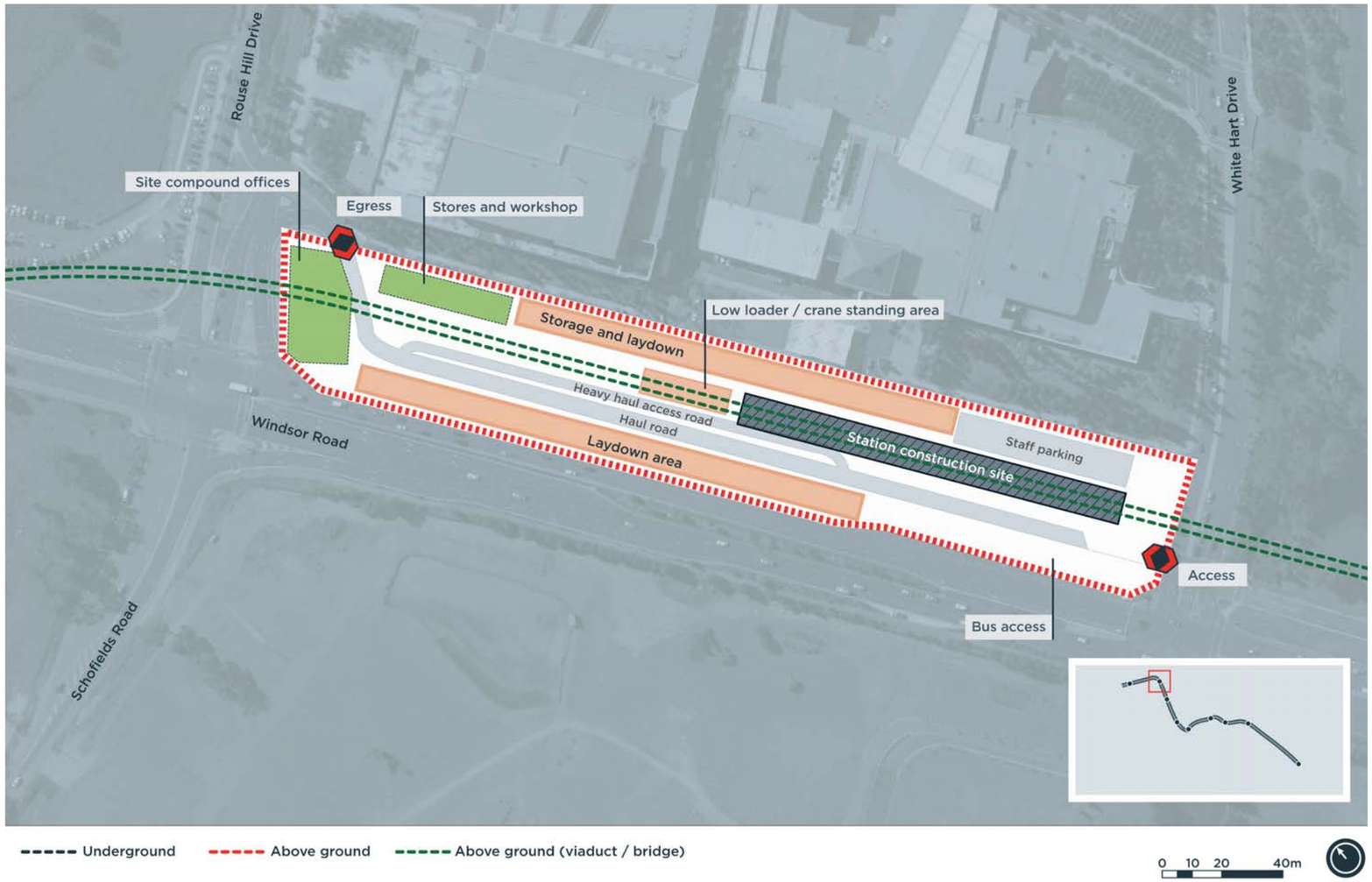
Following platform construction and installation of the vertical transport structures, the platform canopy would be constructed. The platform canopy would likely be fabricated at an offsite location. The canopy would be assembled at ground level adjacent to the station platform then lifted into place by crane to form a single structure.

The construction of the station buildings would occur concurrently with the station construction. Station buildings would generally consist of two main buildings located underneath the station structure. The buildings would typically be constructed using conventional steel frame methods.

Table 7.8 Rouse Hill Station indicative program

Construction activities	Indicative construction timeframe																			
	2015				2016				2017				2018				2019			
Station structural works								•	•	•										
Internal walls and architectural finishes									•	•	•	•								
Mechanical and electrical fit-out									•	•	•	•								
Precinct works												•	•							
Testing and commissioning												•	•							

Figure 7.5 Rouse Hill Station site layout



Elevated station fit-out works

As per the underground stations, the mechanical and electrical fit-out of the elevated stations consists of two major elements, being the rail systems located at the stations and the services required for the function of the stations.

The installation of the services would need to be undertaken concurrently with the station structural works and building frame construction. The final fit-out of mechanical and electrical services would occur after the completion of structural works and concurrently with the architectural fit-out.

The architectural fit-out of the elevated stations would occur upon completion of the station structural works and involves the final finishes for the stations. The architectural fit-out would include elements such as glazing, wall and ceiling cladding, and floor finishes.

7.5.3 Open cut stations

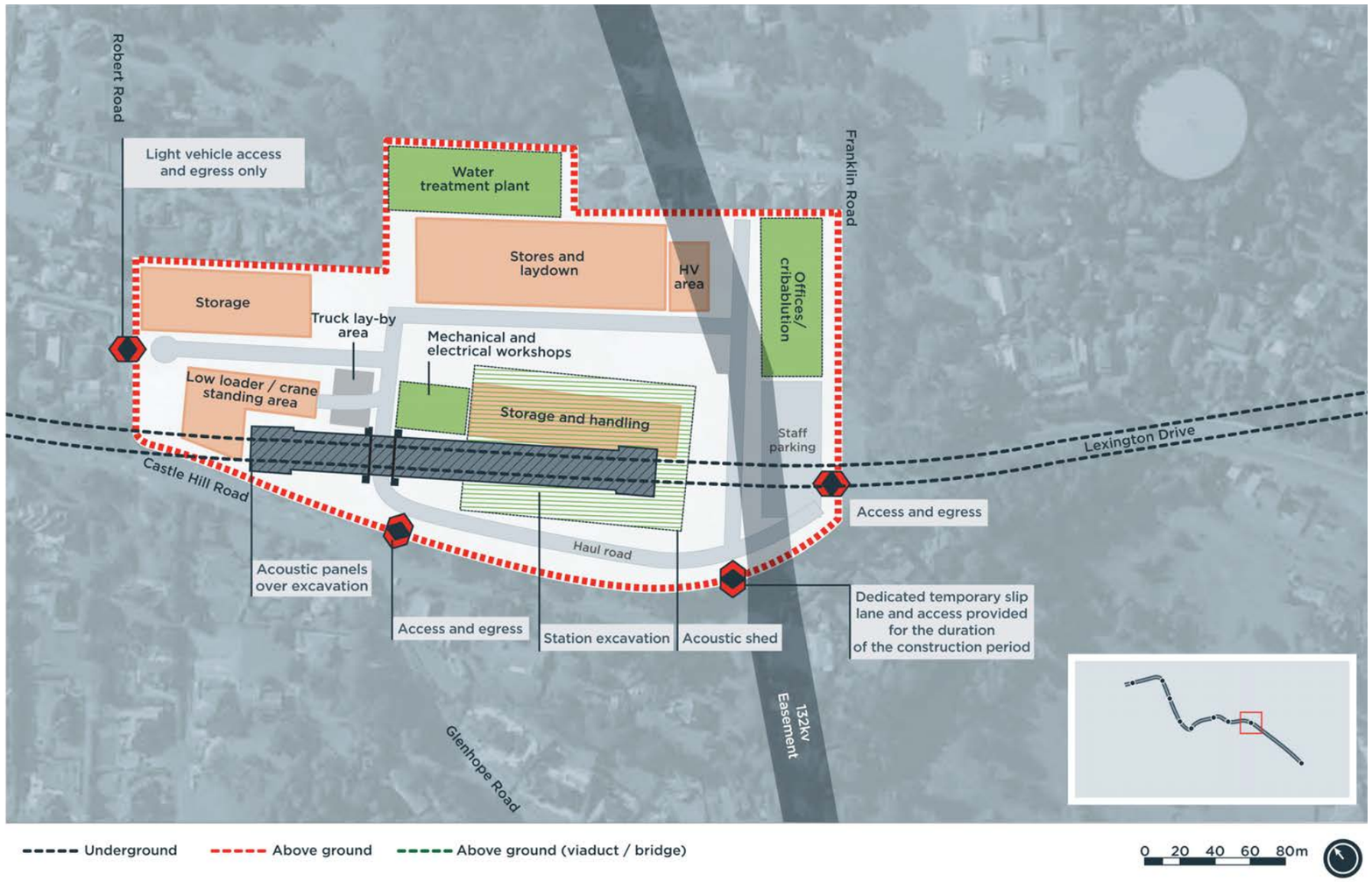
Cherrybrook and Bella Vista Stations would comprise open cuts, whilst Cudgegong Road Station would be located within a shallow cutting.

Indicative construction site layouts for Cherrybrook, Bella Vista and Cudgegong Road Stations are provided in **Figure 7.6**, **Figure 7.7** and **Figure 7.8**, with indicative construction site programs in **Table 7.9**, **Table 7.10** and **Table 7.11**.

Table 7.9 Cherrybrook Station indicative program

Construction activities	Indicative construction timeframe																			
	2015				2016				2017				2018				2019			
Station structural works							•	•	•	•										
Internal walls and architectural finishes								•	•	•	•									
Mechanical and electrical fit-out								•	•	•	•	•								
Precinct works										•	•	•	•	•	•					
Testing and commissioning												•	•							

Figure 7.6 Cherrybrook Station Site Layout



Open cut station structural works

The construction includes:

- Support columns and foundations for vertical transport structures and the station buildings.
- The platform structure.
- Vertical transport structure and the pedestrian accesses.
- The platform canopy.
- The emergency egress stairs.
- The station buildings.

Foundations would be constructed which would then be tied into a base slab and supporting column.

The vertical transport structure would generally be constructed from pre-fabricated steel. The majority of the steel structure would be assembled at ground level then moved into place by cranes.

The platform canopy would likely be fabricated at an offsite location. The canopy would likely be assembled at ground level adjacent to the station platform then moved into place as a single structure.

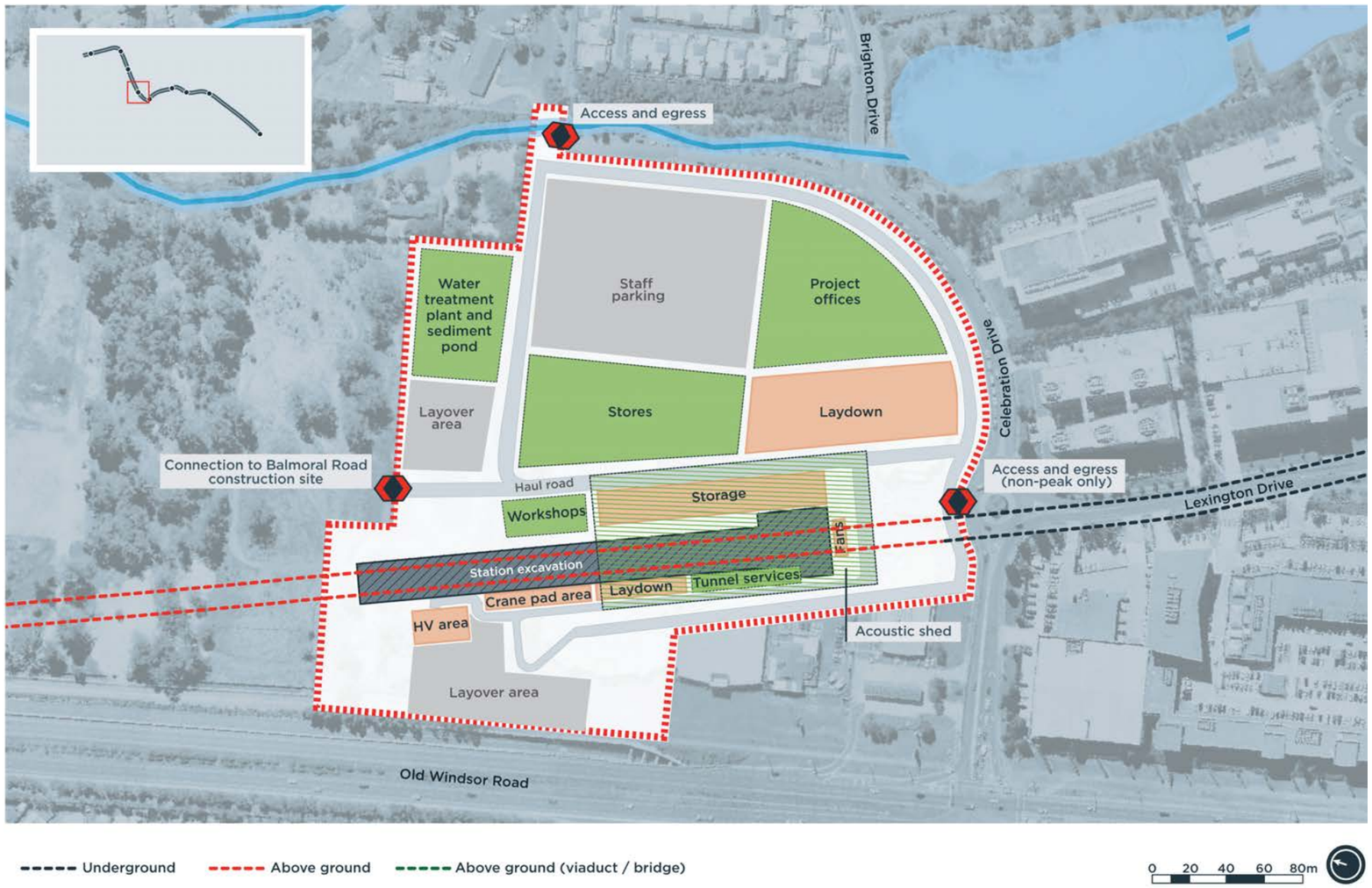
The emergency stairs would likely be constructed as steel structures, fabricated offsite, assembled at ground level and then lifted directly into place.

The construction of the station buildings would occur concurrently with the station construction.

Table 7.10 Bella Vista Station indicative program

Construction activities	Indicative construction timeframe																			
	2015				2016				2017				2018				2019			
Station structural works							●	●	●											
Internal walls and architectural finishes							●	●	●	●	●									
Mechanical and electrical fit-out								●	●	●	●									
Precinct works									●	●	●	●	●							
Testing and commissioning											●	●								

Figure 7.7 Bella Vista Station Site Layout



Open cut station fit-out works

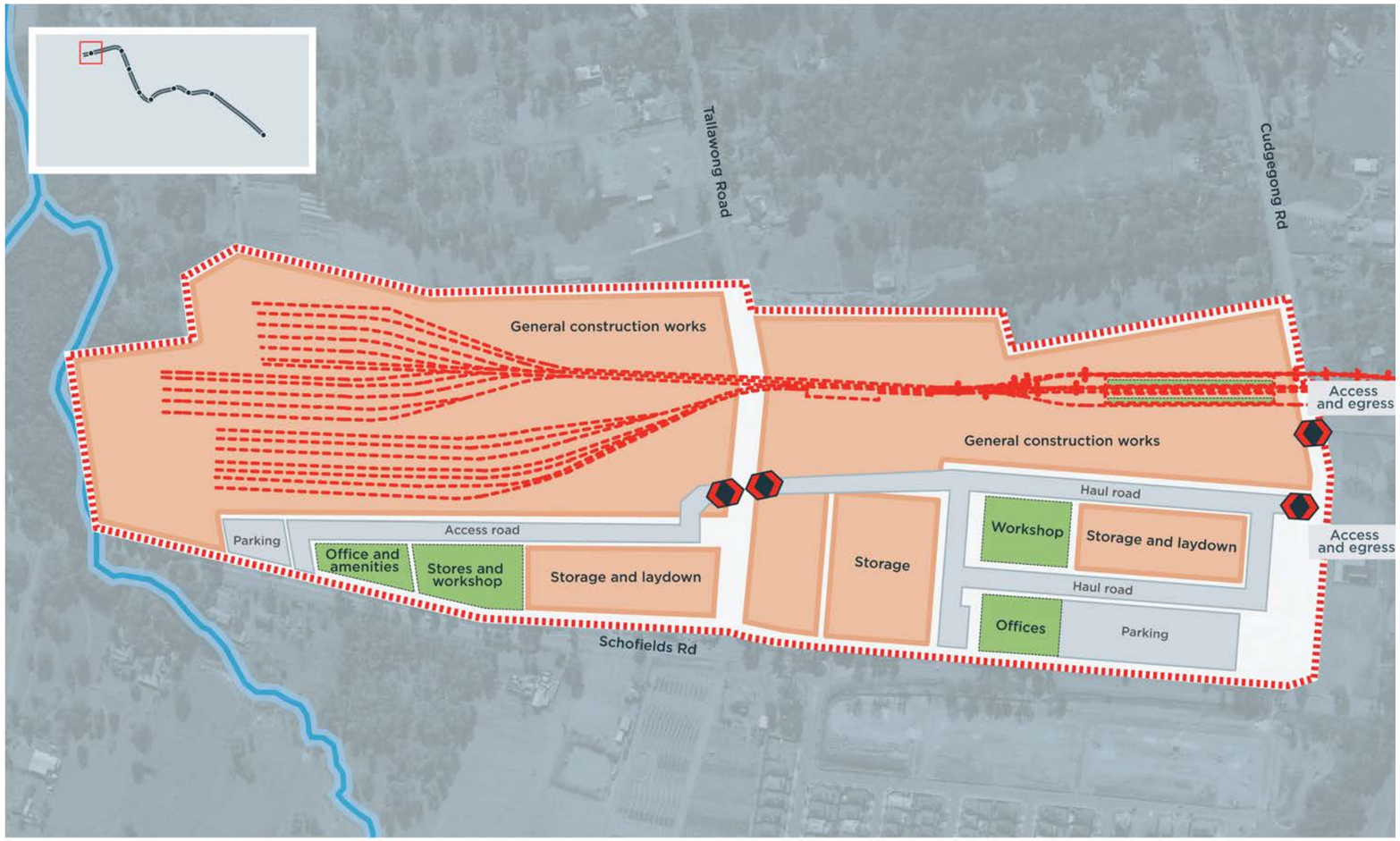
The mechanical and electrical fit-out of the open cut stations consists of two major elements, being the rail systems located at the stations and the services required for the function of the stations. Fit-out of the stations would be similar to the elevated stations.

The architectural fit-out of the at-grade station would occur upon completion of the station structural works and involves the final finishes for the stations. The architectural fit-out would include elements such as glazing, wall and ceiling cladding, and floor finishes.

Table 7.11 Cudgegong Road Station and Tallawong Stabling Facility indicative program

Construction activities	Indicative construction timeframe																			
	2015				2016				2017				2018				2019			
Station structural works								•	•	•	•									
Internal walls and architectural finishes										•	•	•	•	•						
Mechanical and electrical fit-out											•	•	•	•						
Precinct works										•	•	•	•	•	•					
Station testing and commissioning														•	•					
Stabling facility installation								•	•	•	•									

Figure 7.8 Cudgegong Road Station and Tallawong Stabling Facility site layout



7.6 Station precinct works

The precinct works around each of the stations would be undertaken following substantial completion of the station structural and fit-out works, and concurrently with testing and commissioning. Precinct works would involve a range of activities including roadworks, buildings works and landscaping. The elements to be constructed at each of the station precincts are detailed in Chapter 6.

Each of the stations would include some form of interface with other transport modes. These works would include the construction of roads and car parks, including:

- Earthworks.
- Drainage works.
- Kerb and guttering.
- Surfacing including asphalt, concrete and pavers.
- Bus shelters and other buildings.
- Line marking, signage and other finishes.

Public amenities would also be constructed at the stations.

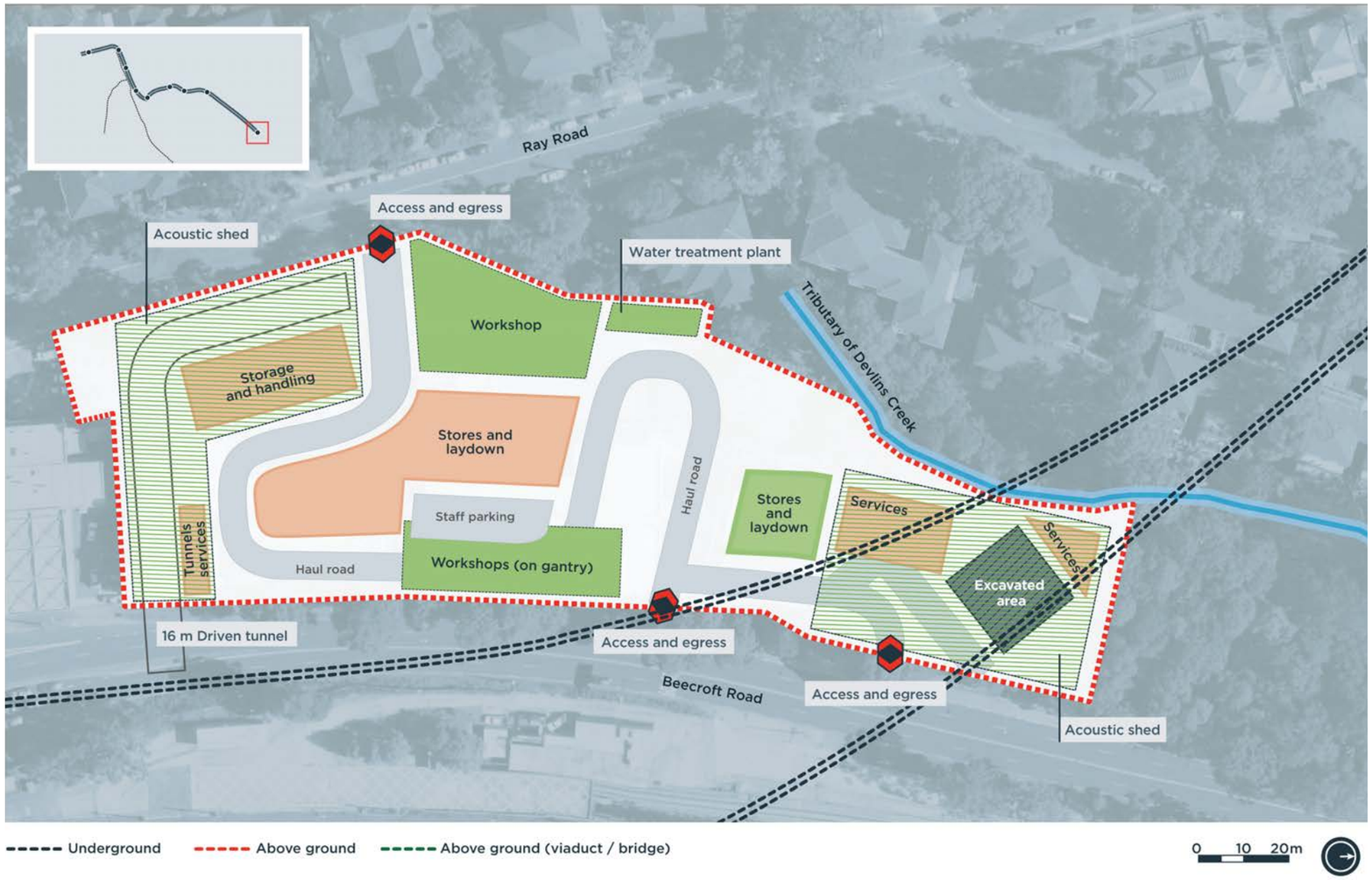
The landscaping works would vary significantly between the station sites, ranging from the protection of existing vegetation to the creation of public spaces. Landscaping works would generally involve:

- Earthworks.
- Soil improvement and topsoil dressing.
- Drainage works.
- Irrigation systems.
- Planting, commencing with large plants and progressing to smaller plants and turf.
- Finishing works.

Table 7.12 Epping Services Facility indicative program

Construction activities	Indicative construction timeframe																			
	2015				2016				2017				2018				2019			
Construction of building and finishes							•	•	•	•										
Construction of substation building							•	•	•	•										
Mechanical and electrical fit-out										•	•									
Testing and commissioning												•	•	•						

Figure 7.9 Epping Services Facility site layout



7.7 Services facility construction and fit-out

Services facilities are proposed at Epping and Cheltenham. Piling works for the permanent services facility support would have been undertaken during the excavation of the shaft (described within EIS 1).

Lining of the shaft would typically be undertaken by a bottom-up sequence with any reinforcement required fabricated on the surface and lifted into the shaft.

Installation of services would also follow a bottom-up sequence occurring progressively as the structural works in these areas are completed.

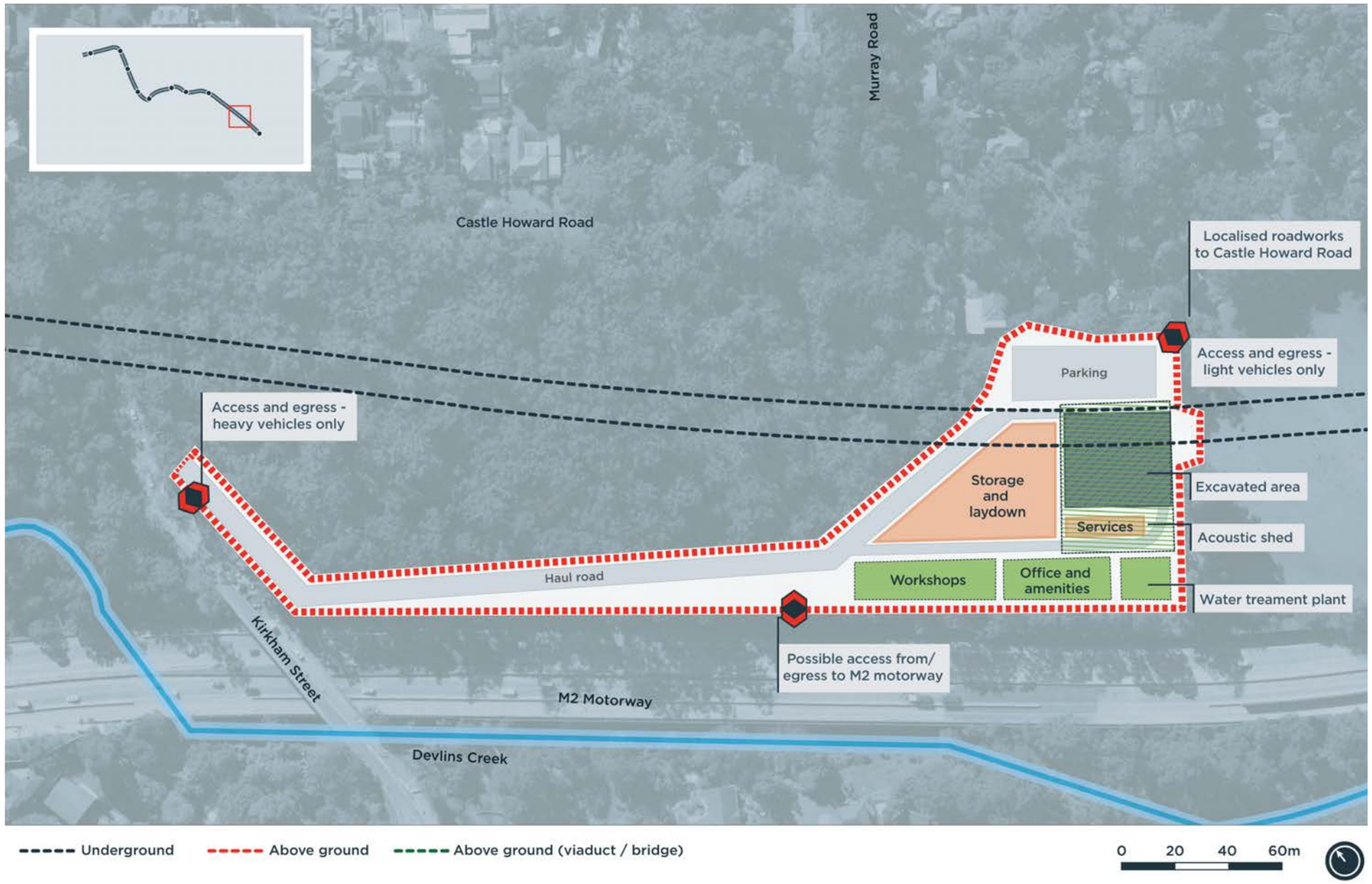
At the conclusion of the installation of services the architectural wall and ceiling cladding fit out would occur, followed by the final fit-out of all services.

Indicative construction site layouts for Epping and Cheltenham Services Facilities are provided in **Figure 7.9** and **Figure 7.10**, with indicative construction site programs in **Table 7.12** and **Table 7.13**.

Table 7.13 Cheltenham Services Facility indicative program

Construction activities	Indicative construction timeframe																			
	2015				2016				2017				2018				2019			
Construction of building and finishes							•	•												
Mechanical and electrical fit-out								•	•	•										

Figure 7.10 Cheltenham Services Facility site layout



7.8 Stabling and maintenance facility construction and fit-out

The rail systems fit-out at the Tallawong Stabling Facility is described as part of the at-grade surface fit-out in Section 7.10.

Buildings located at the Tallawong Stabling Facility would be constructed using conventional steel frame methods, with access roads and car parking constructed using the methods described for the station precinct works in Section 7.6.

An indicative construction site layout for the Tallawong Stabling Facility is provided in **Figure 7.8**, with an indicative construction site program in **Table 7.11**.

7.9 Tunnel rail systems fit-out

Access points for tunnel fit-out would include the portal at Bella Vista, Showground and Cherrybrook Stations and the temporary Epping decline tunnel. The Balmoral Road and / or Memorial Avenue construction sites would be utilised for storage and co-ordination of material delivery into the tunnels. Alternative access via the underground stations would be possible, however this access would diminish as the station fit-out progresses.

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

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

Indicative construction site programs for the tunnel fit-out works are provided in **Table 7.14**, **Table 7.15** and **Table 7.16**.

Table 7.14 Bella Vista Station to Showground Station

Construction activities	Indicative construction timeframe																			
	2015				2016				2017				2018				2019			
Trackwork							•	•												
Overhead wiring and signalling										•										
Fire & life safety								•												
Electrical and communications								•	•	•										
Rail systems testing and commissioning											•	•	•							

Table 7.15 Showground Station to Cherrybrook Station

Construction activities	Indicative construction timeframe																			
	2015				2016				2017				2018				2019			
Trackwork									•	•	•									
Overhead wiring and signalling													•							
Fire & life safety											•									
Electrical and communications											•	•	•							
Rail systems testing and commissioning													•	•	•					

Table 7.16 Cherrybrook Station to Epping

Construction activities	Indicative construction timeframe																			
	2015				2016				2017				2018				2019			
Trackwork							•	•	•											
Overhead wiring and signalling												•	•							
Fire & life safety									•											
Electrical and communications									•	•	•	•								
Rail systems testing and commissioning												•	•	•						

7.9.1 Ventilation

The majority of tunnel ventilation equipment would be located at the stations and service facilities. The fit-out of these elements are described as part of the mechanical and electrical fit-out components in the respective sections above.

Impulse fans would be required to be installed within niches located underground at the Cheltenham Services Facility. The plant required is likely to be delivered through the Epping Services Facility.

7.9.2 Track slab and rail fastening

The track slab would be formed by mass concrete pours. Rail fasteners would be attached to the concrete. Rail fasteners would typically incorporate resilient base plates as required to mitigate operational noise and vibration (refer to Chapter 10 – Noise and Vibration).

7.9.3 Rail installation, fixing and welding

Rail would be delivered to site in lengths between 13m and 20m where they would be welded into 110m lengths. The main welding yard is likely to be at Bella Vista, with additional yards at Tallawong Road and Cherrybrook. In tunnel welding would also be required once rail is in place.

Placement, fixing and fastening of rail within the tunnels would be an automated process.

Potentially, some rail may be delivered by work trains from the Main North Rail Line, subject to availability of train paths.

7.9.4 Cable and equipment installation

Dedicated cable routes would be provided within the tunnel environment for signalling, communications and electricity. Rooms for signalling and communications equipment would be provided at every second cross passage, alternating with power equipment rooms within the other cross passages.

7.9.5 Overhead wiring

Overhead wiring would be installed at intervals between 20m (on tight curves) to 70m (on straight sections of track). Overhead wiring would have a main support located centrally over the track with a secondary support to the side of the tunnel.

7.9.6 Other equipment

Installation of equipment in the tunnel would comprise pre-cast elements, construction in-situ and mechanical and electrical fit out.

7.10 Surface and viaduct rail systems fit-out

The rail systems fit-out for the surface and the viaduct sections of the alignment follow similar processes to the tunnelling fit-out.

The main access point for the viaduct fit-out would be the Tallawong Stabling Facility and the Balmoral Road and / or Memorial Avenue construction sites with secondary access provided via other surface work sites. At-grade and viaduct systems fit-out works would include:

- Track and rail fastening.
- Rail installation, fixing and welding.
- Cable and equipment installation including signalling, communications and electricity.
- Overheard wiring structures installation.
- Other equipment including – lighting (including emergency lighting), drainage works, noise attenuation where required and fire and life safety systems (including walkways connecting to emergency egress and fire hydrant systems).

Indicative construction site layouts for the surface and viaduct sites are provided in **Figure 7.11** to **Figure 7.16**. An indicative construction site program for the surface and viaduct section of the alignment is provided in **Table 7.17**.

Figure 7.11 Balmoral Road construction site layout

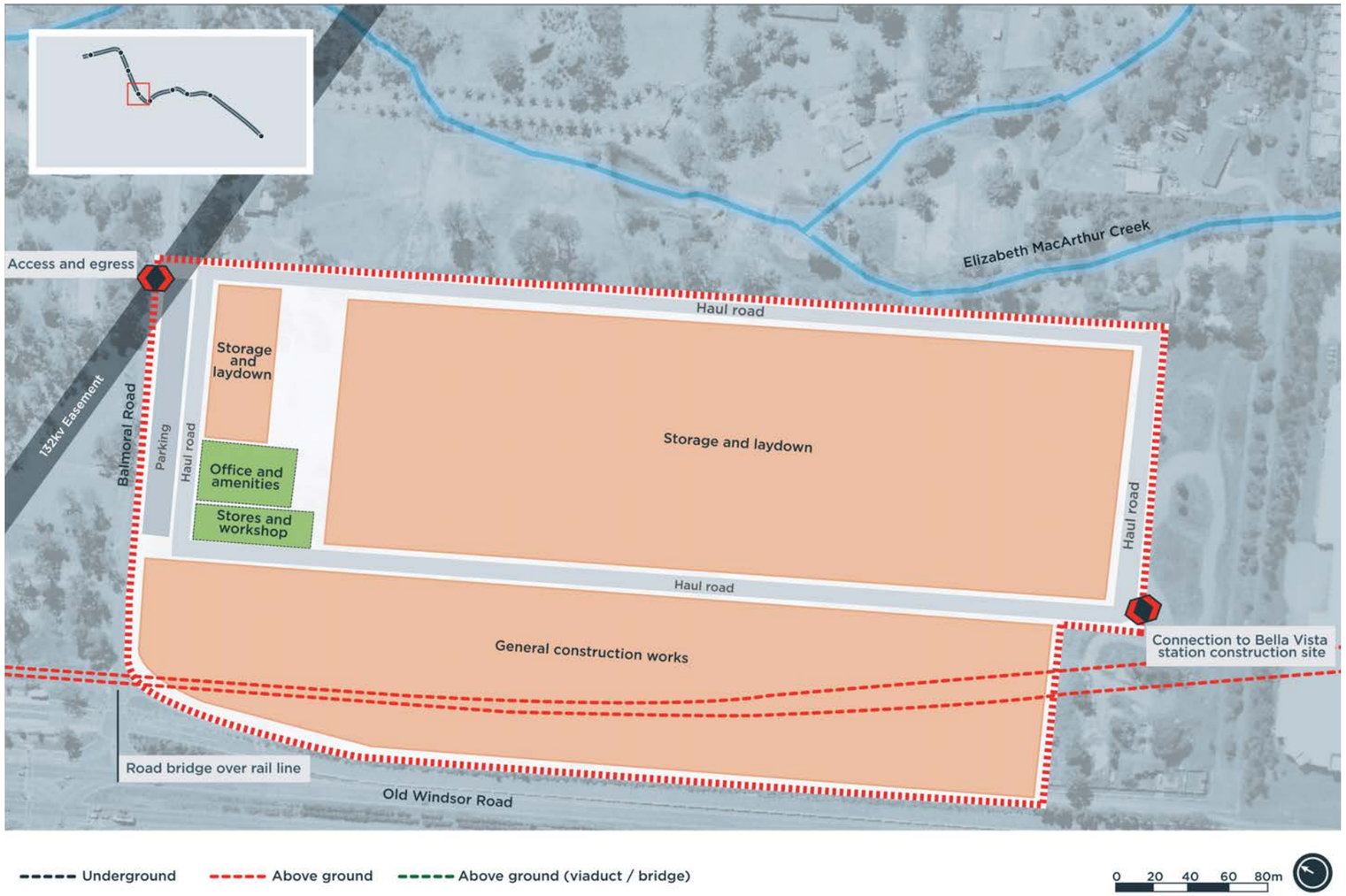


Figure 7.12 Memorial Avenue construction site layout

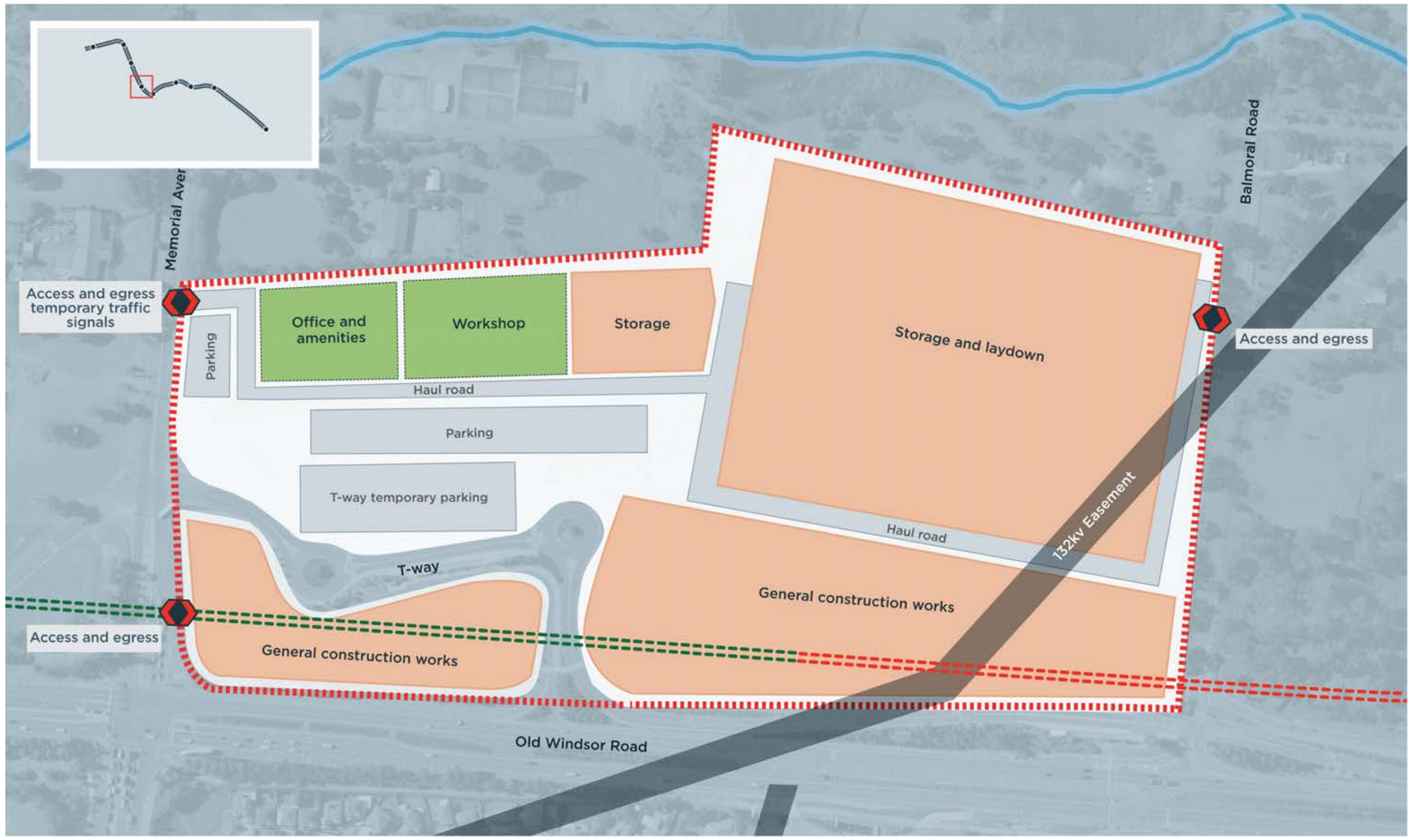


Figure 7.13 Samantha Riley Drive to Windsor Road construction site layout

Figure 7.14 Old Windsor Road to White Hart Drive construction site layout

Figure 7.15 Windsor Road Viaduct construction site layout

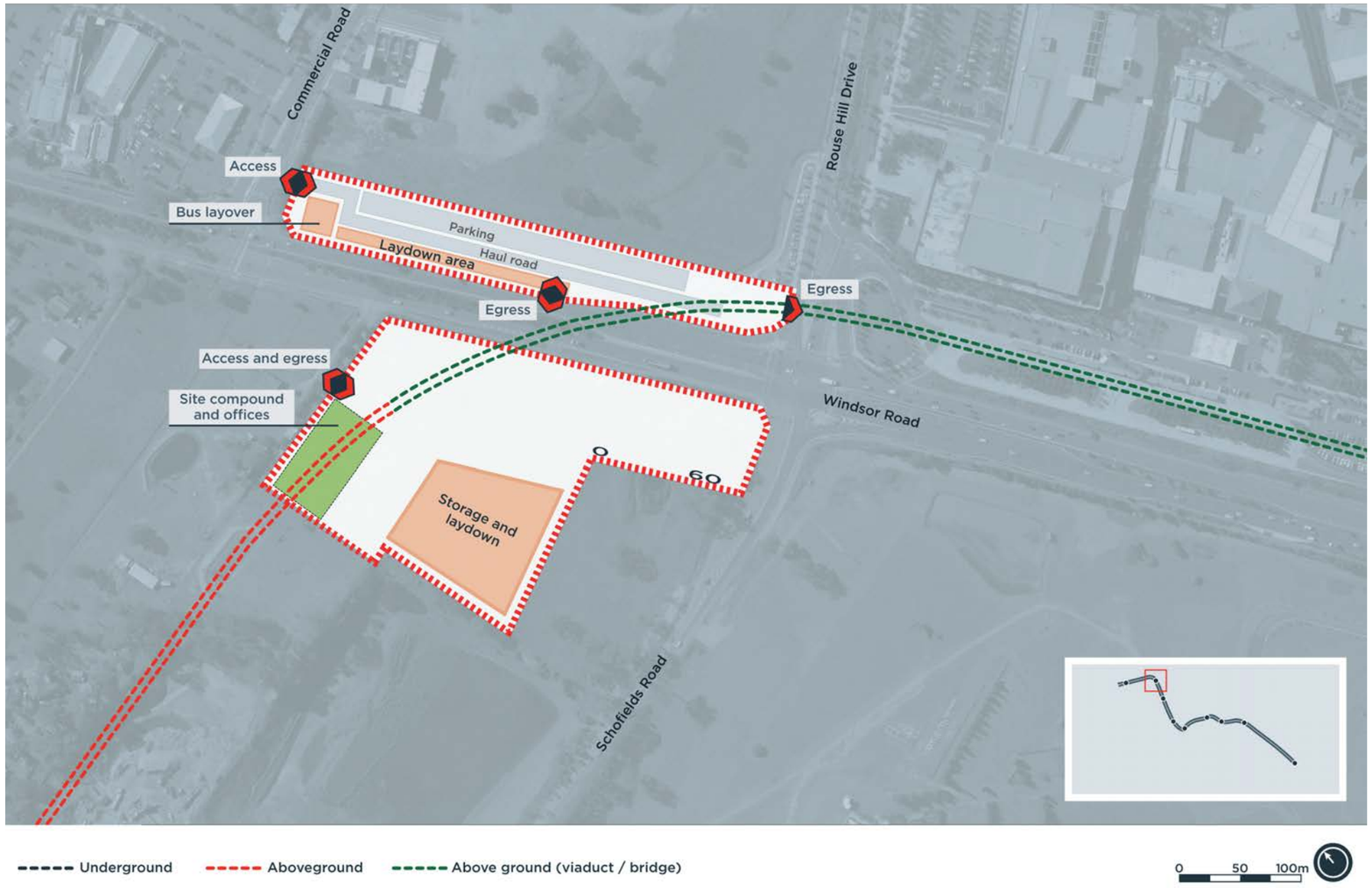


Figure 7.16 Windsor Road Viaduct to Cudgegong Road construction site layout

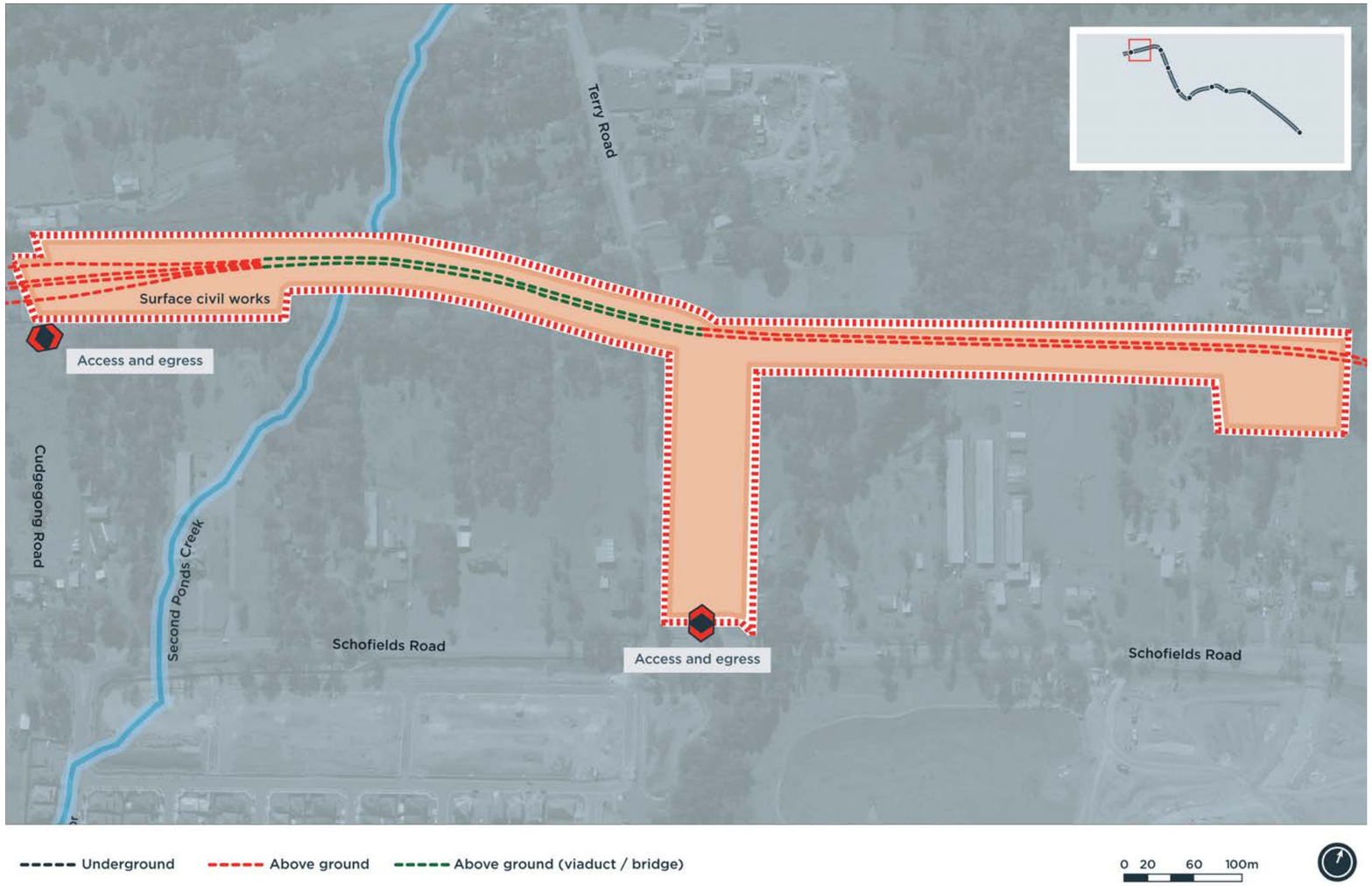


Table 7.17 Above-ground alignment indicative program

Construction activities	Indicative construction timeframe				
	2015	2016	2017	2018	2019
Trackwork			• •		
Overhead wiring and signalling		• • •			
Electrical and communications		• • • • • •			
Rail systems testing and commissioning			• • • •		

7.10.1 Track and rail fastening

Track is likely to be delivered into place using a portable end fed track laying technique. Materials may be supplied to the track laying face by either end or side delivery depending on access arrangements within the particular zone.

7.10.2 Rail installation, fixing and welding

Rail would be delivered to site in lengths between 13m and 20m where they would be welded into 110m lengths. The main welding yards are likely to be at Balmoral Road and / or Memorial Avenue construction sites and at Tallawong Road. In track welding would also be required once rail is in place.

7.10.3 Cable and equipment installation

Cable brackets, trays and conduits would generally be installed by rubber tyred plant prior to track fit-out. Dedicated cable routes would be provided for signalling, communications and electricity.

Signal equipment rooms would be provided at the stabling area, at each station and alongside the surface alignment as required. Communication rooms would be provided at the stabling area, and at each station. The signal and communication rooms at the station would be connected to the communications backbone and subsequent system destinations.

7.10.4 Overhead wiring

Overhead wiring structures would be installed for the surface sections with footings installed into the track subgrade.

The viaduct sections would require a more complex overhead wiring structure with structures connected directly to the concrete viaduct segments.

Overhead wiring structures at the stabling yard would support the stabling roads and turnout configurations.

Wiring would be installed at intervals between 20 metres (on tight curves) to 70 metres (on straight sections of track). There would be a concentration of overhead wiring structures at rail turnout locations.

7.10.5 Other equipment

Installation of equipment would comprise of pre-cast elements, construction in-situ and mechanical and electrical fit out.

7.11 Testing and commissioning

The rail systems at each individual site (station, services facility or stabling yard) would be commissioned as standalone entities.

Once all services fit-out work is complete, testing and commissioning would occur in the following three stages:

- **Assemble testing procedures and pre-checks** – the collection of safety and quality assurance documentation and commissioning readiness checks.
- **Installation and operation tests** – all tests and checks with installation elements of work.
- **Site acceptance tests** – the final inspection, testing, commissioning and validation of individual systems.

During the final stages of commissioning, test trains would be run on the line for final signal system testing and commissioning, and traction power testing.

7.12 Other construction issues

7.12.1 Epping interface works

The proposed works would connect directly into the ECRL around Epping Station. Bulkheads would have been installed at the commencement of the major civil construction works (detailed in EIS 1) in order to physically separate the NWRL from the operational ECRL, and to ensure a safe workplace and operational safety of existing rail lines. A number of works would be required as part of the rail systems and stations construction on the ECRL side of the bulkhead, including:

- Installation of rail turnouts.
- Relocation of existing electrical, signalling and communications cables and installation of new NWRL electrical, signalling and communications cables.
- Installation of overhead wiring, including construction of the overhead wiring structure.
- Removal of the separation bulkheads.
- Testing and commissioning.

These works would be required to be carried out under a series of rail possessions (closure of the rail line to allow works to be safely undertaken on or adjacent to the existing infrastructure). Rail possessions would be planned to ensure alternative arrangements are in place for passengers.

7.12.2 Traffic management

The proposed access to the construction worksites is detailed in **Table 7.18** along with anticipated daily heavy vehicle and light vehicle movements. These vehicle movements are associated with waste removal, material deliveries, and the arrival and departure of construction workers. Wherever possible, access is proposed to be gained from major arterial roadways. A vehicle movement is defined as a vehicle entering the site or a vehicle leaving the site. Therefore, each vehicle would generate two movements.

EIS 2 works are expected to commence after EIS 1 works are largely or fully complete, and as such the peak vehicle movements for EIS 1 and EIS 2 works would not coincide at the nominated sites. Further assessment of the potential construction traffic impacts is provided in Chapter 9.

Table 7.18 Access routes to construction sites

Construction Site	Proposed Access Route	Peak Daily Heavy Vehicle Movements	Daily Light Vehicle Movements
Epping Services Facility	Beecroft Road (left in, left out) Ray Road (right in, left out)	100	60
Cheltenham Services Facility	M2 Motorway (left in, left out) Kirkham Street (left in, right out)Castle Howard Road (light vehicles only)	70	30
Cherrybrook Station	Castle Hill Road at Glenhope Road (All movements)[1] Robert Road (left in, left out)[1] Franklin Road (left in, left out, right out)	150	60
Castle Hill Station	Old Northern Road / Terminus Street (all movements) McMullen Avenue (left in, left out) Crane Road (left out only)	150	30
Showground Station	Showground Road (all movements) Carrington Road (all movements)	120	60
Norwest Station	Norwest Boulevard Brookhollow Avenue	150	20
Bella Vista Station	Celebration Drive (all movements) Balmoral Road (right in, left out)	100	20
Balmoral Road / Memorial Avenue	Balmoral Road (left in, right out) Memorial Avenue (all movements)	200	300
Kellyville Station	Samantha Riley Drive (all movements)	100	40
Rouse Hill Station	White Hart Drive (left in) Rouse Hill Drive (left out)	100	40
Windsor Road Viaduct	Rouse Hill Drive (left in, right out) Commercial Road (right in, left out) Windsor Road (left in, left out)	150	60
Cudgegong Road Station and Tallawong Stabling Facility	Cudgegong Road (all movements) Tallawong Road (all movements)wSchofields Road (all movements)	276	240

Note 1: The Castle Hill Road access to Cherrybrook Station would be utilised until the permanent Robert Road signalised intersection is established.

7.12.3 Materials

The rail systems and stations construction works would require the use of a variety of construction materials. The major items and indicative quantities would be:

- Concrete – 250,000m^3.
- Steel – 35,000 tonnes.

7.12.4 Construction hours

The proposed construction hours for the underground and aboveground activities are outlined in **Table 7.19**.

Table 7.19 Proposed construction hours

Activity	Construction Hours	Comments or Exceptions
Underground Construction Activities		
Trackwork, tunnel systems and tunnel rail systems.	24 hours per day, seven days per week	Activities on the surface that support trackwork, tunnel systems and tunnel rail systems may need to occur 24 hours per day, up to seven days per week.
Above ground Construction Activities		
Above ground construction	❖ 7am – 6pm Monday to Friday ❖ 8am – 1pm Saturdays ❖ No works on Sundays or Public Holidays	Surface works supporting underground construction (eg concrete pumping, truck loading) would be expected to be required 24 hours per day, up to seven days per week at sites where noise impact management measures have been established. Non-disruptive preparatory work, repairs or maintenance may be carried out on Saturday afternoons between 1pm and 5pm or Sundays between 8am and 5pm. Activities requiring the temporary possession of roads may need to be undertaken outside the standard daytime construction hours during periods of low demand to minimise safety impacts and inconvenience to commuters. Activities requiring rail possessions may need to be undertaken outside the standard construction hours up to 24 hours per day, seven days per week.

Other works which would be undertaken outside of the above standard daytime construction hours without any further approval include:

- Works which are determined to comply with the relevant Noise Management Level (NML) at the nearest sensitive receiver.
- Works required to be undertaken during rail possessions.
- Works required to be undertaken by RMS outside the standard hours
- The delivery of materials outside of approved hours as required by the Police or other authorities (including RMS) for safety reasons.
- Where it is required to avoid the loss of lives, property and / or to prevent environmental harm in an emergency.
- Where agreement is reached with affected receivers.

With the exception of emergency works, activities would not take place outside standard daytime construction hours without prior discussion with and / or notification of local residents, businesses and the EPA.

7.12.5 Construction plant and equipment

Table 7.20 lists the typical plant and equipment likely to be used. The number provides the likely maximum in use at any one site at any point in time.

Table 7.20 Indicative construction plant and equipment

Plant and Equipment	Number per site[1]
Excavator (3 tonne)	1
Excavator (6 tonne)	4
Excavator (10 tonne)	2
Excavator (20 tonne)	2
Excavator (30 tonne)	1
Skidsteer loader	2
Backhoe / front end loader	2
Bulldozer	1
Grader	2
Vibratory roller (10 tonne)	3
Dump truck (15 tonne)	5
Concrete truck	2
Concrete pump	2
Concrete vibrator	2
Bored piling rig (60 tonne)	1
Bored piling rig (20 tonne)	4
12 tonne track mounted drill rig	2
Compressor (600 CFM)	1
Compressor (1500 CFM)	2
Concrete saw	1
Rockbreaker	1
Jackhammer	1
Generator	1
Lighting tower	1
Crawler crane (50 tonne)	1
Mobile crane	3
Alimak hoist	1
All terrain forklift	3
Elevated work platform	6
Low loader	1
Water treatment plant	1
Hi Rail cable installation vehicles	18 in total across the project
Hi Rail overhead wiring vehicles	9 in total across the project
Specialised on track plant	9 in total across the project
Rail maintenance vehicles	9 in total across the project
Hand tools	Numerous

Note 1: Plant and equipment numbers are per site unless otherwise indicated

This list is indicative only. The actual plant and equipment used on site and the numbers required would be further refined during the detailed design phase of the project.

7.12.6 Workforce

During the rail systems and stations construction works, approximately 600 jobs are expected to be directly created during the peak construction period. Further jobs would also be indirectly created by the project. **Figure 7.17** provides a breakdown of the peak construction workforce numbers across thealignment.

7.12.7 Demobilisation and rehabilitation

At the completion of the construction phase the contractor(s) would demobilise all construction equipment from the work sites, and undertake rehabilitation and revegetation works on work sites which were occupied temporarily (ie sites not forming part of the operational footprint). As part of operational readiness phase the contractor would be progressively delivering the station precinct and services facility elements as described in Chapter 6. Typically this would involve the progressive removal of construction equipment, site sheds and other temporary construction site elements.

7.13 Construction Environmental Management Framework

A Construction Environmental Management Framework has been developed for the NWRL project and is provided in Appendix B. The Framework provides a linking document between the planning approval documentation and the CEMP to be developed by the construction contractors.

The Framework details the environmental, stakeholder and community management systems and processes for the construction of the NWRL. Specifically, it details the requirements in relation to the CEMP, sub-plans and other supporting documentation for each specific environmental aspect.

The mitigation measures relevant to each environmental issue are identified within the respective sections of this EIS.

Figure 7.17 Construction Workforce

CHAPTER 8

SOILS AND GROUNDWATER

8 SOILS AND GROUNDWATER

8.1 Introduction

This chapter describes the physical environment within the NWRL corridor in relation to soils and groundwater. It assesses the impact related to the operation of the railway as well as construction activities associated with Stations, Rail Infrastructure and Systems (the subject of EIS 2). The scope of the soils and groundwater assessment for the purposes of EIS 2 is:

Operations

- ❖ Assessment of potential groundwater and geotechnical issues after completion of the major civil construction works (which were the subject of EIS1).
- ❖ Treatment and discharge of long term tunnel water inflow.

Construction

- ❖ Soil erosion and land surface disturbance due to station precinct construction and related roadimprovements.
- ❖ Impacts on groundwater quality due to construction related activities.
- ❖ Discharge of groundwater to watercourses.

8.2 Director-General's Requirements and Statement of Commitments

The following sections set out the Director-General's Requirements, the Conditions of Approval and Statement of Commitments as they related to soils and groundwater, and where in the project these have been addressed. Unless otherwise stated, references are to chapters of EIS 1 in relation to major civil works and EIS 2 for Stations, Rail Infrastructure and Systems.

Table 8.1 Director-General's Requirements, Conditions of Approval and Statement of Commitments

DGR Reference	Description	Addressed
Director-General's Requirements 31 August 2012	Groundwater ❖ Details of groundwater management during operation, particularly with regards to; • Details of the groundwater management. • Proposed water discharge locations. • Volume of water to be discharged at each location. • Discharge water quality commitments; and • Details of any ongoing treatment (if required). Soils ❖ Soil erosion and assorted water course impacts, soil salinity and potential acid sulphate soils.	▪ Groundwater management addressed in Sections 8.5 and 8.7.1 Operation; 8.6.2 and 8.7.2 Construction. ▪ Soil erosion, soil salinity, water course impacts in Sections 8.5 and 8.6. ▪ Acid Sulphate Soils in Section 8.4.8
CoA Reference	**Description**	**Addressed**
3.7	**Geotechnical** The Proponent shall identify risks to groundwater quality and/ or risks to surface water quality from contaminated groundwater during construction and operation, including measures to avoid, manage, mitigate and monitor impacts.	▪ Groundwater in Sections 8.4 and of EIS 1. ▪ Surface water quality in Chapter 18 EIS 1. ▪ Groundwater impacts relating to stations and operation in Section 8.5 EIS 2.
CoA Reference	**Description**	**Addressed**
3.8	The Proponent shall identify the following matters in relation to the bored tunnel components of the project: a. existing groundwater conditions (level and quality), taking into consideration seasonal variability; b. local and regional drawdown impacts, including any groundwater users impacted by the project and measures to offset impacts; c. options for the sustainable use and/or disposal of tunnel inflow; d. measures to minimise the risk of bed cracking and loss of surface flow when tunnelling below creek lines and contingency measures for restoring affected waterways consistent with pre-construction conditions, including monitoring procedures and performance criteria; e. impacts to groundwater dependent ecological communities (affected by groundwater drawdown) and to riparian and in stream ecology (affected by surface cracking and water flow impacts); and f. surface locations (and associated infrastructure) above the tunnel alignment that are likely to be at risk to land subsidence or settlement impacts, including relevant settlement design criteria and measures to minimise, monitor and offset impacts.	▪ Section 8.3.6 EIS 1 with additional data on existing groundwater conditions in Section 8.4 EIS 2. ▪ Sections 8.4.2 and 8.5 EIS 1 and Section 8.6 EIS 2 for stations and operation. ▪ Section8.5 (SG32) of EIS1. ▪ Section 8.5 EIS 1, measures for restoring water quality in Chapter 18 EIS 1. ▪ Chapter 15 and Chapter 18 EIS 1 and Sections8.5 and 8.6 EIS 2 for stations and operation. ▪ Section 8.4.1 EIS 1.
Statement of Commitment Requirements	**Description**	**Addressed**
35	Detailed geotechnical and groundwater investigations would be undertaken involving site investigations to inform future design development.	Sections 8.2.2 and 8.5 EIS1.

8.3 Assessment Methodology

8.3.1 Background information

A number of geotechnical studies and investigations have been undertaken to support previous proposals for the NWRL and predecessor schemes during the period 2002 to 2009. These have been reviewed for the purposes of this assessment.

Geotechnical investigations for NWRL are being undertaken in three phases as follows:

- **Phase One Investigations** – geotechnical and contamination scope that began on 6th September 2011 and concluded in January 2012 for investigations along the base case alignment. Data available from the Phase One investigation up until November 2011 and previous project data was incorporated in the geotechnical report *NWRL Preliminary Geotechnical Interpretive Report 14 December 2011* which formed basis for the Soils and Groundwater assessment in EIS 1. Groundwater monitoring and quality testing is ongoing, with a 6 monthly testing regime from selected standpipes underway as of January 2012. This data is to inform the geotechnical design and groundwater treatment requirements.
- **Phase Two Investigations** – geotechnical and contamination investigations for gaps in the Phase One study and for the revised NWRL horizontal and vertical alignment of 16th December 2011. Works for the Phase Two field investigations commenced on 30th January 2012 and concluded on 23rd March 2012. A Final *NWRL Geotechnical Data Report and Geotechnical Interpretive Report,* based on the Phase One and Two studies, was completed in May 2012.
- **Phase Three Investigations** – mitigation measures set out in Section 8.7 include recommendations for additional investigations. Contractors bidding for delivery contracts are also expected to request additional investigation.

The scope of geotechnical investigations completed to date has been:

- A limited field and laboratory program to assess the identified Areas of Environmental Concern (AEC) and Contaminants of Potential Concern (CoPC) and to provide a general coverage at selected accessible areas, utilising the geotechnical test pits and boreholes as sampling points.
- Soil samples for contamination assessment collected from 57 selected boreholes drilled as part of the geotechnical investigation. Boreholes were drilled up to a 75m depth and representative soil samples were collected at selected/regular intervals in fill and near surface soil where practicable.
- Soil samples for contamination assessment also collected from 21 test pits excavated as part of the geotechnical investigation. Test pits were excavated up to a 3m depth and representative soil samples collected at selected/regular intervals in fill and near surface soil where practicable.
- Laboratory analysis of selected soil samples for CoPC including Total petroleum hydrocarbons (TPH), benzene, toluene, ethylbenzene and xylenes (BTEX), Polycyclic aromatic hydrocarbons (PAH), Organochlorine pesticides (OCP), Polychlorinated biphenyls (PCBs), heavy metals (Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Zinc), total phenolics, asbestos, cations, anions, total dissolved solids (TDS) and sulphate reducing bacteria (SRB)
- Two rounds of groundwater sampling were undertaken. The first round was undertaken from 19 January to 13 February 2012 and groundwater samples were collected from 35 monitoring wells. The second round of groundwater sampling was undertaken from 9 March to 13 April 2012 and groundwater samples were collected from 57 monitoring wells, including 9 existing monitoring wells. The monitoring wells were installed up to a 75m depth with some shallower monitoring wells installed to target service station sites and the Hills Council Depot.
- Inclusion of approximately 55 historical measurements (1991 to 2008) for groundwater have been included at completed piezometers.
- Review of laboratory results and preparation of a Final Geotechnical Interpretive Report.

In addition to the contamination testing program, the samples collected were also utilised for durability testing and the assessment of general groundwater chemistry.

8.3.2 Methodology

The monitoring wells were installed and monitored following installation. Groundwater samples were collected in accordance with industry's accepted standards and protocols. Prior to groundwater sample collection, the monitoring wells were purged and water quality parameters were measured in the field (pH, conductivity and temperature).

Soil samples were collected in accordance with industry accepted standards and protocols with the aid of a decontaminated soil penetration test split spoon sampler, a decontaminated hand auger or from an excavator bucket.

Quality assurance and quality control (QA/QC) samples were collected including duplicates, trip spikes, trip blanks and rinsate wash blanks.

The samples were dispatched to mgt-Labmark, a NATA accredited laboratory, under chain of custody protocol.

8.4 Existing Environment

8.4.1 Introduction

For the purposes of this assessment, existing environmental conditions are assumed to be those that exist at the time of publication of EIS 2. However, as the EIS 2 related works would only proceed upon completion of the major civil construction works (assessed in EIS 1), the future environment would be altered as a result of those works.

8.4.2 Landform

The route of the proposed NWRL is located on the northern edge of the Cumberland Plain. Surface elevations along the route range from approximately 42m in the area of Caddies Creek to around 180m in the Old Northern Road area between the proposed Castle Hill and Cherrybrook stations. The steeper flanking slopes of the Castle Hill ridgeline between West Pennant Hills and Castle Hill, are subject to landslide mass movement. These landslide areas are well documented in published literature and on The Hills Shire Council planning maps.

The eastern half of the route is within elevated ridgeline terrain that is incised by creeks at several locations along the proposed route, namely Devlins Creek (four times) near Epping and West Pennant Hills, and Cattai Creek near the proposed Showground Station. The western half of the route traverses gently undulating terrain with meandering watercourses, namely Strangers Creek near Norwest Station, Elizabeth Macarthur Creek at Kellyville, Caddies Creek tributaries in Kellyville and Rouse Hill, and Second Ponds Creek in Rouse Hill (Area 20). A detailed geotechnical long section showing subsurface and geological structure and borehole locations is provided in Appendix C.

8.4.3 Soil landscapes

The published 1:100,000 series Soil Landscape maps for Sydney (sheet 9130) and Penrith (sheet 9030) indicate that the proposed NWRL route corridor is underlain by three categories of soil landscape, defined by the former Department of Land and Water Conservation. Five soil groupings are crossed as described below and shown in **Figure 8.1**

Glenorie Soil Landscape

These soils occur on the low undulating hills on Wianamatta Group shales between Epping and Castle Hill. The soils are typically shallow to moderately deep (<1.0 m) on crests, moderately deep (>1.75 m) brown podsols (leached soil in a temperate climate) on upper slopes, deep (>2.0 m) yellow podsols on lower slopes and humic gleyed (waterlogged) soil along drainage lines. Natural slopes are typically less than 20°. These soils are typically highly erosive and moderately reactive. Localised impermeable layers may create perched water tables.

West Pennant Hills Landscape

Soils in the West Pennant Hills Landscape occur on the steeper slopes of the Wianamatta Group shales and shale colluvium, just to the west of the proposed alignment in the area of Cherrybrook and Castle Hill Road. These soils are deep (>2.0 m) red and brown podsols. Natural slopes may exceed 20° but are characteristically unstable and present a mass movement hazard (slope instability). These soils are highly erosive, plastic and prone to water logging.

Hawkesbury Landscape

Soils in the Hawkesbury Landscape occur on slopes developed on Hawkesbury Sandstone. These soils tend to be shallow (<0.5 m) lithosols and siliceous sands. Natural slopes of up to 25° occur and soils are prone to extreme soil erosion and are highly permeable.

Luddenham Landscape

These soils occur on rolling hills on the Wianamatta Group shales between Castle Hill and Norwest Business Park. Soils are generally moderately deep (<1.5 m) red podsols. These soils form low hills (5°-20°), have high soil erosion hazard, are highly plastic and moderately reactive.

Blacktown Landscape

Soils in the Blacktown Landscape occur on low undulating terrain on the Wianamatta Group shales between Norwest Business Park and Cudgegong Road. They are generally moderately deep (1.0 m) red and brown podsols. These soils are moderately reactive, highly plastic and generally poorly drained.

The five soil landscapes above comprise the following classifications:

- Residual (Glenorie, Blacktown and Hawkesbury Soil Grouping)
- Colluvial (Hawkesbury Soil and West Pennant Hills Grouping)
- Erosional (Luddenham Soil Grouping).

Figure 8.1 Soil Landscapes

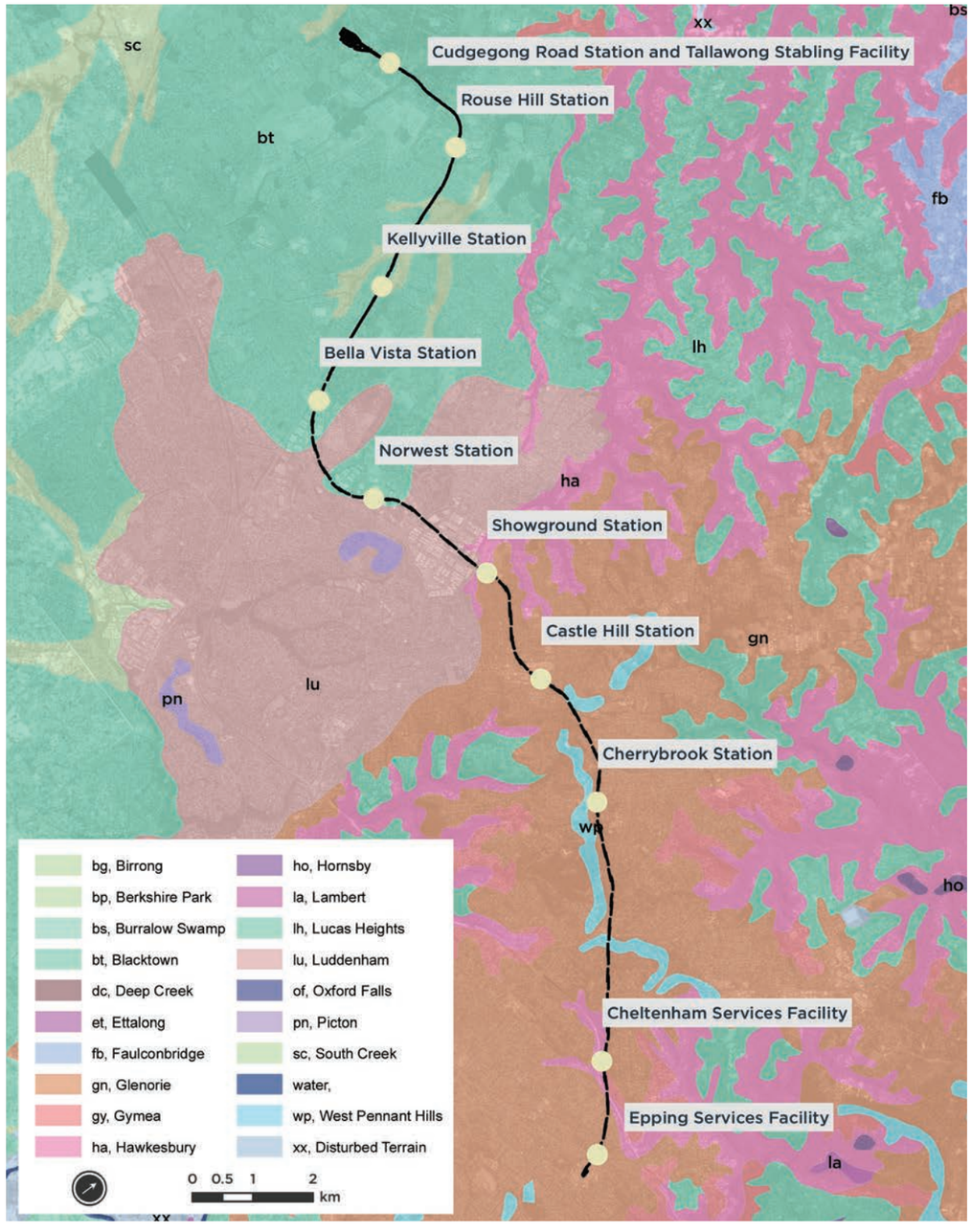
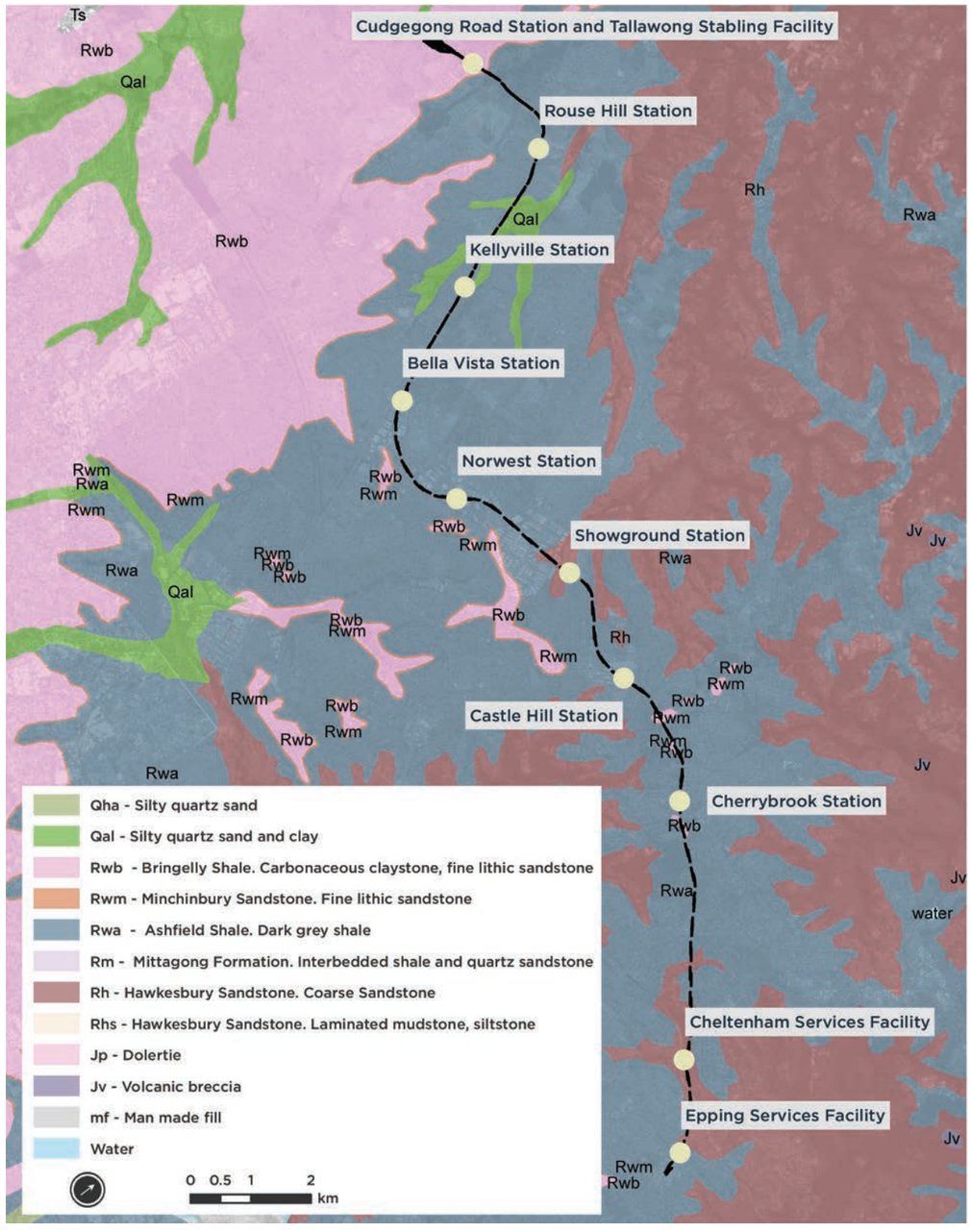


Figure 8.2 Regional Geology Map of the NWRL alignment (base case alignment shown in black)



8.4.4 Regional geology

The proposed NWRL corridor is situated in the north-west of Sydney, in the Sydney Basin, which is characterised by a sub-horizontally lying Permo-Triassic sedimentary sequence. The published 1:100,000 series geological maps for Sydney (sheet 9131) and Penrith (sheet 9030) indicate the proposed route corridor is underlain by Wianamatta Group rocks and the older Hawkesbury Sandstone Formation. The Mittagong Formation separates the two major units across much of the Sydney Basin.

The centre of the Sydney Basin is commonly identified as the Fairfield Basin where the greatest thickness of the sedimentary sequence has been encountered. The Fairfield Basin is located to the west and south of the proposed NWRL alignment, resulting in a general regional dip of up to 3° to the south west. The alignment passes close to the structural features known as the "Hornsby Warp", a tectonic feature known to have resulted in localised faulting and/or folding, the 'Roseville Warp' and the Dural Dome

The stratigraphic units to be encountered along the length of the NWRL will comprise the Bringelly Shale, Minchinbury Sandstone, Ashfield Shale, Mittagong Formation and Hawkesbury Sandstone Formation. **Figure 8.2** shows the proposed alignment in a regional geology context.

Igneous dykes and breccia diatremes of Jurassic Age are sparsely distributed throughout the Sydney Region, with the Sydney 1:100,000 Geology Sheet (9131) indicating the presence of 25 diatremes and over 100 dykes. Previous desk-based assessment (Golder Associates, 2008) has identified two possible dykes crossing the eastern section of the NWRL alignment in the area of Murray Farm Road in Beecroft South.

Based on experience with previous tunnel projects in Sydney of similar length as the NWRL, it is anticipated that a number of igneous dykes may be encountered along the NWRL during tunnel excavation.

The dykes within the Sydney region generally consist of linear basaltic rock bodies, typically less than 3m wide intruded into the surrounding country rock. Locally the dykes may be considerably wider with up to 16m reported elsewhere in the Sydney Basin (Golder Associates, 2008). The dykes are typically extremely weathered and altered to white kaolinitic clay to a depth of some 10m to 20m below ground level.

8.4.5 Quaternary and Recent Sediments

Quaternary and recent alluvial and estuarine sediments occur as channel infills within the incised river systems and meandering river systems along the proposed NWRL alignment. These deposits are anticipated to occur as limited thin deposits within the incised sandstone channels (Devlins Creek and Cattai Creek). Thicker alluvial deposits (<10m thick) are anticipated in close proximity to the meandering tributaries of Caddies Creek, Elizabeth Macarthur Creek and Second Ponds Creek in the Kellyville and Rouse Hill area.

8.4.6 Landslides

The proposed NWRL tunnels and Cherrybrook Station are located upslope of some 12 known landslide areas, as identified by the NSW Soil Conservation Service (1977), along the south flanking slope of the escarpment adjacent to Castle Hill Road.

The NWRL horizontal alignment between Ch29,400 and Ch29,800, and between Ch30,700 and Ch31,000 (refer to Appendix C Geotechnical Long Section), passes beyond the southern edge of an escarpment and partly beneath steeper flanking slopes. The tunnel section from Ch29,400 to Ch29,800 has some 40m of fresh shale rock above the tunnel and the tunnel horizon is below the Ashfield Shale and below the level of landsliding down slope. As a consequence of these site factors, this section of NWRL tunnel is assessed to not be influenced by the landslide activity.

The landslide scarp feature at Ch 30,700 to Ch 31,000 is situated immediately south of Castle Hill Road and west of Coonara Avenue. Part of this landslide feature is within 20m of Castle Hill Road. The landslide area is characterised by a ground slope of 5° to 10°,

hummocky terrain, seepages and a deepened slide debris profile.

The following targeted geotechnical investigations were located within the Coonara landslide scarp area between Ch30,700 and Ch31,000:

- Borehole NWR-BH014 (refer to Appendix C Geotechnical Long Section Sheet 3) was located on the Castle Hill Road footpath upslope of the landslide scarp. Borehole completed as a standpipe piezometer, screened in Mittagong Formation.
- Boreholes NWR-BH137, NWR-BH138 and NWR-BH139 were located immediately below Castle Hill Road, on the tunnel alignment and at the crest of the landslide scarp. Boreholes NWR-BH137 and NWR-BH139 were incline drilled with defect orientation measurements. Borehole NWR-BH138 and an adjacent shallower borehole (NWR-BH138A) were completed as standpipe piezometers, screened in Ashfield Shale.
- Boreholes NWR-BH109, NWR-BH109A and NWR-BH109B were located 130m down slope of the NWRL alignment and within the landslide mass. These boreholes had drill depths ranging from 10m to 39m, with standpipe piezometers screened in the base of landslide debris, within the underlying Ashfield Shale and the deeper Hawkesbury Sandstone.

8.4.7 Hydrogeology

The regional water table within the Hawkesbury Sandstone is affected by the beds of low lying permanently flowing streams in the Beecroft / Castle Hill area. The water table rises away from these watercourses, following the topography but in a more subdued fashion deep between ridges, shallow close to streams. Its level may fluctuate by several metres between wet and dry seasons, especially beneath ridges. Recharging water is believed to enter the system along the upper, non-perennial tributaries of these streams, and to ultimately discharge at sea level.

Groundwater flow directions are controlled by the topographic setting. For the eastern part of the alignment the groundwater flow direction in the upper rock strata is expected to be southerly towards the Parramatta River, and for the western part of the alignment the flow direction is expected to be northerly / north westerly towards Eastern and Cattai Creeks.

Station excavations will be constructed within Ashfield Shale and Hawkesbury Sandstone which is overlain in places by residual soils. The Hawkesbury Sandstone is a relatively competent, moderate strength formation of horizontally bedded sandstone, which hosts a generally confined fractured rock aquifer. Groundwater within the Hawkesbury Sandstone typically migrates through secondary porosity features such as fractures, joints, shears and bedding planes.

The Ashfield Shale was deposited in a marine environment and groundwater within this environment is generally of higher salinity than that of Hawkesbury Sandstone. Saline groundwater may also have permeated into groundwater bodies within the Hawkesbury Sandstone in places.

The quality of the rock profile generally improves with depth and the permeability of the intact shale and sandstone is expected to be low in general with some areas of higher permeability associated with isolated major defects in the rock.

Groundwater inflows will predominantly occur via structural features including bedding partings, sub-vertical and inclined joints, and faults. Experience in the Sydney area is that long term groundwater inflows into drained tunnels are typically at about 1 L/s/km excluding sections where adverse structural features are present. Sustained groundwater inflow rates significantly higher than this typical value have occurred where combinations of adverse structural features such as valley bulging, joint swarms or sub-horizontal defects, link tunnels to recharge sources (eg tidal, ponded water sources and saturated alluvium).

Groundwater levels

Groundwater levels were assessed using available measurements from monitoring wells described previously in Section 8.2. Measurements have generally been obtained from depths at about tunnel level. Measurement dates cover a large time range (2002 to the present) and have been used as a general guide with measured water levels varying between 40m AHD and 170m AHD.

Water level measurements indicate that the tunnels will generally sit below the water table. The depth of the tunnel below the measured water levels generally ranges between about 10m to 40m (average of about 30m).

Seasonal variations in groundwater levels will occur in response to rainfall and may also affect seepage rates. Variations of levels in the order of 10 metres within the Hawkesbury Sandstone may occur.

Groundwater quality

A groundwater monitoring network established during the NWRL geotechnical program consists of 57 monitoring wells. Groundwater sampling has been undertaken in each monitoring well to identify any groundwater contamination and characterise the groundwater quality.

Groundwater within Hawkesbury Sandstone is typically of low to moderate salinity, with electrical conductivity (EC) generally between 500 microsiemens per centimetre (µS/cm) and 2000µS/cm and pH generally varying between 4.5 and 6.5. The sandstone tends to have naturally elevated iron concentrations.

The quality of groundwater in shale of the Wianamatta Group tends to be inferior to groundwater in sandstone, with EC varying between 2000µS/cm to in excess of 10,000µS/cm in this part of the Sydney Basin.

Laboratory analysis results have been obtained for representative samples. The pH and TDS results indicate that salinity of groundwater along the alignment is high overall, and pH is near neutral. Sandstone underneath the Wianamatta Group has slightly higher salinity and a lower pH than the overlying shale.

The groundwater present along the NWRL alignment would not be regarded as fit for drinking water, but could possibly be used for stock watering, industrial uses or construction purpose, subject to further water quality assessment.

Groundwater captured by the NWRL is generally expected to be of similar quality to that observed from the ECRL, with the potential exception of a reater need for processing higher salinities for NWRL drainage water.

The concentrations of chloride, sodium and TDS reported in groundwater samples analysed indicate that the groundwater in the vicinity of the proposed tunnels and stations is generally slightly saline and consequently, unsuitable for discharge to the stormwater system.

Water quality testing has been and will continue to be undertaken on groundwater samples from selected standpipes, with testing for aggressivity, heavy metals and hydrocarbons.

Samples have been tested for the following:

- Major cations.
- Total Nitrogen.
- Sulfate.
- Chloride.
- Magnesium.
- Calcium.
- Carbonate.
- Bicarbonate.
- Total alkalinity as $CaCO_3$.
- Dissolved Iron.
- Sulfate Reducing Bacteria Count.

Selected samples were also analysed for:

- TPH.
- BTEX.
- PAH.
- Phenols.
- Metals (dissolved).
- OCP.

Groundwater samples were submitted to an external NATA accredited laboratory for testing and analysis. **Table 8.2** describes the anticipated groundwater chemistry issues.

Table 8.2 Anticipated groundwater chemistry issues

Issue	Comment	Sandstone	Shale
Water salinity	Water too brackish for discharge to creeks	Yes	Yes
Dissolved iron	Oxidization at drainage system leads to accumulation of precipitates and clogging/ staining	Yes	Yes - minor
Turbidity	Water too turbid for discharge to creeks	Yes	Yes - minor
Iron (Fe) reducing bacteria	Combine with oxidized Fe at drainage points to produce sludge; durability issues	Yes	No

8.4.8 Acid Sulfate Soils

Acid sulfate soil (ASS) are associated with marine or estuarine areas in NSW. ASS are naturally occurring soils containing pyrite (iron sulphides) which, on exposure to air, causes oxidisation and creates sulfuric acid. The increased acidity can lead to mobilisation of aluminium, iron and manganese from the soils. Other impacts include the de-oxygenation of water. Potential acid sulfate soils (PASS) are soils containing pyrite that have not yet been exposed to air and oxidised to form sulfuric acid.

ASS risk mapping for the area undertaken by the former Department of Land and Water Conservation (DLWC) in 1998 show that the project lies within areas designated as 'no known risk' of ASS or PASS.

8.4.9 Contamination

A field and laboratory program has been undertaken to assess the identified Areas of Environmental Concern and COPC at selected accessible areas, utilising the geotechnical sampling points.

The assessment of contamination included:

- Soil samples for contamination assessment collected from 57 boreholes and 21 test pits drilled and excavated as part of the geotechnical investigation. Representative soil samples were collected at selected/regular intervals in fill and near surface soil where practicable.
- Laboratory analysis of selected soil samples for contaminants including TPH, BTEX, PAH, OCP, PCBs, heavy metals and asbestos.
- A field and laboratory program undertaken to target the areas of environmental concern and to provide a general coverage for screening purposes. This additional investigation indicated that, generally, the alignment has a low risk of encountering soil or groundwater contamination.
- Two rounds of groundwater sampling and testing. The first round was undertaken from 19 January to 13 February 2012 with groundwater samples collected from 35 monitoring wells. The second round of sampling was undertaken from 9 March to 13 April 2012 with groundwater samples collected from 57 monitoring wells including 9 existing monitoring wells.

Although the concentrations of heavy metals found as part of groundwater testing were considered to be generally indicative of background levels, concentrations of iron, copper, nickel and zinc were above National Health and Medical Research Council (NHMRC) (2004) Australian Drinking Water Guidelines and Australia and New Zealand Environment Conservation Council (ANZECC) (2000) Guidelines for Fresh and Marine Water Quality. Additionally, a concentration of zinc was reported in the vicinity of Castle Hill Road, Cherrybrook that exceeds the typical value for road run off listed in Cooperative Research Centre for Catchment Hydrology (2004).

A summary description of findings in regard to soil and groundwater contamination conditions at each of the major construction sites is provided in **Table 8.3**

Table 8.3 Summary of assessment of contamination conditions and potential constraints to construction

Area of environmental concern	Medium (soil or water)	Assessment summary
Cherrybrook Station (Open-cut Station)	Soil	A low concentration of lead was reported east of the proposed station. Further delineation and / or waste classification may be required if excavation and offsite disposal of soil is to take place in this area, during the construction of Cherrybrook Station.
	Groundwater	Concentrations of CoPC were reported at levels considered to be indicative of background levels.
Castle Hill Station (Underground Station)	Soil	Concentrations of CoPC in the soil samples analysed were either detected below the Limits of Reporting (LOR) or typical of background concentrations.
	Groundwater	Concentrations of CoPC were generally typical of background concentrations with the exception of trace levels of TPH found in a sample well. This anomalous detection is considered potentially to be naturally occurring though the well is directly outside the former Mobil service station. Due to this anomaly, further monitoring of the wells within the former service station site would be undertaken during the detailed construction planning stage of the project.
Showground Station (Underground Station)	Soil	Further delineation and / or waste classification may be required if excavation and offsite disposal of soil is to take place in this area, during the construction of the Showground Station.assessed to have nickel and PAH impacts and the presence of asbestos fibres.
	Groundwater	TPH, PAH and phenol impacts were identified. Given that groundwater in the vicinity of The Hills Shire Depot is likely to be disturbed during construction of ShowgroundStation, impacts on the construction workers (via dermal contact and inhalation) as well as disposal management would need to be further assessed during the detailed construction planning stage of the project. Further delineation, remediation or management may be required.
Norwest Station (Underground Station)	Soil	Concentrations of CoPC in the soil samples analysed were either detected below the LOR or typical of background concentrations.
	Groundwater	TPH impact was identified in groundwater. Given that groundwater in the vicinity of the Shell service station is likely to be disturbed during construction of the Norwest Station, impacts on the construction workers (via dermal contact and inhalation) as well as disposal management would need to be further assessed during the detailed construction planning stage of the project. Further delineation, remediation or management may be required.
Bella Vista Station (Open cut Station)	Soil	Further waste classification in this area may be required if excavation and offsite disposal of fill is to take place in this area, during the construction of the Station due to concentrations of nickel in the fill material.
	Groundwater	Concentrations of CoPC in groundwater samples analysed were generally typical of background concentrations. Further assessment of groundwater in the vicinity of the BP service station would be required if the shallow seepage water is to be disturbed during construction of Bella Vista Station as TPH and PAH impacts were identified at the BP service station.
Bella Vista to Rouse Hill (Open Cutting for Bella Vista Dive and skytrain)	Soil	If excavation for offsite disposal is to take place, additional assessments for waste classification may be required due to low TPH and heavy metals impacts reported in fill samples. Further assessment in this area may be required if disturbance is to take place in this area.
	Groundwater	If groundwater is to be disturbed, groundwater management may be required due to low concentrations of TPH and PAH reported in this area.
Rouse Hill to Cudgegong Road (Earthworks and Bridges)	Soil	If excavation for offsite disposal is to take place, additional assessments for waste classification may be required due to low TPH and phenol impacts reported in fill samples. The contamination assessment at this stage is not intended to be comprehensive and not all of the Areas of Environmental Concern in this area were specifically targeted, ie individual above-ground storage tanks , farm dams and asbestos in buildings. Additional assessment and waste classification may be required.
	Groundwater	Concentrations of CoPC in groundwater samples analysed were generally typical of background concentrations.
Rouse Hill to Tallawong Stabling (On-grade Works)	Soil	The contamination assessment at this stage is not intended to be comprehensive and not all of the Areas of Environmental Concern in this area were specifically targeted, ie individual above-ground storage tanks, farm dams, and asbestos in buildings. Further assessment and waste classification may be required. The contamination assessment at this stage is not intended to be comprehensive and not all of the AEC in this area were specifically targeted, ie individual Above-ground Storage Tanks (AST), farm dams, asbestos in buildings, and therefore additional assessment and waste classification may be required.
	Groundwater	Concentrations of CoPC in groundwater samples analysed were generally typical of background concentrations.

8.5 Potential Operational Impacts

8.5.1 Groundwater drawdown

Potential operation impacts to groundwater drawdown include:

- Localised drawdown within a narrow corridor in which the tunnel and station boxes are centred.
- A fall in long term local groundwater levels to levels governed by the level of drainage infrastructure.
- Drawdown incurred by bed cracking or interference with geological features beneath drainage lines.

A long term drawdown of more than two metres is estimated for the water table underneath the upper reaches of Cattai Creek (as a result of tunnelling and station construction addressed in EIS 1). A long term drawdown of less than one metre is estimated for the water channels of Second Ponds Creek and an unnamed tributary, increasing to more than two metres at the confluence of the drainage channels at about Ch 43,000 where the tunnel comes close to the surface (refer to Appendix C Geotechnical Long Section for chainage locations). The drawdown estimates are for the water table, not for the water flowing in the channel.

Mitigation measure E14 in EIS 1 describes the requirement to undertake visual inspections of creeks above the tunnel to monitor for drawdown impacts to creeks.

Note that Section 15.5.4 of EIS 1 discusses the identification of impacts to Groundwater Dependent Ecosystems. It was identified that the potential impacts and risk level associated with the loss of aquatic fauna habitat, general hydrological changes and altered groundwater recharge were all low.

8.5.2 Groundwater inflow and discharge requirement

Hydraulic modelling of the proposed tunnel and station designs has provided an estimate of total inflow of 0.35 megalitres per day (ML/d) at the end of the first stage of tunnelling (completion of the Cherrybrook to Epping section), increasing to a maximum of approximately 0.6ML/d at the completion of tunnelling. This rate is estimated to reduce to around 0.5ML/d during both construction and over the long term. Groundwater inflow at this level would exceed the options for reuse and as a result treatment to an acceptable standard would be required prior to discharge to natural waterways.

The estimated long term inflow comprises some 0.36ML/d from the tunnels, or 72% of the total long term inflow. Additional estimated long term inflow to individual station boxes from the tunnels is listed in **Table 8.4.**

Actual inflows may vary from these estimates. In addition, inflows are expected to vary according to climate, with inflows increasing during periods of rainfall and decreasing during drier periods.

Table 8.4 Estimated long-term groundwater inflows to bored tunnels and station boxes

Station	Estimated long-term groundwater inflow from rock (ML/day)1	
	Drained tunnels (numerical model)	Undrained tunnels (numerical model)
Cherrybrook	0.035	0.049
Castle Hill	0.026	0.038
Showground	0.0332	0.0472
Norwest	0.026	0.035
Bella Vista	0.022	0.026
Tunnels	0.359	0
TOTAL INFLOW	0.502	0.195

No evaporative losses are included in the inflow estimate (evaporative losses could be 50%)
With undrained tunnels, more water is directed into station boxes (rather than captured in the tunnel

1. Short-term and long-term inflows from alluvium and fill at Showground Station are not simulated in the inflow model. It is assumed these inflows would be managed by construction methods (see SG2 in **Table 8.7**)
2. Short-term and long-term inflows from alluvium and fill at Showground Station are not simulated in the inflow model. It is assumed these inflows would be managed by construction methods (see SG2 in **Table 8.7**)

8.5.3 Groundwater disposal to the environment

Groundwater captured by the NWRL would require a long term treatment solution prior to discharge to the environment.

Typical treatment would include:

- Brackish water reverse osmosis where water salinity is found to be too high for discharge to creeks.
- Removal of dissolved iron would typically be removed from discharge water by oxidising the Ferric ion (Fe3+) to Ferrous (Fe2+) which enables precipitation and physical removal.
- Use of settling / filters to treat water turbidity.
- Biocide dosing of iron reducing bacteria in discharge water.

A water treatment plant is currently in operation as part of the completed ECRL project. Water treatment of captured groundwater from NWRL is intended to be treated at this facility located at Lady Game Drive, Lindfield. The predicted daily volume from the NWRL would be accommodated within the existing Lady Game Drive water treatment plant, with existing water quality standards able to be maintained.

The Lady Game Drive water treatment plant is located on Lady Game Drive, Lindfield, in the vicinity of Fullers Bridge and Millwood Avenue. Discharge from the plant at this location occurs near the confluence of the Lane Cove River and Blue Gum Creek. The plant at this location on the Lane Cove River is considered preferable to other potential discharge locations such as Cattai Creek. Cattai Creek is a much smaller water body that has significant seasonal variability in its flows and has generally less ability to receive treated groundwater without potentially impacting upon its ecology and hydrology. This is due to seasonal variability and occasional low

flow conditions having a negative impact on desired dilution ratios of treated groundwater discharge. In contrast the water quality of the Lane Cove River is well understood and is regularly monitored with the proposed discharge location being tidal in nature with less potential for seasonal variability of flow Further details of existing conditions for Cattai Creek and other relevant waterways are included within Chapter 18.

The Lady Game Drive water treatment plant has been designed to treat up to 33 L/s or approximately 2.9 ML/day (Review of Environmental Factors, SKM 2005) and was known to be treating an average of 1ML/day as part of water quality monitoring in 2010. It is anticipated that the increase in water treated at the Lady Game Drive water treatment plant as a result of the NWRL would be 0.6ML/day at completion of Stage 1 major civil construction works, reducing to a long term rate 0.5ML/day. This additional volume of water to be sent to the water treatment plant could be accommodated within the stated design capacity of the plant.

Captured groundwater is to be transferred to the Lady Game Drive water treatment plant by a combination of gravity flow through the NWRL tunnel and pumping within the tunnel where required.

Lane Cove River potential impacts

Potential impacts to the Lane Cove River were considered in the determination of water quality criteria and licence requirements for the Lady Game Drive water treatment plant as part of ECRL project. The water treatment plant does not require an Environment Protection Licence and is operated in accordance with the Operation and Maintenance Manual (RailCorp, 2009). The operation has a number of 'fail-safe controls' built into the plant, including the monitoring of the final treated water discharge for a range of discharge criteria. Modifications to the plant were undertaken in 2010 and following monitoring (March 2010) it was found that all water quality parameters were being met for discharge from the Lady Game Drive water treatment plant to the Lane Cove River. The existing environment of the Lane Cove River has been established by this monitoring and previous studies, with water quality both at the discharge location and downstream of the discharge location known to be at or above ANZECC trigger values for total phosphorus, total nitrogen, ammonia, NOx, and total iron. This existing condition is considered to be a product of the location of the river in a highly developed area.

The local mixing within the discharge location had been previously modelled by SKM (2005) in the order of 4.5:1 dilution of the discharge water in river water.

However, assuming future discharge at the current operational limit of 2.9ML/day and with average river flows approaching 100 ML/day a 4.5:1 ratio for mixing is likely to be a conservative estimate.

Current water discharge criteria for the Lady Game Drive water treatment plant which are proposed to be applied to the water discharged from the NWRL project are provided in **Table 8.5**.

Table 8.5 Lady Game Drive water treatment plant discharge criteria

Analyte	Recommended Discharge Criteria
pH	7.0 - 8.5
Total Suspended Solids (mg/L)	-
Turbidity (NTU)	0.5 – 10
Dissolved Oxygen (mg/L)	8.2-10
Oil & Grease (mg/L)	<5 or ND
Sulfate	-
Ammonia (mg/L)	2.8
Oxidised Nitrogen (mg/L)	7.2
Total Nitrogen (mg/L)	2.8
Total Phosphorus (mg/L)	0.03
Aluminium (mg/L)	0.69
Beryllium (mg/L)	-
Chromium (mg/L)	0.14
Copper (mg/L)	0.005
Iron (mg/L)	7.7
Lead (mg/L)	0.028
Manganese (mg/L)	10
Nickel (mg/L)	0.32
Tin (mg/L)	0.00175
Zinc (mg/L)	0.2
Coliforms (CFU/100 mL)	-

8.6 Potential Construction Impacts

8.6.1 Soil erosion and land surface

The proposed construction associated with station development would include road development and earthmoving for precinct development. The proposed construction works (described in Chapter 7) has the potential to generate erosion and sedimentation impacts. Each of the defined construction sites along the alignment would be subject to site specific potential impacts from:

- Soil erosion and soil disturbance.
- Stockpiling procedures and locations.
- Dust generation (addressed in Chapter 19).
- Land remediation on completion of construction.

Proposed mitigation measures with regard to soil and land surface impacts are provided in Section 8.7. Additional mitigation measures for watercourse impacts are included in Chapter 18.

Acid Sulfate Soils

Although the project lies within areas designated as 'no known risk' of ASS or PASS (DLWC, 1998), should ASS be encountered on construction sites, potential impacts may include:

- ASS can weaken concrete and steel infrastructure, which can increase maintenance and replacement costs
- Sulphuric acid generated from oxidised ASS can damage aquatic environments, if allowed to be released during construction
- Increased acidity from disturbing ASS can lead to mobilisation of aluminium, iron and manganese from soils.

Soil Salinity

Salt occurs naturally within many parts of the Australian landscape. However, urbanisation can increase the movement of water through the soil profile and thus exacerbate salinity. Excess salt levels can affect vegetation and building materials such as concrete and steel. The accumulation of salt can be exacerbated by human practices that increase the rate of water movement in soils.

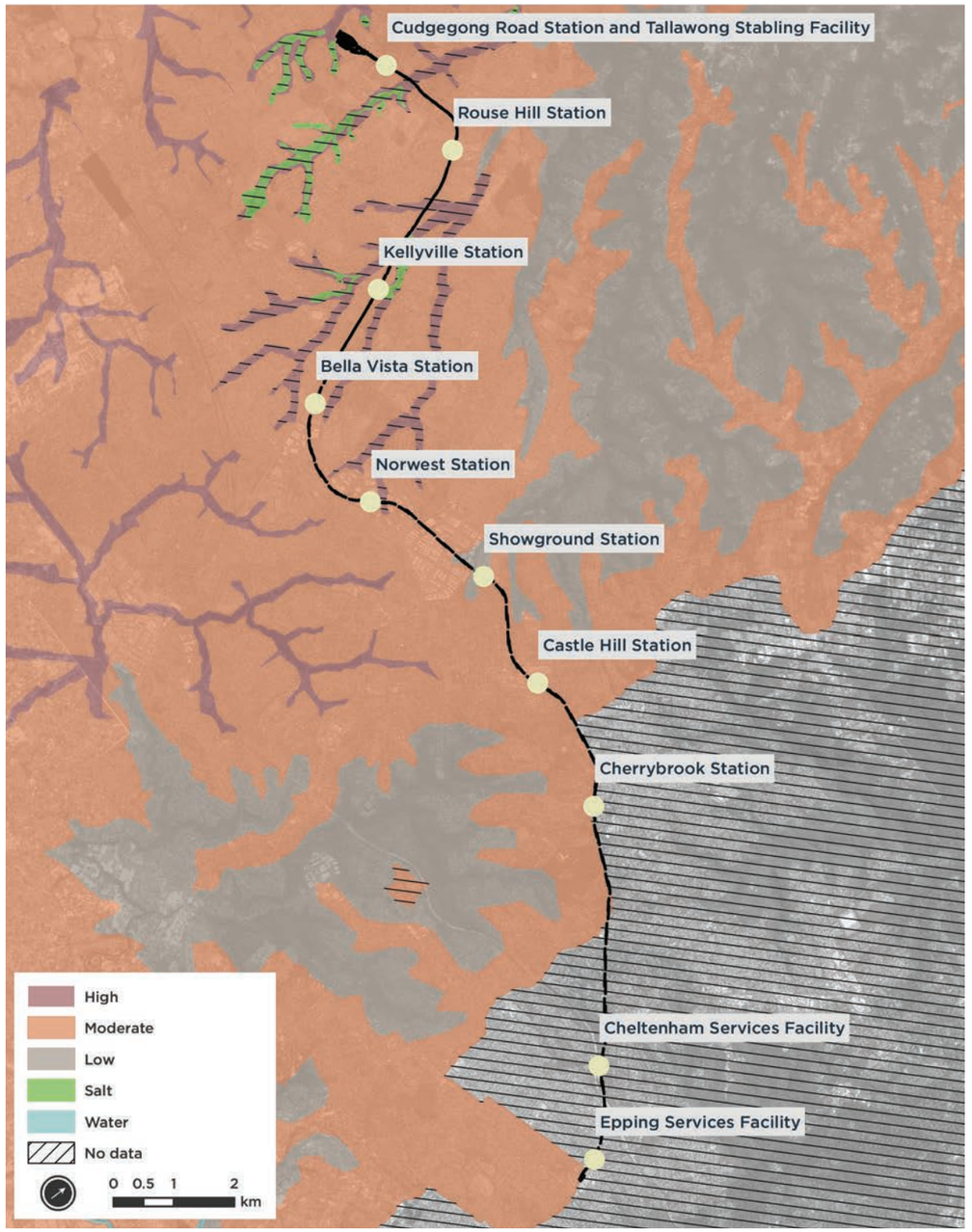
Soil salinity has been identified as a growing problem in the Western Sydney region. Salinity potential maps prepared by the former Department of Infrastructure, Planning and Natural Resources (DIPNR, 2002) identify the potential risk of soil salinity. Based on these maps, areas around Caddies Creek, First Ponds Creek and Second Ponds Creeks show high salinity potential or known salinity.

Potential areas of Soil Salinity in the general vicinity of the NWRL are shown in **Figure 8.3**

Construction in areas of known soil salinity can have the following potential environmental impacts:

- Soil and water contamination through leaching of disturbed saline soils
- Soil and water contamination through modification of groundwater levels
- Increased salinity of waterways.

Figure 8.3 Soil Salinity Map



8.6.2 Groundwater

Potential impacts that could arise during construction of works as described in Chapter 7 include:

- Turbid, saline or contaminated water collected within excavations and station boxes requiring disposal.
- Contaminants such as oils and chemicals from construction activities leaking to the water table where excavations are above the water table.
- The lowering of the water table could result in loss of output from wells in the vicinity of the rail line.
- Any deep excavations are likely to require localised dewatering during the construction phases.

Dewatering programmes would likely involve construction of extraction bores, gravity drainage systems and/or pumping to extract groundwater. Discharge of the extracted groundwater would depend on the groundwater quality but options include discharge to creeks or temporary storage in detention basins to reduce turbidity prior to discharge.

Potential groundwater drawdown impacts from the Stage 2 construction works are considered to be negligible.

8.6.3 Ground movement

Potential impacts in regards to ground movement from the proposed station construction works are considered to be negligible.

Impact of Landslides on NWRL

Based on the current topographic setting (slope profiles, distance to the incised watercourses and accumulated debris) and quality of the rock, it is concluded that the relative risk of landslide enlargement affecting the NWRL alignment is very low and no alteration to the current alignment would be warranted.

Impact of Cherrybrook Station on the Existing Landslide Features

The construction and operation of the NWRL may have a potential impact on existing downslope landslide features by potentially altering the groundwater regime beneath the edge of the escarpment.

A drained Cherrybrook Station (as proposed) would locally drawdown the groundwater table around the station. This effect is not likely to extend far from the station due to the limited excavation depth and the low permeability of the residual soil and weathered shale materials. The escarpment with landslide features in the vicinity of Cherrybrook Station (Ch 30,700 to Ch 31,000 – refer to Appendix C Geotechnical Long Section) may however have potential impacts associated with tunnelling as addressed in the Submissions Report to EIS1.

8.6.4 Contamination

The nature and extent of contamination at the proposed locations of stations and infrastructure, road and precinct development along the NWRL requires further investigation as described in Section 8.4.9. Details of contamination are to be refined through ongoing investigations prior to construction.

Potential contamination which may arise from construction activities include:

- Disposal of turbid, saline or contaminated water collected within the tunnel or excavations from dewatering or seepage.
- Disturbance of contaminated land or groundwater.
- Contaminants leaking to the ground surface.
- Accidents or spills involving construction equipment.

The quality of groundwater flowing into existing underground structures in the Sydney area is generally high in iron, may contain manganese and other contaminants, has a relatively high TDS and a low pH and has the potential to contaminate receiving waters.

8.7 Mitigation measures

8.7.1 Operation

OEMP would be developed detailing the processes to manage environmental impacts during the operation of the project.

Mitigation measures in **Table 8.6** have been developed to avoid, reduce and manage identified potential operational impacts.

8.7.2 Construction

Mitigation measures developed to address construction impacts would form part of the Construction Environmental Management Framework, provided in Appendix B which details the environmental, stakeholder and community management systems and processes for the construction of the NWRL.

These mitigation measures and their application to the construction sites for the NWRL are presented in **Table 8.7**.

A number of mitigation measures detailed in other chapters would also be relevant to soils and groundwater. These include:

- Mitigation measures relevant to water discharge to surrounding waterways, and the storage and handling of hazardous substances and dangerous goods - refer Chapter 18 (Surface Water and Hydrology).

Mitigation measures relevant to contaminated spoil - refer Chapter 19 (Non-Key Issues – Waste Management)

Table 8.6 Mitigation measures Operation

No.	Mitigation Measures	Applicable Areas
	Ground Movement	
OpSG1	A post construction monitoring program for ground movement and groundwater levels would be established for the land slip area near Cherrybrook Station.	Cherrybrook Station
	Contamination	
OpSG2	Procedures to quickly address any contaminant spill or accident would be developed and implemented during operation of the station sites.	All
	Groundwater Management	
OpSG3	Groundwater quality would be subject to testing. Where it does not meet license requirements it would be treated prior to discharge.	All
	Groundwater Treatment	
OpSG4	Water treatment of captured groundwater from NWRL is to be treated at the existing water treatment plant located at Lady Game Drive, Lindfield. The incremental increase in volume from the NWRL would be accommodated within the existing capacity of the ECRL facility as long as water quality criteria can be met.	Tunnel
OpSG5	All feasible and reasonable opportunities would be identified for the reuse of captured groundwater.	Tunnel

Table 8.7 Mitigation measures Construction

No.	Mitigation Measures	Applicable Sites*
	Contamination	
SG11	Any contaminated areas directly affected by the project would be investigated and remediated prior to the commencement of construction works. All remediation works would be undertaken in accordance with the requirements of the *Contaminated Land Management Act 1997 and Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites* (EPA, 1997b).	All
SG12	Prior to the commencement of site preparation or construction in potentially contaminated areas, a summary of soil contamination would be prepared detailing the outcomes of the Stage 2 contamination site investigations. The summary would detail, where relevant, whether or not the soil is suitable for the intended land use or can be made suitable for reuse through the application of a Remediation Action Plan (or similar).	All
SG13	An accredited Site Auditor would endorse the documentation of site contamination and any Remediation Action Plan or similar.	All
SG14	In the event of discovery of previously unidentified area(s) of potentially contaminated material, all work would cease in the vicinity of the discovery and not recommence until the extent of contamination has been assessed and if necessary, a Remediation Action Plan or similar has been prepared and endorsed by an accredited Site Auditor.	All
SG15	A Site Auditor would be required to certify that any contaminated areas have been remediated to a standard consistent with the intended land use prior to operation of the remediated site(s).	All
SG16	Bunds around fuel depots and stockpile areas would be installed to minimise the risk of contaminants reaching the water table.	All
	Groundwater Management	
SG17	A groundwater monitoring plan would be prepared for the duration of the construction period. Parameters to be monitored would include groundwater levels and groundwater quality with field parameters, laboratory parameters and sample frequency to be developed prior to construction.	All
SG18	A groundwater monitoring network to monitor groundwater levels and groundwater quality would be established throughout the construction phase. The groundwater monitoring network would contain monitoring wells along the whole NWRL route intersecting groundwater in both Ashfield Shale and Hawkesbury Sandstone.	All
SG19	Water sampling and testing of groundwater would be undertaken during construction to determine the most suitable treatment processes to meet the required water quality standards.	All
SG20	Groundwater quality would be subject to testing. Where it does not meet license requirements it would be treated prior to discharge.	All
SG22	All feasible and reasonable measures would be implemented during construction, to limit operational groundwater inflows to stations and crossovers. Any inflows would be collected and treated prior to discharge.	All
SG24	A groundwater water supply from the Hawkesbury Sandstone for construction purposes would be used where feasible and reasonable. Negotiation with the NOW would be undertaken regarding impacts and applicable licenses.	All
SG25	If ASS are encountered, they would be managed in accordance with the Acid Sulfate Soil Manual (*Acid Sulfate Soil Management Advisory Committee, 1998*)	All
	Groundwater Treatment	
SG26	All feasible and reasonable opportunities for groundwater reuse for construction purposes or recycling nearby would be utilised in the first instance. Should groundwater inflows and required treatment volumes outstrip potential for water reuse for construction purposes, options for discharge would be investigated.	All
SG27	Where water salinity is found to be too high for discharge to creeks, brackish water reverse osmosis would be undertaken.	All
SG28	Dissolved iron would typically be removed from discharge water by oxidising the Ferric ion (Fe3+) to Ferrous (Fe2+) which enables precipitation and physical removal.	All
SG29	Water turbidity would typically be treated by settling / filters.	All
SG30	Iron reducing bacteria in discharge water would be typically treated by biocide dosing.	All
SG31	A typical discharge into a natural waterway (where approved) would require a groundwater treatment process that includes the following steps: ▪ Inlet buffer tank, with aeration ▪ Coagulation / flocculation ▪ Dissolved air floatation (solids removal) ▪ Multimedia filtration (25 micrograms) ▪ Cartridge filtration (2 micrograms) ▪ Brackish water reverse osmosis ▪ Disposal of water brine concentrate to sewer (dependant on future environmental policies) ▪ Discharge of adequately treated water (into aquifer of origin, stormwater (creek catchments), sewer under a trade waste agreement, onsite reuse or recycling or a combination of these options).	Sites 1 – 8
SG32	Groundwater discharge quality would comply with the relevant Environment Protection Licence	Sites 1 – 8
SG33	Specific processes regarding groundwater discharge and treatment methods would be identified during detailed design.	Sites 1 - 8

No.	Mitigation Measures	Applicable Sites*
	Soil Salinity	
SG34	Appropriate site specific soil salinity mitigation measures would be adopted in accordance with Draft Salinity Code of Practice (Western Sydney Regional Organisation of Councils, 2004) and the *Guidelines to Accompany Map of Salinity Potential in Western Sydney* (DIPNR 2002). These mitigation measures would be included within Sub-Plans to the CEMP at all sites within areas of known risk of soil salinity.	All
SG35	A soil salinity assessment would be undertaken for each high risk site in accordance with the Site Investigations for Urban Salinity (DLWC 2002), including Phase 2 and Phase 3 investigation. This assessment would enable site specific mitigation measures to be developed to ensure saline soils are appropriately managed and damage to the environment and infrastructure is minimised. These investigations would be informed by the completed groundwater monitoring program.	Sites 8, 9, 13 -15
	Soil contamination	
SG36	A low concentration of lead was reported east of the proposed station. Further delineation and / or waste classification may be required, if excavation and offsite disposal of soil is to take place in this area, during the construction of Cherrybrook Station.	Site 4
SG37	Showground Station. Further delineation and / or waste classification may be required if excavation and offsite disposal of soil is to take place in this area, during the construction of the Showground Station due to nickel and Polycyclic aromatic hydrocarbons (PAH) impacts and the presence of asbestos fibres.	Site 5
SG38	Further waste classification in the area of Bella Vista Station may be required if excavation and offsite disposal of fill is to take place, during the construction of the Station due to concentrations of nickel in the fill material.	Site 8
SG39	Bella Vista to Rouse Hill (Open Cutting for Bella Vista Dive and skytrain). If excavation for offsite disposal is to take place, additional assessments for waste classification may be required as low TPH and heavy metals impacts were reported in fill samples. Further assessment in this area may be required if disturbance is to take place in this area.	Sites 8-14
SG40	Rouse Hill to Cudgegong Road (Earthworks and Bridges). Should excavation for offsite disposal take place, additional assessments for waste classification may be required as low TPH and phenol impacts were reported in fill samples. Not all of the Areas of Environmental Concern in this area have been specifically targeted, ie individual above-ground storage tanks, farm dams and asbestos in buildings. Additional assessment and waste classification may be required.	Sites 14 -17
SG41	Rouse Hill to Tallawong Stabling (On grade works). Not all of the Areas of Environmental Concern in this area were specifically targeted, ie individual above-ground storage tanks, farm dams and asbestos in buildings. Additional assessment and waste classification may be required.	
	Groundwater contamination	
SG42	Castle Hill Station. Concentrations of CoPC were generally typical of background concentrations with the exception of trace levels of TPH found in a sample well. Due to this anomaly, further monitoring of the wells within the former service station site would be undertaken during the detailed construction planning stage of the project.	Site 5
SG43	Showground Station. TPH, PAH and phenol impacts were identified. As groundwater in the vicinity of the Hills Shire Depot is likely to be disturbed during construction of the Showground Station, impacts on the construction workers (via dermal contact and inhalation) as well as options for disposal management would be further assessed during the detailed construction planning stage of the project and further delineation, remediation or management would be required.	Site 6
SG44	Norwest Station. TPH impact has been identified. Given that groundwater in the vicinity of the Shell service station is likely to be disturbed during construction of the Norwest Station, impacts on the construction workers (via dermal contact and inhalation) as well as options for disposal management would need to be further assessed during the detailed construction planning stage of the project and further delineation, remediation or management would be required.	Site 7
SG45	Bella Vista Station. Should shallow seepage water be disturbed during construction of Bella Vista Station, further assessment of groundwater in the vicinity of the BP service station would be required owing to TPH and PAH impacts reported at the BP service station.	Site 8
SG46	Bella Vista to Rouse Hill (Open Cutting for Bella Vista Dive and skytrain). If groundwater is to be disturbed, groundwater management may be required due to low concentrations of TPH and PAH reported in this area.	Site 8 - 14
	Soil erosion and land surface	
SG47	Soil and land remediation is to occur as soon as practicable following construction. This is to include remediation in stages as the construction process allows.	All

*Site 1 - Epping Services Facility, Site 2 – NOT USED, Site 3 - Cheltenham Services Facility, Site 4 - Cherrybrook Station, Site 5 - Castle Hill Station, Site 6 - Showground Station, Site 7 - Norwest Station, Site 8 - Bella Vista Station, Site 9 - Balmoral Road, Site 10 - Memorial Avenue, Site 11 - Kellyville Station, Site 12 - Samantha Riley Drive to Windsor Road, Site 13 - Old Windsor Road to White Hart Drive, Site 14 - Rouse Hill Station, Site 15 - Windsor Road Viaduct, Site 16 - Windsor Road Viaduct to Cudgegong Road, Site 17 - Cudgegong Road Station and Tallawong Stabling Facility

CHAPTER 9

TRAFFIC AND TRANSPORT

9 TRAFFIC AND TRANSPORT

9.1 Introduction

An Operational Traffic and Transport Report (Aurecon / Arup /TfNSW 2012) and a Construction Traffic and Transport Management Technical Paper (Aurecon / Arup / TfNSW, 2012) have been prepared to support this EIS (refer to Technical Papers 1 and 2). This chapter provides a summary of the Technical Papers.

The assessment of construction and operational impacts has been undertaken with the aid of SIDRA and LINSIG intersection analysis. The construction related analysis considers both AM and PM peak periods while the operational analysis focuses on AM peak period impacts. This is because the analysis uses forecasts produced from the TfNSW's Bureau of Transport Statistics (BTS) Public Transport Project Model (PTPM) which is an AM model. The AM peak period is generally considered to provide an analysis of the worst-case traffic impacts. In the case of the operational analysis, traffic generation figures are based on evolving mode and demand forecasts to assess the effects of alterations in vehicle demand on the road network. As development in the North West Growth Centre continues, traffic forecasts and precinct planning would continue to evolve and supplementary analysis of future proposals may be required.

9.2 Director-General's Requirements, Conditions of Approval and Statement of Commitments

Table 9.1 sets out the Supplementary Director-General's Requirements, Concept Plan Approval Requirements and Statement of Commitments as they relate to operational and construction traffic, and where these have been addressed within this EIS. Unless otherwise stated, references are to chapters of EIS 2.

Table 9.1 Director-General's Requirements, Conditions of Approval and Statements of Commitment

Reference	Description	Addressed
Supplementary Director-General's Requirements		
Traffic and Access	As per the Concept Plan, the Proponent shall detail mode-of-access arrangements at Epping and each new station. With consideration to (but not necessarily limited to) the following matters: ▪ at Bella Vista Station – details of park and ride provisions, road access arrangements (including the feasibility of provisions of a signalised intersection replacing the Lexington Drive / Celebration Drive roundabout), and pedestrian and cycle linkages between the station and residential areas (including west of the station across Old Windsor Road); and ▪ at Cudgegong Road Station – details of park and ride provisions, road access arrangements, and cycle and pedestrian linkages with the Area 20 residential catchment, including a potential connection between Tallawong and Cudgegong Roads.	Mode-of-access arrangements for each of the proposed stations are detailed in Section 9.5.2 to 9.5.9. Specific details relating to traffic management and access to Bella Vista Station is detailed in Section 9.5.6. Specific details relating to traffic management and access to Cudgegong Road Station is detailed in Section 9.5.9. Details of traffic facilities, including park-and-ride, are detailed in Chapter 6.
Concept Plan Approval Requirements		
3.3	The Proponent shall review mode-of-access demand and peak traffic predictions at Epping Station taking into account the impact of ECRL operations on patronage distribution; and identify any required changes to mode-of-access arrangements at Epping.	Chapter 6.

Reference	Description	Addressed
3.4	The Proponent shall confirm mode-of-access arrangement at each new station, with consideration to (but not limited to) the following matters: ▪ at Cherrybrook Station – details of park and ride provisions, road access arrangements (including the feasibility of a signalised intersection between Castle Hill, Glenhope and Franklin Roads); and pedestrian and cycle linkages to the surrounding pedestrian catchments of Cherrybrook and West Pennant Hills; ▪ at Castle Hill Station – investigation of options for shared use parking; bus access arrangements; and pedestrian and cycle linkages between the station and residential areas surrounding the Castle Hill town centre, retail areas within the town centre and Castle Towers shopping centre; ▪ at Hills Centre Station – details of park and ride provisions; road access arrangements; and pedestrian linkages to the Castle Hill industrial estate; ▪ at Norwest Station – investigation of options for shared use parking, access for buses, kiss and ride and taxis; and pedestrian and bus linkages to the Norwest Business park and surrounding residential catchments; ▪ at Kellyville Station – details of park and ride provisions; bus interchange arrangements which are integrated to the Parramatta to Rouse Hill Transitway; and road, pedestrian and cycle access that are integrated with the planned provisions for the Balmoral Road Release Area; and ▪ at Rouse Hill Station – bus interchange arrangements which are integrated to the Parramatta to Rouse Hill Transitway; and road, pedestrian and cycle access that are integrated with the planned provisions for the Rouse Hill Regional Centre.	Mode-of-access arrangements for each of the proposed stations are detailed in Section 9.5.2 to 9.5.9.

Reference	Description	Addressed
3.5	The Proponent shall confirm the construction traffic impacts associated with the project, identifying: ▪ haulage routes; ▪ peak congestion and intersection performance impacts at local and arterial roads considering cumulative impacts from surrounding development and from concurrent construction sites; ▪ reasonable and feasible construction options at road crossings to avoid and / or minimise traffic disruptions; and ▪ requirements for road and / or lane closure and alternative travel arrangements.	Construction traffic relating to rail systems and stations in Section 9.6. Construction traffic relating to major civil construction in EIS 1 Sections 9.3.3 and 9.5.
Statement of Commitments		
11	At each station, further studies would be undertaken to consider the integration of the station with the local area to ensure that predicted patronage and mode access are catered for during operation. Studies would consider local connectivity requirements; pedestrian modelling (including emergency access); bicycle facilities; the potential impacts of traffic accessing the station from the surrounding road network; parking requirements and the integration of the Transitway and other bus services with the new rail stations. These investigations would be undertaken in consultation with Councils, RailCorp, Ministry of Transport and the Roads and Traffic Authority.	Operational mode of access arrangements are detailed in Section 9.5. Facilities within station precincts are detailed in Chapter 6.
12	The location, scale, design and quantum of park-and-ride facilities at the Franklin Road, Hills Centre and Burns Road[1] Station would be reviewed during further design. This is to be undertaken with reference to relevant parking policies and in consultation with Councils, RailCorp and the Ministry of Transport.	The park-and-ride facilities at all stations is discussed in detail in Chapter 6.
13	In consultation with Councils, RailCorp, the Ministry of Transport and surrounding landowners, investigate opportunities for 'shared use' or complementary parking facilities adjacent to Norwest Station.	Opportunities for shared use car parking at Norwest Station are detailed in Section 9.5.5.
14	In consultation with the RTA and Councils, investigate the feasibility of providing a direct access point to the Franklin Road site from Castle Hill Road and the potential for a signalised intersection at the intersection of Glenhope Road with Castle Hill Road.	Operational access to and from Cherrybrook Station would be via Robert and Franklin Roads. This is detailed in Section 9.5.2.

Reference	Description	Addressed
15	In consultation with the RTA and Councils investigate potential access improvements to Franklin Road Station from areas to the north.	Operational access to and from Cherrybrook Station would be via Robert and Franklin Roads. This is detailed in Section 9.5.2.
16	The design of construction activities would consider access points, surrounding intersections, bus routes and pedestrian flows.	Discussion of access points, impacts on surrounding intersections, bus routes and pedestrians, for each site during construction is discussed in Section 9.6. Traffic impact from major civil construction is addressed in Section 9.5 of EIS 1.
17	Traffic modelling and traffic management analysis would be undertaken for the roads and intersections impacted by the project during the project construction and operation. This analysis would consider existing and planned road upgrades.	Traffic modelling and analysis for operation of the NWRL and rail systems and stations construction are addressed in Sections 9.5 and 9.6 respectively. Traffic modelling and analysis for major civil construction in Section 9.5 of EIS 1.
18	A detailed construction methodology for the construction over and/or under roads would be developed in consultation with the RTA and Councils with the aim of minimising traffic disruptions (including construction of the bridge over Windsor Road at Kellyville and cut and cover construction under Norwest Boulevard, Windsor Road and Burns Road[1]).	Construction methodologies and works on existing roadways are detailed in Chapter 7 and Section 9.6. Construction methodologies at existing roadways for major civil construction works are addressed in Chapter 7 and Section 9.5 of EIS 1.
19	Maintenance access points would be identified and planned in consultation with RailCorp and Councils.	Maintenance access points are addressed in Section 9.5 and Chapter 6.

Note 1: The alignment at Burns Road (Memorial Avenue) and Windsor Road is now elevated on a viaduct.

9.3 Assessment methodology

As development in the North West Growth Centre continues, traffic forecasts and precinct planning will continue to evolve and supplementary analysis of future proposals may be required. The methodology used in this EIS will remain relevant through the gradual development of planning concepts that will occur in the future and provides a basis for evaluation of development and movement in the future.

9.3.1 Operational traffic assessment methodology

The traffic and road safety impacts due to the operation of the NWRL were assessed based on the RMS *Guide to Traffic Generating Developments* (RTA, 2002) and other relevant Austroads guidelines. The measures to mitigate these impacts are proposed in order to facilitate access to, and around, the stations.

The station precincts are generally located within an urban environment and the traffic capacity of the road network immediately adjacent to the station precincts is primarily governed by the operation of the intersections located on the road network. The performance of the key intersections has been modelled using the SIDRA and LINSIG modelling software programs to assess the effects of the altered vehicle demand on the road network.

A Level of Service(LoS) analysis and a Degree of Saturation(DoS) analysis was undertaken of key intersections around the station precincts (refer to Sections 9.3.3 and 9.3.4).

The LINSIG analysis represents the worst case scenario and may require updating as part of final detailed station precinct planning.

9.3.2 Construction traffic assessment methodology

The methodology for the construction traffic assessment included:

- Traffic count information was collected for key intersections in the vicinity of the proposed construction sites during the peak periods. These were supplemented with seven day counts along selected roads in the area.
- The results of the traffic counts were utilised to undertake intersection modelling using the LINSIG modelling software program. Predicted intersection performance was determined as both the DoS and the LoS. The LINSIG analysis represents the worst case scenario and may require updating as part of final detailed station precinct planning.

9.3.3 Level of Service

The LoS refers to an overall indication of the operational performance of traffic on any given intersection, traffic lane or roadway. The LoS parameter provides an indication of how well an intersection operates. The LINSIG analysis provides an estimate of intersection performance and then categorises this against the LoS criteria for intersections specified in the RMS *Guide to Traffic Generating Developments* (RTA, 2002) as described in **Table 9.2**.

Table 9.2 LoS criteria for intersections

LoS	Average delay per vehicle (seconds)	Traffic signals and roundabouts	Give way and stop signs
A	Less than 14	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study is required
D	43 to 56	Operating near capacity	Near capacity and accident study is required
E	57 to 70	At capacity; at signals incidents will cause excessive delays	At capacity, another control mode required
F	Greater than 70	Over capacity, unstable operation	Over capacity, unstable operation

Note: A LoS F is defined as as forced flow, the amount of traffic approaching the point exceeds that which can pass it. Flow breakdown occurs, and queuing and delays occur.

9.3.4 Degree of Saturation

The DoS value indicates the ratio of arrival volumes to capacity. Values above 1.0 represent oversaturated conditions, ie arrival volumes exceed capacity, whereas degrees of saturation below 1.0 represent under saturated conditions, ie arrival volumes are below capacity.

It should be noted that the LoS provides an assessment of the intersection as a whole, whilst the DoS provides an assessment of the worst performing approach to the intersection.

9.4 Existing environment

9.4.1 Traffic data

Traffic count data was obtained as part of the assessment carried out for the construction traffic assessment for EIS 1, and was collected for a number of key intersections and roads along the NWRL proposed corridor in the last week of November 2011 and the first week of December 2011. This data was collected along selected roads during weekday AM and PM peak hour for intersections and 24 hour / 7 day mid-block classification which allows identification of different vehicle types. This data along with current traffic levels and the current LoS is shown in **Table 9.3**.

Table 9.3 Existing LOS at selected intersections

Worksite	Intersection	Control	Existing conditions							
			AM				PM			
			Total (vph)	DoS	AVD (sec)	LoS	Total (vph)	DoS	AVD (sec)	LoS
Cherrybrook Station	Castle Hill Road / Coonara Avenue / Edward Bennet Drive	Signals	2,718	0.75	45	D	3,168	0.85	42	C
	Castle Hill Road / Glenhope Road	Priority	1,971	1.00	7	NA	2,626	1.00	6	NA
	Castle Hill Road / County Drive / Highs Road	Signals	4,046	1.01	64	E	4,418	1.01	63	E
Castle Hill Station	Old Northern Road / McMullen Road	Signals	4,121	0.89	36	C	4,347	0.74	30	C
	Old Northern Road / Crane Road / Castle Street	Signals	967	0.44	28	B	1,028	0.46	27	B
	Crane Road / Terminus Street	Signals	3,178	0.88	43	D	2,941	0.68	40	C
Showground Station	Showground Road / Carrington Road	Signals	2,735	0.75	32	C	3,078	0.92	44	D
	Victoria Avenue / Carrington Road	Roundabout	2,088	0.42	9	A	2,776	0.57	10	A
	Showground Road / Gilbert Road	Signals	3,955	0.80	34	C	3,798	0.66	24	B

Worksite	Intersection	Control	Existing conditions							
			AM				PM			
			Total (vph)	DoS	AVD (sec)	LoS	Total (vph)	DoS	AVD (sec)	LoS
Norwest Station	Norwest Boulevard / Windsor Road	Signals	5,107	0.90	40	C	5,038	0.92	49	D
	Norwest Boulevard / Columbia Circuit / Brookhollow Avenue (East)	Roundabout	3,545	0.77	7	A	3,827	1.04	20	B
	Norwest Boulevard / Brookhollow Avenue (West)	Roundabout	3,213	0.60	8	A	3,207	0.57	8	A
Bella Vista Station	Old Windsor Road / Celebration Drive	Signals	4,257	0.82	24	B	4,181	0.83	38	C
	Lexington Drive / Celebration Drive	Roundabout	1,962	1.02	35	C	1,892	0.95	20	B
Balmoral Road & Memorial Avenue	Old Windsor Road / Balmoral Road	Signals	4,011	0.67	31	C	4,051	0.89	27	B
	Old Windsor Road / Memorial Avenue / Sunnyholt Road	Signals	5,437	1.07	64	E	5,669	1.02	64	E
Kellyville Station	Old Windsor Road / Samantha Riley Drive	Signals	4,106	1.00	66	E	4,015	0.94	55	D
Windsor Road Site	Old Windsor Road / Windsor Road	Signals	3,567	0.46	22	B	4,061	0.55	32	C
Rouse Hill Station	Windsor Road / White Hart Drive	Signals	3,492	0.65	27	B	4,399	0.66	25	B
	Windsor Road / Schofields Road / Rouse Hill Drive	Signals	3,863	0.95	49	D	4,491	0.93	44	D
Schofields Road Sites	Schofields Road / Cudgegong Road	Priority	1,084	0.51	7	NA	1,118	0.37	5	NA
	Schofields Road / Tallawong Road	Priority	1,013	0.30	2	NA	1,226	0.33	2	NA

Notes:
- Peak Hours: 8.00-9.00am and 5.00-6.00pm
- For priority intersections, LoS=NA: Intersection LoS and Major Road Approach LoS values are Not Applicable for two-way sign control since the average delay is not a good LoS measure due to zero delays associated with major road movements.

9.4.2 Planned road upgrades and improvements

It is expected that there will be a number of scheduled and potential upgrades of the arterial road network in the North-West over the next 10 years. The first stage of the Schofields Road widening to four lanes from Windsor Road to Hambledon Road is to be constructed, commencing toward the end of 2012. This will be followed by two subsequent upgrade stages of Schofields Road through to Railway Terrace at Schofields.

RMS is also giving consideration to the future traffic needs of the higher order road network including Norwest Boulevard and key intersections such as the Old Windsor Road / Sunnyholt Road / Memorial Avenue intersection and the intersection of Windsor Road / Schofields Road. Planning is also underway for the upgrade of the two way, two lane section of Showground Road from Pennant Street to Carrington Road in the vicinity of the proposed Showground Station.

The new developments occurring in the North-West (Balmoral Road Release Area, North Kellyville, Box Hill, Alex Avenue and Area 20) will increase background traffic volumes. Some road improvements and changes will occur as a consequence of these developments.

The road improvements proposed as part of EIS 1 (required to mitigate impacts for stage 1 construction works) would remain in place to mitigate impacts during the stage 2 construction works. Some examples include the proposed signalisation of the intersection of Franklin Road and Castle Hill Road at the Cherrybrook Station construction site and the proposed new signalised intersection on Showground Road at the Showground Station construction site.

9.4.3 Bus services

As buses currently form the main public transport mode for the North-West area, there is a comprehensive network of services operating at the local level and regional services to other centres across Sydney. This includes services to the Sydney CBD, North Sydney and Macquarie Park operating as cross regional services, and M2 express buses. There are also a number of connections provided to regional centres and the rail stations such as Parramatta, Hornsby, Blacktown, Riverstone, Seven Hills, Epping, Beecroft and Pennant Hills.

Hillsbus and Busways, under a contract with TfNSW, are the current providers of bus services in the area surrounding the NWRL alignment. Hillsbus currently provides the majority of services in and around the NWRL corridor. These services cover the suburbs around the proposed Cherrybrook, Castle Hill, Showground, Norwest, Bella Vista, Kellyville and Rouse Hill Stations.

Busways generally operates in the western area of the NWRL corridor providing services within the residential areas of Stanhope, Glenwood, Kellyville Ridge and the vicinity of Schofields Road. It also provides links from these residential areas to Blacktown, Riverstone, Castle Hill and Macquarie Park.

A significant volume of buses currently operate from the Hills District to the Sydney CBD. The main routes are the 610 and M61 services which operate between Castle Hill and the Sydney CBD on a high frequency basis during the peak periods with services also operating to early morning on most days and 24 hours on Friday and Saturday nights. A high level of park-and-ride currently occurs for passengers using the Hills-City services, particularly around Baulkham Hills Intersection, Barclay Road and Oakes Road bus stations. There are approximately 40 services which operate through Baulkham Hills Intersection toward the Sydney CBD between 7:00am and 8:00am on a weekday. It is understood that Hillsbus is experiencing significant growth on services that operate from around the Kellyville / Rouse Hill area travelling via the North-West Transitway (T-way) to the M2 Motorway and onto the Sydney CBD or North Sydney.

In addition passenger numbers on T-way services to and from Parramatta are continuing to increase.

Castle Hill and Rouse Hill are the two major bus interchanges along the NWRL currently operating where significant bus layover occurs. The majority of the bus layover occurs in Old Castle Hill Road, north of the Crane Road / Castle Street intersection. There is also some shorter layover occurring in the 'Bus Only' section of Old Northern Road. The Old Castle Hill Road layover provides space for approximately 7 – 8 buses, with a further 2 – 3 buses accommodated in Old Northern Road.

The Rouse Hill bus layover area was specifically constructed as part of the Rouse Hill Transport Interchange for the T-way. The bus layover area is located between the bus interchange and Windsor Road with driver facilities (toilets, meal room) provided in the interchange. The bus layover area provides for approximately eight buses to stand during breaks for the drivers.

9.4.4 North-West Transitway

The T-way was opened in 2007 and provides a priority bus link from the North-West to Parramatta and Blacktown.

The T-way includes the following sections:

- Parramatta and Rouse Hill – this section includes 14 kilometres of bus only roads and three kilometres of bus lanes on existing roads.
- Blacktown and Parklea – this section provides seven kilometres of bus only road.

Both T-way sections intersect at Burns interchange at Parklea. A total of 30 bus stations are provided along the T-way. The following T-way bus stations are located along the NWRL corridor:

- Celebration.
- Balmoral.
- Burns.
- Riley.
- Merriville.
- Sanctuary.
- Rouse Hill.

Busways and Hillsbus operate T-way services. Hillsbus routes that are traveling along the NWRL corridor are T63, T64, T65, T66, 602, 607X and 617X. Busways routes are T71, T75 and 740.

The frequency of bus services are:

- Weekday – every 3-4 minutes during peak period and 7-8 minutes during off peak period.
- Weekend and public holidays – every 10 minutes.

9.4.5 Cycling

There is a limited network of on-road and off-road cycleways in the vicinity of the proposed stations at the present time, with only the stations at Showground, Bella Vista, Kellyville and Rouse Hill having any cycle paths or lanes in close proximity.

The proposed Cherrybrook Station is located within the Hornsby Shire LGA. Hornsby Shire Council has produced a Cycling Map indicating on-road and off-road paths and difficulty levels, although none are identified in the area around the proposed station.

The Hills Shire Council completed The Hills Shire Bike Plan Review in 2009. This review identified an extensive proposed off road cycleway network with many identified routes that could be linked to the proposed NWRL stations.

In 2011, Blacktown City Council commenced a revision of its bike plan. While the only proposed NWRL station in Blacktown City LGA is Cudgegong Road Station, Blacktown City Council's boundary with The Hills Shire Council is along Old Windsor Road.Opportunities therefore exist for cycle routes in Blacktown City LGA to connect with the proposed NWRL stations of Rouse Hill, Kellyville, and Bella Vista (within The Hills Shire LGA).

9.4.6 Pedestrians

Existing and upgraded pedestrian facilities such as sealed footpaths, pedestrian crossings, pedestrian refuges and kerb ramps would be required to facilitate pedestrian movements to and from the NWRL stations. The safe and easy access to stations from the surrounding areas would encourage future rail passengers to walk to the stations where possible.

Pedestrian facilities are proposed as part of the station developments for those walking from the surrounding area, from the park-and-ride car parks, bus stands, taxi stands and kiss-and-ride parking spaces. In some cases this involves a fully signalised crossing, particularly where there is the need to cross a major road, the provision of a marked crossing or pedestrian refuge and pedestrian bridges.

The principal aim is to ensure that the pathways are clearly marked and provide all weather access to minimise any potential conflicts between vehicles and pedestrians.

9.5 Potential impacts – operation

Potential traffic impacts would arise primarily from the modification of existing transport infrastructure, the addition of new transport generating precincts and change to vehicle traffic, pedestrian use and cycling within precincts and on surrounding roadways.

The following sections describe the proposed operational traffic arrangements and potential impacts on the road network and intersections surrounding the station precincts. Traffic management facilities within the station precincts are described within Chapter 6.

9.5.1 Future travel demand

The NWRL would not be a traffic-generating development in its own right. Rather, the NWRL would reduce traffic in the NWRL corridor that is currently generated by commercial, retail and residential development. The NWRL would provide an alternative to use of the private car (the North-West has the highest levels of car ownership in Sydney) for customers accessing destinations along the rail line including Macquarie Park, the lower North Shore and the Sydney CBD; as well as centres at NWRL stations including Castle Hill, Showground, Norwest, Bella Vista and Rouse Hill.

Analysis, based on the Bureau of Transport Statistics estimates, indicates that in 2021 there could be approximately 12,000 fewer car trips (two way, two hour AM peak) made as a result of the NWRL project. This could equate to almost 14 million fewer car trips annually. By 2036 the corresponding reduction could be about 18,000 fewer car trips (two way, two hour AM peak) resulting in almost 20 million fewer car trips annually. These findings are based on transport demand estimates produced with the aid of the BTS Public Transport Project Model. The model provides an understanding of the existing demand for travel in the project corridor, accounting for growth and change in the drivers of this travel, and enables a comparison of future scenarios with and without a project intervention.

In addition, the NWRL would offer an alternative public transport access mode to M2 buses which presently provide the bulk of public transport access to Macquarie Park, the lower North Shore and the Sydney CBD for residents of the North-West. These bus services make use of the M2 Motorway including the partial busway (with different routes making use of greater or lesser sections of the M2 Motorway), and enter the Sydney CBD across the Sydney Harbour Bridge. In 2011 some 90 M2 buses entered the Sydney CBD in the AM peak hour, and TfNSW forecasts that in the absence of the NWRL there would be a growth of 144% in M2 buses entering the Sydney CBD by 2021.

TfNSW is currently preparing bus modal strategies as part of finalisation of the NSW Long Term Transport Masterplan. Planning of bus network changes associated with the commencement of NWRL operations will be completed in the context of this long term master planning.

The forecast changes in movements of cars, buses, pedestrians and cyclists on the network around the new station precincts are detailed within Technical Paper 1.

Bus

For the purpose of analysis the following changes to the existing bus services have been assumed:

- Replacement of long haul M2 bus services from the western extent of the NWRL corridor with train services, while preserving some M2 bus services mainly in the eastern part of the corridor.
- A major bus-rail and bus-bus interchange at Rouse Hill Station, for buses from the North West Growth Centre, T-way services and the NWRL.
- Minor bus interchanges at Kellyville, Bella Vista and Norwest Stations.
- A minor interchange at Showground Station between the NWRL and bus services from Kellyville including growth precincts of North Kellyville.
- A major interchange at Castle Hill Station between the NWRL and bus services from the extensive central part of the corridor including opportunities for interchange with cross-regional services to Parramatta and Hornsby, as well as Baulkham Hills and other areas to the south.

Car

To cater for a high variety of car ownership and usage patterns, particularly in the western part of the corridor with relatively recent residential developments, both park-and-ride and kiss-and-ride demand is likely to be high in the NWRL catchment area. This is consistent with existing outer stations in the CityRail network where a relatively small proportion of rail users live within a walking catchment of a station. These aspects of the NWRL corridor are an important foundation for the approach adopted on car access provisions. The eastern NWRL stations have more constraints on the provision of park-and-ride facilities and less capacity in the road network, however they also have a stronger bus network to offer an alternative to car access. In contrast, the western NWRL stations have less existing development around stations and less developed bus networks. As a result, a higher provision of park-and-ride spaces is targeted at the western stations of Bella Vista, Kellyville and Cudgegong Road.

The provision of park-and-ride and kiss-and-ride facilities at the proposed NWRL stations would cater for potential redistribution of:

- Traffic movements on the road network located immediately adjacent to the station precincts.
- Some of the parking demand at the existing stations that are currently servicing North-West residents, in particular railway stations located along the Northern Line, Richmond Line and Western Line.
- Vehicle trips for wider areas of road network.

The operational transport modifications and their potential impacts are summarised for each station precinct in the sections below.

Pedestrians

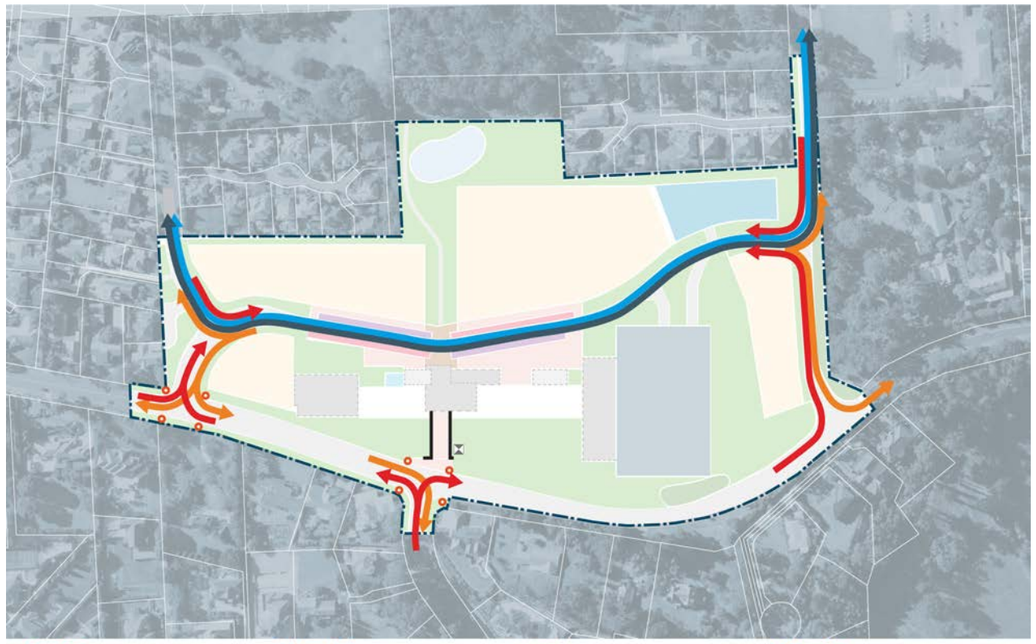
Analysis to define the needs of and impacts on pedestrians has been undertaken for both the construction and operational phases of the proposed NWRL project. The LINSIG analysis undertaken for the construction and operational impact assessment takes into account the access needs of pedestrians at key intersections. Pedestrian crossing times and resultant phasing time adjustments have been factored into the analysis to provide an indication of intersection operation in the post construction and post NWRL operational scenarios. Additionally, analysis has been undertaken to identify how best to manage pedestrian access and safety in situations where construction hoardings and associated infrastructure is likely to affect or impede access. Specific pedestrian modelling has not been undertaken within or external to the proposed stations.

The design of the stations has been based on significant patronage growth over time and for rapid transit operations, ie turn-up-and-go.

9.5.2 Cherrybrook Station

The proposed Cherrybrook Station would mainly serve the suburbs of Cherrybrook and West Pennant Hills, which are currently being served by buses.

Figure 9.1 Cherrybrook Station access routes



Existing road network

The following roads are located immediately adjacent to the proposed station:

- Castle Hill Road is a four-lane undivided road and is classified as a State Road under the care and control of RMS. The section of Castle Hill Road between Old Northern Road and County Drive is part of the Strategic Bus Corridor between Hornsby and Castle Hill.
- Franklin Road and Robert Road are two way, two lane roads and are classified as local roads. These roads are currently maintained by Hornsby Shire Council.
- Glenhope Road is a two way, two lane road and is classified as a local road. This road is maintained by The Hills Shire Council.

The following intersections are located immediately adjacent to the proposed station and operate as priority intersections:

- Castle Hill Road / Franklin Road – left out movements from Franklin Road onto Castle Hill Road only are the only turning movements allowed at this intersection.
- Castle Hill Road / Glenhope Road – all movements are allowed at this intersection.
- Castle Hill Road / Robert Road – left in / left out movements are the only turn movements allowed at this intersection.

NWRL traffic generation in 2021

Chapter 6 provides details of the interface with other transport modes proposed within the station precinct.

The majority of the traffic generated by the station is expected to be from the suburbs to the north and west of the station including Cherrybrook, Dural, Castle Hill and Glenhaven. A smaller volume of traffic is expected to be generated from the West Pennant Hills valley to the south of the site. In most cases this traffic would approach the station precinct along Castle Hill Road from Old Northern Road or County Drive however, it is expected that approximately half of the local traffic generation from the residential areas south of New Line Road may approach along Robert Road or Franklin Road.

Buses would generally approach the station along either Franklin Road or Robert Road from the north and access bus stops provided on the proposed station precinct access road. These buses would be originating from the areas of Cherrybrook, Castle Hill, Round Corner and Dural to the north of the proposed station. This would be achieved through the diversion of existing routes which already pass in close proximity to the station precinct.

To accommodate this traffic, road upgrades would be required and there would likely be an impact on parking along Franklin Road and Robert Road. A number of alternatives for accessing Cherrybrook Station were considered:

- One-way bus circulation along Franklin Road and Robert Road in order to avoid the need for buses to pass one another. This option would create an inefficient bus service by forcing eastbound buses to traverse the section of John Road between Robert Road and Franklin Road twice, whilst westbound buses would not service this section.
- Numerous options to route buses via County Drive and Castle Hill Road in order to avoid one or both of Robert Road and Franklin Road. However, these options would weaken bus services in the key station catchment to the north, increase congestion, result in delays along County Drive and Castle Hill Road, and result in reduced pedestrian safety for bus passengers around Cherrybrook Station.

On balance, the access arrangements utilising Robert and Franklin Road was determined to be the preferred option as it would minimise diversions of the existing bus routes, avoid buses utilising the busy Castle Hill Road, increase services to the key catchment to the north, and maximise pedestrian safety and accessibility to the station precinct.

Although use of Franklin Road and Robert Road for access would result in impacts on kerbside parking and require some other minor physical works, it is considered the best option on the basis of accessibility (especially for bus passengers), safety and traffic efficiency.

Further details of the bus route options analysis is provided within the Operational Traffic & Transport Report (Technical Paper 1).

There is also the opportunity for buses servicing the West Pennant Hills Valley area to access the station from Castle Hill Road, via either Robert Road or Franklin Road.

Most buses would operate on a through routing basis at Cherrybrook Station, ie route operation would not start or terminate at the station.

Figure 9.1 shows the approach and departure routes for cars and buses at Cherrybrook Station.

Proposed NWRL road upgrades

Following extensive consultation with the local community, NWRL has made improvements to the design of the Cherrybrook Station precinct to improve access, and mitigate and reduce potential impacts on local residents. The new design incorporates a realignment of Robert Road and the new station access road to give priority to station access from Castle Hill Road and reduce the potential for "rat-running" on residential streets. The reconfigured design features improved access and safety for neighbouring residents, with landscaping proposed to screen properties from headlight glare. This new design would produce a better outcome for residents in conjunction with an improved address and access to Cherrybrook Station. Mature landscaping at this junction would become an urban marker for the entrance to the proposed station.

In order to facilitate access to the station precinct, a number of traffic management measures would be required. These would include:

- Widening of Robert Road from 7.5 metres to around 14 metres between Castle Hill Road and the station access road to provide two traffic lanes in both directions.
- Provision of traffic signals at Castle Hill Road / Robert Road to facilitate an all movements intersection.
- Development of a two lane precinct access road running between Robert Road and Franklin Road, parallel to Castle Hill Road, to provide access to the car parks, bus bays, taxi ranks and short term on street parking (kiss-and-ride). Pedestrian facilities would be provided across the access road at the entrance to the station. This road would be provided with a traffic lane and parking lane in each direction.
- Widening of Franklin Road from 7 metres to 11 metres from Castle Hill Road to just south of the Kayla Way intersection to provide for a right turn lane into the access road and through lanes in each direction. South of the access road intersection Franklin Road would be provided with two northbound lanes and one southbound lane.
- Provision for left in and left out traffic movements at the intersection of Franklin Road / Castle Hill Road under priority control (unsignalised). This would include the provision of a 60 metre left turn lane into Franklin Road on Castle Hill Road. A zebra pedestrian crossing would be provided across Franklin Road at the intersection.
- Provision of traffic signals (subject to RMS approval) with pedestrian crossing facilities at the intersection of Glenhope Road and Castle Hill Road. This would include the provision of a right turn bay for vehicles turning from Castle Hill Road into Glenhope Road. The pedestrian crossing facilities would be provided across Castle Hill Road and Glenhope Road at the intersection with all traffic movements being allowed.
- Reconfiguration of parking and traffic lanes on Robert Road and Franklin Road to facilitate bus access to the station from John Road.

A number of measures have been developed, and discussed with Hornsby Shire Council and RMS, to improve access to Cherrybrook Station from the north. These include a new shared path link from the station to the end of the proposed Blue Gum Drive, footpath upgrades on Robert Road and Franklin Road to link with existing footpaths as well as removal of parking on Robert Road and Franklin Road to facilitate access by buses, which would provide a key link between the station and the catchments to the north and north west.

Integrating Cherrybrook Station

The principal vehicle-borne customer catchment for Cherrybrook Station is to the north, including the established areas of Cherrybrook and Dural. There is a lesser catchment to the south in the West Pennant Hills Valley area.

Customer access to the station by road is constrained by the nature of the road network including limited north-south road links (particularly across New Line Road) and substantial peak period traffic congestion on arterial and sub-arterial roads.

There is expected to be a strong demand for commuters to make their way to the station via the most direct available route and this would see some park-and-ride, and kiss-and-ride commuters accessing the station via Robert Road and Franklin Road, particularly in view of the congestion on County Drive and Castle Hill Road.

In order to ensure bus access is as direct and delay-free as possible, it is proposed that buses (operating on three routes to and from the north and north west) would approach the station along Robert Road and Franklin Road and access bus stops provided on the proposed access road located immediately north of the station. These buses would originate from Cherrybrook, Castle Hill, Round Corner and Dural to the north of the proposed station.

This would be achieved through the diversion of existing routes, two of which already pass in close proximity to the station precinct. In this way direct bus routes to the station would be provided, consistent with the TfNSW West / East split bus strategy which aims to have Cherrybrook Station served by buses on their way to other existing destinations.

Owing to existing road network constraints, alternative bus route options to the station,using Castle Hill Road for instance instead of Robert Road and Franklin Road, would have difficulty serving the same catchment area as the route would experience greater congestion and potential delays. and would either require the introduction of entirely new bus routes or the lengthy diversion of existing routes, to the detriment of existing customers.

A key element of the station precinct is a new link road between Robert Road and Franklin Road. This would provide a ‘front door’ to the station and a high quality space for management of buses, kiss-and-ride and park-and-ride access, with commuter car parking spaces also accessed from the link road.

Overall, the integration of Cherrybrook Station would involve providing access to the station precinct to and from Castle Hill Road (via Robert Road and Franklin Road for vehicles, and from Glenhope Road for pedestrians from the south), as well as via Robert Road and Franklin Road from the north for local access.

Pedestrian and cyclist provisions

Pedestrian access to the station precinct would be provided by way of footpaths along Castle Hill Road, Robert Road and Franklin Road in the vicinity of the station. A zebra crossing would be provided across Franklin Road at the intersection with Castle Hill Road.

Pedestrian access from south of the station would be provided by way of the signalised intersections at Castle Hill Road / Glenhope Road and Castle Hill Road / Robert Road.

Cyclists would have the opportunity to access the station via the local road network along Robert Road, Franklin Road or Glenhope Road.

Car access

Four hundred commuter car parking spaces would be provided at Cherrybrook Station, with access via a new east-west running station access road. This station access road would also provide 14 kiss-and-ride spaces to allow for safe passenger drop off and pick up.

Improvements to traffic access have been considered in the project concept design, with the proposed widening of Robert Road between Castle Hill Road and the station access road, and Franklin Road between Castle Hill Road and Kayla Way. The intersection of Robert Road / station access road would be realigned to improve the priority of vehicle movements from Castle Hill Road.

On-street parking on Robert Road would be retained during the construction phase. It would be necessary to restrict parking between Castle Hill Road and the northern boundary of the accesses to the site. This is expected to have minimal impact on residents as these properties have been acquired for the project and there is currently no demand for on-street parking from the Inala School. During construction, on-site parking at the Cherrybrook Station site is expected to be minimal. However, parking would generally be provided off-site with shuttle buses transferring workers to and from the site.

In end-state, the majority of on-street parking on Robert and Franklin Roads would be removed due to inadequate width for safe operation of buses along these roads. This could result in a loss of up to 160 on-street parking spaces. However, observed usage of on-street parking by residents is currently low, due to the availability of off-street parking at all residential properties, with the majority of residences having a minimum of two off-street parking spaces. Any impacts on short-term visitor parking would be partly offset by the 400-space car park within the station precinct and retention of on-street parking in surrounding streets. Any on-street parking retained on Robert and Franklin Roads would be managed with time restricted parking controls if turnover is to be maintained and if occupation of spaces by rail commuters is to be avoided. On-going management of on-street parking is under discussion with Hornsby Shire Council.

Traffic assessment

The performance indicators for each of the key intersections surrounding the Cherrybrook Station precinct are provided in **Table 9.4**.

Table 9.4 Cherrybrook Station – AM Peak Hour Intersection Performance (2021)

Location	Without NWRL		With NWRL	
	LoS*	DoS**	LoS*	DoS**
Castle Hill Road / County Drive / Highs Road	F	1.10	F	1.02
Castle Hill Road / Robert Road	A	0.09	B	0.52
Castle Hill Road / Glenhope Road	B	0.69	A	0.42
Castle Hill Road / Franklin Road	A	0.48	A	0.50
Castle Hill Road / Edward Bennett Drive	D	0.76	D	0.85

* Overall intersection performance ** Worst performing lane

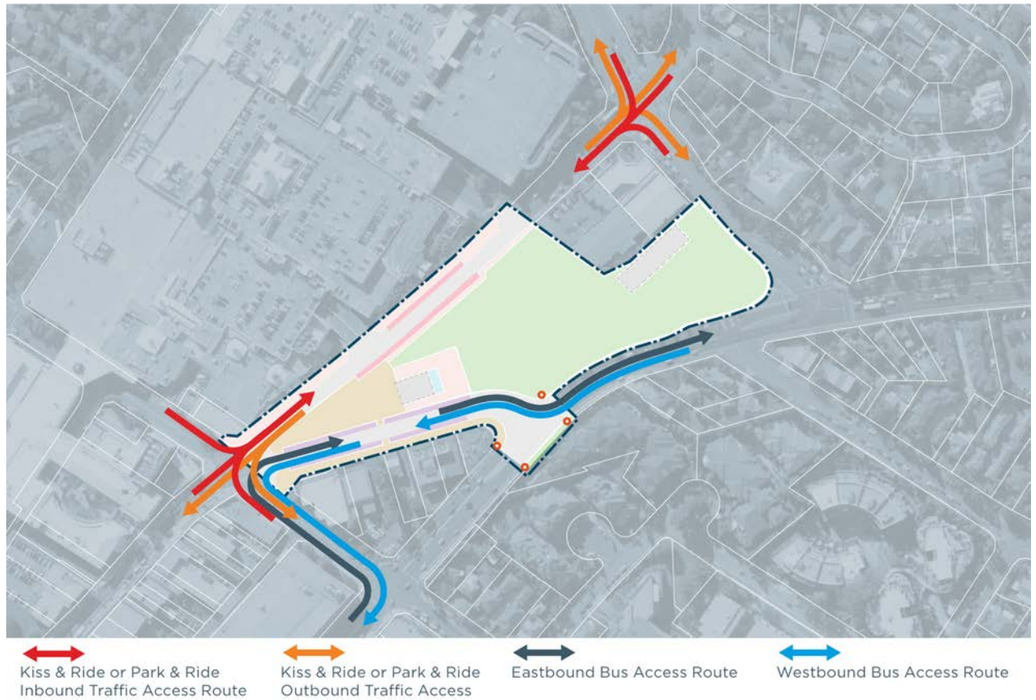
The modelling results indicate:

- The Castle Hill Road / Country Drive / Highs Road intersection is predicted to operate beyond capacity, either with or without the inclusion of the NWRL. Both the DoS and LoS are essentially the same for these two scenarios, suggesting the predicted congestion is a result of general forecast traffic growth rather than the NWRL.
- All of the other intersections within the vicinity of the station are predicted to operate within capacity and with satisfactory LoS.
- From inspection of the modelling results for the Castle Hill Road / County Drive / Highs Road intersection, it is evident that a number of movements are predicted to operate over capacity, including the through movement on Castle Hill Road (west approach), the right turn movement from County Drive and the approach from Highs Road. Consequently it is evident that to improve the operation of this intersection to a more acceptable standard, additional capacity would need to be provided, perhaps through the addition of a further through lane on this section of Castle Hill Road and / or increased turning bay lengths.

9.5.3 Castle Hill Station

The proposed Castle Hill Station would mainly serve the suburbs of Castle Hill and Baulkham Hills.

Figure 9.2 Castle Hill Station traffic access routes



Existing road network

The following roads are located immediately adjacent to the proposed Castle Hill Station:

- Old Northern Road between Showground Road and Terminus Street is classified as a Collector Road, whilst the road section between Terminus Street and McMullen Avenue is classified as a State Road. Traffic arrangements were reconfigured as part of the ring road development so that the section of Old Northern Road between Crane Road and Terminus Street is now a bus only road. It is used as a bus stop and as a layover facility.
- Pennant Street, McMullen Avenue and Terminus Street are classified as State Roads and are under the care and control of RMS. These roads generally provide two traffic lanes in each direction with a narrow median and provision of turn bays at key intersections.
- Crane Road and Old Castle Hill Road are classified as Collector Roads. These roads provide access to a number of the Castle Towers Shopping Centre car parks. Old Castle Hill Road is a one way (northbound) road between the Crane Road / Castle Street intersection and Eric Felton Street. This section of road is also part of the bus interchange, catering for northbound services on the western side of the street and bus layover on the eastern side of the street.

The following key intersections are located immediately adjacent to the proposed Castle Hill Station:

- Old Northern Road / McMullen Avenue (traffic signals) – this intersection is a T-intersection which is the convergence of the eastern and western ring roads around the Castle Hill Town Centre. Medians are provided on all approaches to the intersection.
- Old Northern Road is provided with two through lanes and two right turn lanes on the northern approach and two through lanes and a left turn slip lane on the southern approach. Brisbane Road intersects with Old Northern Road approximately 30 metres south of the McMullen Avenue intersection. A median opening and short right turn bay is provided for vehicles turning from Old Northern Road into Brisbane Road. McMullen Avenue is provided with two right turn lanes and two left turn lanes at the intersection.
- Old Northern Road / Crane Road / Castle Street / Old Castle Hill Road (traffic signals) – there are five legs to this intersection. The southern approach of Old Northern Road provides a single through right lane and a short left turn lane. Old Castle Hill Road is one way northbound at the intersection. Crane Road is provided with two lanes on approach with a shared left / through lane and shared right / through lane. Castle Street has two lanes on approach with a shared left / through lane and shared right / through lane. The northern leg of Old Northern Road is a Bus Only road with a single lane approach to the intersection.
- Crane Road / Terminus Street (traffic signals) – this is a four way intersection with Terminus Street having a divided four lane configuration providing a shared left / through lane, through lane and right turn bay on each approach. Crane Road is provided with two traffic lanes on each approach with the western approach having an exclusive left turn lane and shared right / through lane and the eastern approach having a shared left / through lane and shared right / through lane.
- Terminus Street / Old Northern Road intersection (priority controlled) – this is a T-intersection which provides for left in and left out movements from Terminus Street for buses only to the existing bus interchange. The right turn in from the northern section of Old Northern Road into the bus interchange is also permitted.
- Old Castle Hill Road / McMullen Avenue intersection – this is a signalised cross intersection allowing all movements at the intersection. McMullen Avenue is provided with two through traffic lanes in each direction and separate right turn lanes. Old Castle Hill Road northbound is provided with two right turn lanes and a shared left / through lane. The southbound approach is provided with a right turn lane, through lane and a left turn slip lane which allows traffic to turn left at any time, with care.

NWRL traffic generation in 2021

Chapter 6 provides details on the transport interchange facilities proposed within the station precinct. Vehicle movements in the station precinct are anticipated to be made up predominantly of kiss-and-ride movements and bus movements.

Figure 9.2 shows the approach and departure routes for cars and buses at Castle Hill Station.

Proposed NWRL road upgrades

Traffic changes required at Castle Hill Station would be minimal, and would include:

- Old Castle Hill Road would operate as a two way road over the full length between McMullen Avenue and the Old Northern Road / Crane Road / Castle Street intersection. This would require some widening of the road to accommodate two traffic lanes and two parking lanes north of the Castle Towers vehicle entry. However, this work is proposed to be carried out as part of the construction works to provide for the relocation of the buses to Old Castle Hill Road during the construction phase. South of the Castle Towers vehicle entry, it is proposed to provide two traffic lanes only (one in each direction) to the stop line at the Old Northern Road / Castle Street / Crane Road intersection.
- The traffic signals provided during construction at the intersection of Old Northern Road / Terminus Street would be retained during operation.
- The provision of short term parking (kiss-and-ride) on the eastern kerb of Old Castle Hill Road adjacent to the station and to the north of the taxi ranks.
- Changes to the traffic signals at the intersection of Old Northern Road / Old Castle Hill Road / Crane Road / Castle Street to facilitate two way traffic movements in Old Castle Hill Road at the intersection. These changes would include pedestrian crossings on the Old Castle Hill Road and Old Northern Road (north) legs of the intersection.
- Relocation of all bus ranks at the conclusion of construction works to the section of Old Northern Road between the intersection with Crane Road / Castle Street and Terminus Street.

Integrating Castle Hill Station

Castle Hill is a major centre with an established, mature road network, featuring a town centre ring route to divert traffic from the heart of the centre, which is located on Old Northern Road around the Castle Towers shopping centre.

The proposed Castle Hill Station area is currently a major bus hub for buses serving the centre, and for M2 express and other trunk bus routes linking Castle Hill with other centres and Sydney CBD. Under the proposed NWRL project, Castle Hill would remain a major bus hub, but the NWRL is expected to divert many commuter trips to Macquarie, Lower North Shore and Sydney CBD from bus to train.

NWRL would also provide opportunities for town centre workers, shoppers and other visitors to access the centre more easily.

As a major centre, there would be no formal commuter parking provided at the station, so high quality bus, kiss-and-ride, and pedestrian access is needed to encourage these more sustainable access modes. Consistent with the access mode hierarchy, the highest priority for Castle Hill Station integration is to ensure the station precinct is pedestrian and cyclist friendly.

As with other NWRL centres, buses and trains must serve the centre as well as meet outbound commuter needs. The current public transport access mode split to Castle Hill for journey to work is around 5%, and while the NWRL would help to improve that by making public transport access better, buses would also continue to have an important role in providing access to the centre.

Bus stops would be consolidated into a new bus interchange on Old Northern Road between Old Castle Hill Road / Crane Road and Terminus Street, separated from kiss-and-ride parking and taxis which would be located in Old Castle Hill Road. Bus layover, if required, would to be located off-site.

Pedestrian and cyclist access

The Castle Towers shopping centre, along with other retail uses in the town centre precinct, attracts a significant volume of pedestrian activity around the proposed station site. No pedestrian crossings are currently provided for the Old Northern Road (north) and Old Castle Hill Road legs of the Old Northern Road / Castle Street / Crane Road / Old Castle Hill Road intersection.

A marked pedestrian crossing is provided at the roundabout on Old Castle Hill Road at the intersection of Eric Felton Street. Pedestrian and cycle routes are provided through Arthur Whitling Park.

Pedestrian and cycle facilities would be reinstated through Arthur Whitling Park with the commissioning of the NWRL. New crossing facilities of Old Northern Road and Old Castle Hill Road would be provided as part of the changes to the adjacent roads. A future below ground pedestrian connection to adjacent developments from the station would be safeguarded.

Bicycle storage facilities would be provided near the station entrance. These would incorporate lockers, cages and racks.

Bus access and layover

Castle Hill forms a major terminus and bus services are currently provided from all directions and surrounding suburbs with a mix of terminating and through services.

Buses currently depart from Old Castle Hill Road for northbound services and Old Northern Road for southbound services. Special Event buses for Sydney Olympic Park / Royal Easter Show (Route 5A) commence their journeys at the Showground with the car parking occurring in the Hills Centre car park and the adjoining Showground. They then travel to Castle Hill as part of the route, then travel along Old Northern Road and Windsor Road towards Homebush Bay.

There is currently provision for approximately four buses at the ranks located in Old Castle Hill Road for northbound buses and four ranks in Old Northern Road for buses travelling south. The eastern kerbline of Old Castle Hill Road, north of the intersection with Castle Street / Crane Road, provides layover space for approximately seven to eight buses.

With the opening of the Castle Hill Station, it is proposed to relocate all bus stands to Old Northern Road between Crane Road and Terminus Street as part of the new interchange facility. The existing site would be reconfigured to provide for both north and south bound buses, providing four ranks in each direction. This would place the bus ranks close to the station entrance. Northbound buses that currently turn right from Crane Road into Old Castle Hill Road would instead turn right into the "Bus Only" section of Old Northern Road and exit at the Terminus Street / Old Northern Road intersection. Southbound buses would continue to operate as normal.

Shelters would be provided for the length of the proposed bus ranks and a pedestrian crossing would be provided at the midpoint of the Old Northern Road bus ranks, to facilitate access between stops on the eastern side of Old Northern Road and the station entrance.

A bus layover facility would be provided in the vicinity of Castle Hill, at a site to be identified, in order to accommodate layover away from the bus interchange.

Car access

No formal park-and-ride facilities would be provided at this station. However 17 kiss-and-ride spaces would be located in Old Castle Hill Road to provide for safe passenger drop off and pick up.

The main vehicle routes for kiss-and-ride customers are expected to be to and from Old Castle Hill Road from the Castle Hill town centre ring road. Old Castle Hill Road would operate two-way as a condition of approval for the planned town centre changes and the NWRL project would adopt this configuration for the full length, between Castle Street and Pennant Street / McMullen Avenue.

As at all stations across Sydney, some park-and-ride rail commuters will park on-street, in the streets surrounding the town centre. Parking restrictions are already in place on a number of streets close to the town centre to discourage commuter parking for users of M2 express city bus services and these would be expected to remain in place with the opening of the NWRL. No on-street car parking would be removed during construction or at end-state.

Traffic assessment

The performance indicators for each of the key intersections surrounding the Castle Hill Station precinct are provided in **Table 9.5**.

Table 9.5 Castle Hill Station – AM Peak Hour Intersection Performance (2021)

Location	Without NWRL		With NWRL	
	LoS*	DoS**	LoS*	DoS**
Old Northern Road / McMullen Avenue	C	0.92	C	0.86
Old Northern Road / Terminus Street	A	0.64	A	0.65
Old Northern Road / Crane Road / Castle Street / Old Castle Hill Road	E	0.71	E	0.75
Crane Road / Terminus Street	C	0.97	D	1.02

* Overall intersection performance ** Worst performing lane

The modelling results indicate:

- The Crane Road northern approach at the Crane Road / Terminus Street intersection is forecast to reach capacity with the operation of the NWRL. This is predominantly due to the additional kiss-and-ride traffic movements travelling southbound along Old Castle Hill Road and then left into Crane Road.
- The queue on the northern leg of the Crane Road / Terminus Street intersection is forecast to extend back to the Old Northern Road / Crane Road / Castle Street intersection, however it would clear every traffic cycle.
- All other intersections within the network are forecast to operate with spare capacity and at satisfactory LoS under both considered scenarios.

Shared car parking

Consideration has been given to opportunities for shared car parking with existing facilities located in the vicinity to the proposed Castle Hill Station. In the case of a rail facility which has its peak utilisation during weekdays between the hours of 6am and 7pm, non-conflicting candidate land uses include churches, cinemas, shopping centres, theatres and restaurants.

Scope exists to investigate opportunities to use nearby commercial car parking facilities in the vicinity of Castle Hill Station for commuter parking as there is a range of compatible land uses in the Castle Hill town centre within reasonable walking distance to the proposed station location.

Shared parking does not necessarily require the provision of additional car parking spaces, however it would result in increased car based access to and from the station, albeit most likely outside of peak periods.

9.5.4 Showground Station

The proposed Showground Station would mainly serve the residential areas of Castle Hill located to the north and east, and the southern areas of Kellyville around the Green Road area. It would also provide access for workers to the industrial / commercial area located to the west of the station. Showground Station would complement Castle Hill Station as it would, to a degree, capture train users from the same catchment. However the proposed ShowgroundStation would provide a park-and-ride option with relatively limited bus access.

Figure 9.3 Showground Station traffic access routes

Existing road network

The following roads are located immediately adjacent to the proposed ShowgroundStation:

- Carrington Road is classified as a Collector Road and is a two way, two lane road with limited parking allowed along the road.
- Showground Road is classified as a State Road. The road section between Windsor Road and Carrington Road is a four lane road whilst the road section between Carrington Road and Pennant Street is a two way, two lane road.

The following key intersections are located immediately adjacent to the proposed Showground Station:

- Showground Road / Carrington Road (traffic signals) – this intersection is a signalised T-intersection with Showground Road being a divided carriageway providing two lanes in each direction with the western approach having a right turn bay. Carrington Road is provided with two lanes on approach with a shared left / right lane and a right turning lane.
- Showground Road / Gilbert Road (traffic signals) – this intersection is a signalised T-intersection with Showground Road having a divided carriageway with two through lanes in each direction, a left turn slip lane on the western approach and a right turn bay on the eastern approach. Gilbert Road is provided with two right turn lanes on approach and a left turn lane.
- Victoria Avenue / Carrington Road (roundabout) – this intersection provides two lanes on each of the Victoria Avenue approaches and two lanes on the Carrington Road approach to the intersection.
- Carrington Road / Middleton Avenue intersection – this intersection is controlled by a roundabout which provides a single lane approach on all legs.
- Carrington Road / Doran Drive intersection – this intersection is a priority intersection and provides access to Castle Hill Showground.
- Carrington Road / Ashford Avenue intersection– this intersection is a priority intersection and left in movement from Carrington Road to Ashford Avenue only is allowed at this intersection.

NWRL traffic generation in 2021

Chapter 6 provides details on the transport interchange facilities proposed within the station precinct.

Park-and-ride traffic is anticipated to mainly originate in the Kellyville area, to the north of Showground Road with these vehicles accessing the station principally via Victoria Avenue, Showground Road and Carrington Road. To a lesser degree, park-and-ride traffic would also access the station from the Baulkham Hills area to the south and west of the station. Kiss-and-ride traffic would principally originate from the Kellyville area and even as far as Beaumont Hills. This is related to the principle traffic movements being toward the east during the AM peak and as the ShowgroundStation would be located in the eastbound corridor for those people that would be dropped off at the station while the car driver continues on the eastward journey.

Figure 9.3 shows the approach and departure routes for cars and buses at Showground Station.

Proposed NWRL road upgrades

The development of the Showground Station would include the following traffic management measures to facilitate this station as one of the identified park-and-ride stations:

- Location of a new access road off Carrington Road to the west of the Ashford Avenue intersection. This road would provide access to the commuter parking proposed to the west of Doran Drive. This road would have one entry and exit lane at Carrington Road.
- Upgrading of Doran Drive to accommodate two traffic lanes at the intersection and provision for bus stands, kiss-and-ride spaces and taxi ranks close to the station entrance. Doran Drive would also provide access to the Showground area.
- In conjunction with the above, the signalisation of the intersection with Carrington Road (subject to RMS approval).
- Provision of a new road linking Doran Drive and Showground Road. The intersection on Showground Road would be between the existing signalised intersections of Gilbert and Carrington Roads and signalised (subject to RMS approval). All movements would be allowed, except for right turns from the new road to Showground Road which would be restricted to buses only.

Integrating Showground Station

Showground Station's proximity to Castle Hill influences its integration with bus networks. As Castle Hill is the major centre, with a strong need for effective bus access to the centre and the station, it would remain the main bus hub for the area.Services which pass Showground Station would allow interchange but would not terminate, instead continuing on towards Castle Hill or other destinations.

Showground Station would primarily be a park-and-ride station with 600 spaces servicing park-and-ride demand mainly from the Castle Hill, Glenhaven, West Baulkham Hills and North Kellyville areas. Car

parking spaces at the Showground would supplement park-and-ride demand and provide for dual use of car parking spaces mainly on weekends.

The station would encourage redevelopment of surrounding land, including the Victoria Avenue industrial area to the west, which would be accessed via on-street and off-street pedestrian and cycle links.

The station precinct 'front door' would be to Doran Drive and new internal roads would manage kiss-and-ride and park-and-ride movements within the station precinct. Bus stops located in Doran Drive would provide for bus access to the station (expected to be around 10% of peak period customers), while preserving bus links continuing through to Castle Hill via a bus-only signal onto Showground Road.

Bus Access and Circulation

Bus stops located in Doran Drive would provide for bus access to the station (expected to be around 10% of peak period customers) while preserving bus links to Castle Hill. Due to the steep grades, bus stops would be impractical along Carrington Road and would be unlikely to to satisfy *Disability Standards for Accessible Public Transport 2002*.

Pedestrian and cyclist access

A cycle path currently runs along the eastern side of Cattai Creek and underneath Showground Road into Fred Caterson Reserve to the north of Castle Hill Showground. This cycle path would be retained during operations and provide access to the station precinct.

Pedestrian footpaths are provided along both sides of Carrington Road. As part of the signalisation of the Carrington Road / Doran Drive intersection, pedestrian crossings would be provided on the northern and eastern approaches. The exisitng pedestrian footpath along Carrignton Road provides a link from the station to the idustrial area located to the west.

Car access

Showground Station is identified as a park-and-ride station with 600 vehicle spaces to be provided immediately adjacent to the station. In total 15 short term parking spaces for kiss-and-ride pick up and drop offs are proposed to be provided on both sides of the new east-west running street linking to Doran Drive.

Showground station would provide car parking and kiss-and-ride facilities for commuters and would also serve the adjacent Castle Hill Showground (for which demand is expected to be mostly outside commuter peak periods, including weekends). Kiss-and-ride and park-and-ride vehicles would access the station precinct from Doran Drive, Middleton Avenue and the new link road from Showground Road and circulate via internal roadways. An additional road link to Carrington Road would be located west of Doran Drive, most likely restricted to left in / left out movements only.

Approximately 200 off-street parking spaces contained in the Hills Centre for Performing Arts car park would be lost during construction. However, parking would no longer be required for users of either the Performing Arts Centre or The Hills Shire Council Chambers. Potential Easter Show and Sydney Olympic Park special events related car parking and bus arrangements in the vicinity of the Showground Station construction site are being investigated and would be detailed further in subsequent Traffic Management Plans. On-street parking is unlikely to be affected, except where 'No Stopping' zones would be extended at the new site access point on Carrington Road.

Traffic assessment

The performance indicators for each of the key intersections surrounding the ShowgroundStation precinct are provided in **Table 9.6**.

Table 9.6 Showground Station – AM Peak Hour Intersection Performance (2021)

Location	Without NWRL		With NWRL	
	LoS*	DoS**	LoS*	DoS**
Windsor Road / Showground Road	F	1.10	F	1.10
Green Road / Victoria Avenue / Showground Road	F	1.18	F	1.25
Gilbert Road / Showground Road	C	0.89	C	0.93
Station access / Showground Road	N/A	N/A	B	0.73
Carrington Road / Showground Road	B	0.71	B	0.75
Middleton Avenue / Carrington Road	B	0.74	F	1.10
Doran Drive / Carrington Road	A	0.52	B	0.62
Station access / Carrington Road	N/A	N/A	A	0.34
Victoria Avenue / Carrington Road	B	0.85	F	1.06

* Overall intersection performance
** Worst performing lane

The modelling results indicate:

- The Windsor Road / Showground Road intersection and the Green Road / Victoria Avenue / Showground Road intersection would operate over capacity and with a LoS of F regardless of the NWRL. The Green Road / Victoria Avenue / Showground Road intersection creates a significant capacity constraint for the wider road network.
- The Gilbert Road / Showground Road and the Carrington Road / Showground Road intersections would continue to operate with spare capacity and acceptable LoS with the introduction of NWRL traffic.
- The proposed station access off Showground Road would operate with spare capacity and at a LoS of B. The proposed left in, left out station access of Carrington Road would also operate with spare capacity and with a LoS of A.
- The Middleton Avenue / Carrington Road intersection would operate with a LoS of B and DoS of 0.70 in 2021 from background traffic growth. However, with the introduction of NWRL traffic, the roundabout at this location would fail with the LoS deteriorating to F and the degree to saturation to 1.10. This indicates that roundabout would be required to be converted to traffic signals (subject to RMS approval).
- The performance of the Doran Drive / Carrington Road intersection would deteriorate slightly with the introduction of NWRL traffic; however it would still operate at an acceptable LoS and DoS.
- The Victoria Avenue / Carrington Road intersection would operate with a LoS of B and DoS of 0.84 in 2021 from background traffic growth. However, with the introduction of NWRL traffic, the roundabout at this location would fail with the LoS deteriorating to F and the degree to saturation to 1.06. This indicates that roundabout would be required to be converted to traffic signals (subject to RMS approval).

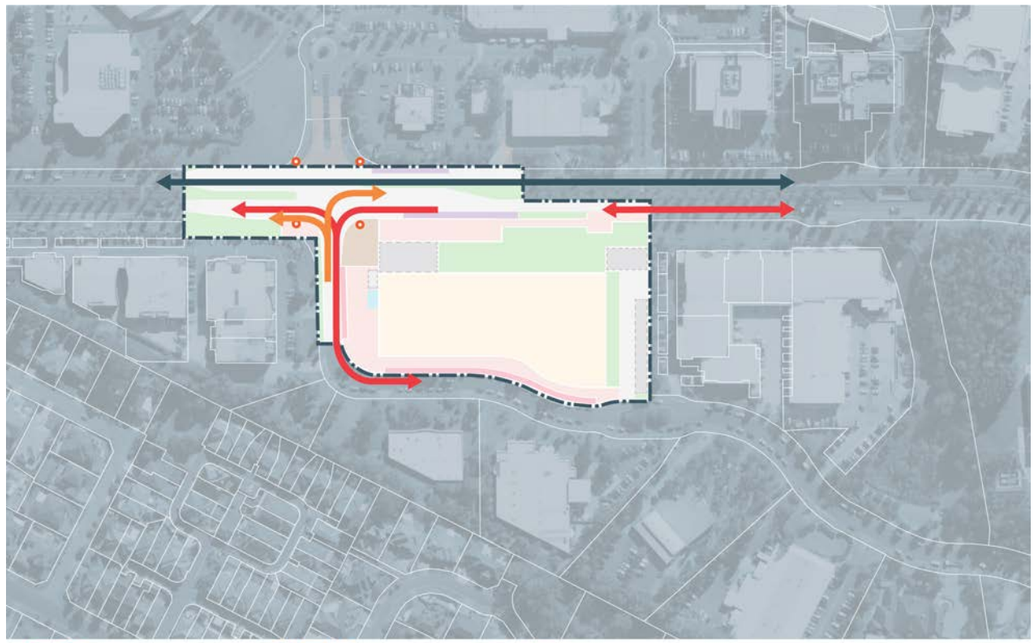
Shared parking

Showground Station would provide commuter parking for 600 cars, demand for which would be greatest on weekdays. On weekends, when demand would be significantly lower, these parking facilities would be available for use by those accessing facilities at the Castle Hill Showground.

9.5.5 Norwest Station

The proposed Norwest Station would mainly serve the workforce of the Norwest Business Park which is currently being served by buses. This station would potentially reduce the congestion along Old Windsor Road and Norwest Boulevard by encouraging a shift from private car to public transport for workers in Norwest Business Park. Norwest Specialised Centre is forecast to increase employment by an estimated 25,000 additional jobs by 2031.

Figure 9.4 Norwest Station traffic access routes



Existing road network

The following roads are located immediately adjacent to the proposed station:

- Norwest Boulevard is a 70 km/h divided four lane arterial with a wide, landscaped central median. It is the only arterial access route for most of the Norwest area and is characterised by high commuter peak flows. Major intersections are controlled by two-lane roundabouts. There are limited alternative routes in the area and private vehicle traffic is the major travel mode.
- Brookhollow Avenue is a local street providing access to a number of commercial properties. Parking is allowed on both sides of the road and incorporates some speed control devices in the form of a contrasting pavement and landscaped medians.
- Century Circuit is a local road which provides access from Norwest Boulevard to the Norwest Shopping Centre, indoor swimming centre and commercial properties adjacent to the shopping centre.

The following intersections are located on the surrounding road network:

- Norwest Boulevard / Windsor Road (traffic signals) – this signalised T-intersection was recently upgraded to provide for three lanes exiting Norwest Boulevard to the south on Windsor Road and two left turn lanes from Windsor Road. Windsor Road is currently a four lane divided carriageway with two through lanes in each direction, two right turn lanes into Norwest Boulevard for the northern approach, and a double left turn for the southern approach. A southbound priority 'Bus Only' lane is provided at the intersection.
- Norwest Boulevard currently has three right turn lanes and two left turn lanes at the intersection with Windsor Road.
- Norwest Boulevard / Columbia Circuit / Brookhollow Avenue (east) (roundabout) – this intersection is a two lane roundabout with Norwest Boulevard having two lanes on each approach and Columbia Circuit a single lane approach and Brookhollow Avenue lanes marked for a short distance on approach to the intersection.
- Norwest Boulevard / Solent Circuit (east) (priority control) – this intersection is a channelised T-intersection with Norwest Boulevard having priority. A right turn bay is provided for traffic turning from Norwest Boulevard into Solent Circuit. Right turns are not permitted out of Solent Circuit.
- Norwest Boulevard / Brookhollow Avenue (west) / Century Circuit (roundabout) – this intersection has a two lane roundabout with both Norwest Boulevard approaches and the Century Circuit approach with two lanes. The Norwest Boulevard approaches are marked as a shared left / through and shared through / right with the Century Circuit approach having an exclusive right turn lane and a shared left / through / right lane. Brookhollow Avenue is provided with a single lane approach to the intersection.
- Norwest Boulevard / Reston Grange / Solent Circuit (west) (roundabout) – this intersection has a two lane roundabout with all approaches having two lanes. The Norwest Boulevard approaches are both marked with a shared left / through lane and a shared through / right lane. Solent Circuit is marked with a right turn lane and shared left / through lane. Reston Grange has two lanes on approach to the intersection without any specific lane allocation.
- Norwest Boulevard / Old Windsor Road (traffic signals) – this is a grade separated intersection with Old Windsor Road has two lanes in each direction and passing under the intersection. Traffic signals are provided for the turning movements from Old Windsor Road and Norwest Boulevard.

NWRL traffic generation in 2021

Chapter 6 provides details on the transport interface facilities proposed within the station precinct.

The majority of the kiss-and-ride traffic movements are expected to be generated from within the Bella Vista residential area and, to a lesser extent, from Baulkham Hills and Glenwood residential areas. As Norwest Station is forecast to generate low demand for commuter parking, no specific provision has been made.

Bus movements operate along Norwest Boulevard providing services from Glenwood, Crestwood and Bella Vista.

Figure 9.4 shows the approach and departure routes for cars and buses at Norwest Station.

Proposed NWRL road upgrades

The proposed Norwest Station would include the following traffic management measures in the development and operation of the station:

- Removal of the roundabout and signalisation of the intersection of Norwest Boulevard / Brookhollow Avenue / Century Circuit.
- Provision of a taxi rank in Brookhollow Avenue near the intersection with Norwest Boulevard.
- Provision of short term parking (kiss-and-ride) in Brookhollow Avenue.

- ❖ Right turn bay extensions and other works required to accommodate growth in through and regional traffic may be undertaken by RMS if required.

Integrating Norwest Station

Norwest is a specialised centre and would become more important as a destination for train trips on the NWRL than as an origin, particularly in the longer term. Currently, Norwest Business Park is highly car focused, with a public transport mode split for journey to work of around 3%, more in keeping with an industrial area than a centre.

NWRL would have an important role in providing access to the centre, with passengers using Norwest as a destination representing just over 50% of all customers in 2021 – with arrivals (exits) at the station in the AM peak period expected to outnumber departures (entries).

However, for the centre to achieve higher levels of public transport use, the NWRL would need to be supplemented by improved bus services to areas outside the rail corridor. While the lack of a coherent secondary road network in the vicinity constrains bus access, buses operating on Norwest Boulevard would provide an important means of access to the station. Bus services on Norwest Boulevard would also provide a link from the station to commercial premises within the larger business park which may be beyond a comfortable walking distance from the station, eg Woolworths head office, approximately 1.2 km to the south west.

A key objective for the Norwest Station precinct is to provide safe pedestrian and easy bus access in order to encourage customers to access or leave the station by foot in the morning and evening peak periods.

The station would front Norwest Boulevard and provision would be made for a future grade-separated pedestrian link across Norwest Boulevard, in addition to a new signalised pedestrian crossing to be installed at the intersection of Century Circuit / Brookhollow Avenue. Bus stops would be located on Norwest Boulevard (initially in indented bus bays) to integrate with existing bus routes through Norwest, Kiss-and-ride parking and taxi stands would be located in Brookhollow Avenue.

As a station within a commercial centre, the lack of formal park-and-ride facilities would require management of parking by Council to discourage commuters from parking on local streets.

With the future implementation of the Opal card by TfNSW, a fare-free zone or similar could permit bus services to be used to help distribute NWRL customers through Norwest business park.

Pedestrian and cyclist access

A key objective for the Norwest Station precinct is to provide safe pedestrian access in order to encourage customers to access or leave the station by foot in the morning and evening peak periods.

The opportunity also exists to investigate provision of additional pedestrian and cycle links to the residential areas to the south of Norwest Station, although these may require additional property acquisition.

Footpaths are currently provided along both sides of Norwest Boulevard, Brookhollow Avenue and Century Circuit. A pedestrian underpass of Norwest Boulevard is also provided to the east of the station site. These would be maintained on completion of construction.

As part of the signalisation of the Norwest Boulevard / Brookhollow Avenue / Century Circuit intersection, pedestrian crossing would be provided across all legs of the intersection.

Provision would also be made to safeguard for a future grade separated pedestrian link under Norwest Boulevard, associated with the station entry point.

Bus and taxi access

Bus services to Norwest Business Park in the vicinity of the proposed Norwest Station are currently operated along Norwest Boulevard by Hillsbus and Busways.

Currently bus stops are located on Norwest Boulevard to the east and west of the proposed station, near the pedestrian underpass toward the Solent Circuit (East) intersection to the east and near the intersection with Reston Grange to the west.

In general, the existing bus network would provide suitable links to the station from the surrounding areas, but services would be enhanced should the frequency and hours of service be increased in the future to provide full-time frequent services linking areas such as Bella Vista Waters and Crestwood to Norwest Station. There may be the opportunity to also link the Balmoral Road Release Area to Norwest Station with the provision of a new local service as the area develops to increase the station's catchment.

While bus stops would be located on Norwest Boulevard (in indented bus bays) to integrate with existing bus routes through Norwest, taxi stands and kiss-and-ride parking would be located in Brookhollow Avenue.

Car access

No formal park-and-ride facilities would be provided at Norwest Station and it is expected that the park-and-ride patrons from surrounding areas would use either the proposed Bella Vista Station or Showground Station commuter car parks. In view of the existing non-timed parking on surrounding streets, future management of parking in the vicinity of Norwest Station may be required by The Hills Shire Council to discourage commuters. However, there may be the potential for commuters driving to the station and parking to make use of on street car spaces vacated by business park workers who have diverted to rail and as a result the park-and-ride demand at Norwest Station is not expected to have a noticeable impact. Nonetheless, parking on street would need to be monitored and managed, if necessary, through implementation of appropriate parking management strategies.

Access to the nine short term kiss-and-ride spaces would be provided off Norwest Boulevard.

It would be necessary to displace 10 – 15 kerbside parking spaces along one side of Brookhollow Avenue during construction works extending along the Brookhollow Avenue frontage to the construction site. Taxi, kiss-and-ride and short term parking would be reinstated in the end state. This is expected to have minimal impact on businesses along Brookhollow Avenue as all properties have ample off-street parking for customers and staff. and there is low existing demand for on-street parking around the station precinct.

There would be no changes to on-street restrictions along Norwest Boulevard as a result of construction activities. The only off-street parking that would be lost will be within the commercial land uses to be acquired by the project on the northern side of Norwest Boulevard.

Traffic assessment

The performance indicators for each of the key intersections surrounding the Norwest Station precinct are provided in **Table 9.7**.

Table 9.7 Norwest Station – AM Peak Hour Intersection Performance (2021)

Location	Without NWRL		With NWRL	
	LoS*	DoS**	LoS*	DoS**
Norwest Boulevard / Brookhollow Avenue (east) / Columbia Circuit	B	1.54	C	2.12
Norwest Boulevard / Solent Circuit (east)	A	0.64	A	0.67
Norwest Boulevard / Brookhollow Avenue (west) / Century Circuit	C	0.90	C	0.93
Norwest Boulevard / Reston Grange / Solent Circuit (west)	D	1.56	D	1.51

* Overall intersection performance
** Worst performing lane

The modelling results indicate:

- The new signalised intersection at Norwest Boulevard / Brookhollow Avenue (west) / Century Circuit is forecast to operate at a satisfactory LoS following the introduction of the NWRL.
- The existing roundabouts on Norwest Boulevard at Reston Grange / Solent Circuit (west) and Brookhollow Avenue (east) / Columbia Circuit (west) are forecast to operate close to capacity, even without the NWRL.

Shared car parking

Consideration has been given to opportunities for shared car parking with existing facilities located in the vicinity to the proposed Norwest Station. In the case of a rail facility which has its peak utilisation during weekdays between the hours of 6am and 7pm, non-conflicting candidate land uses include churches, cinemas, shopping centres, theatres and restaurants.

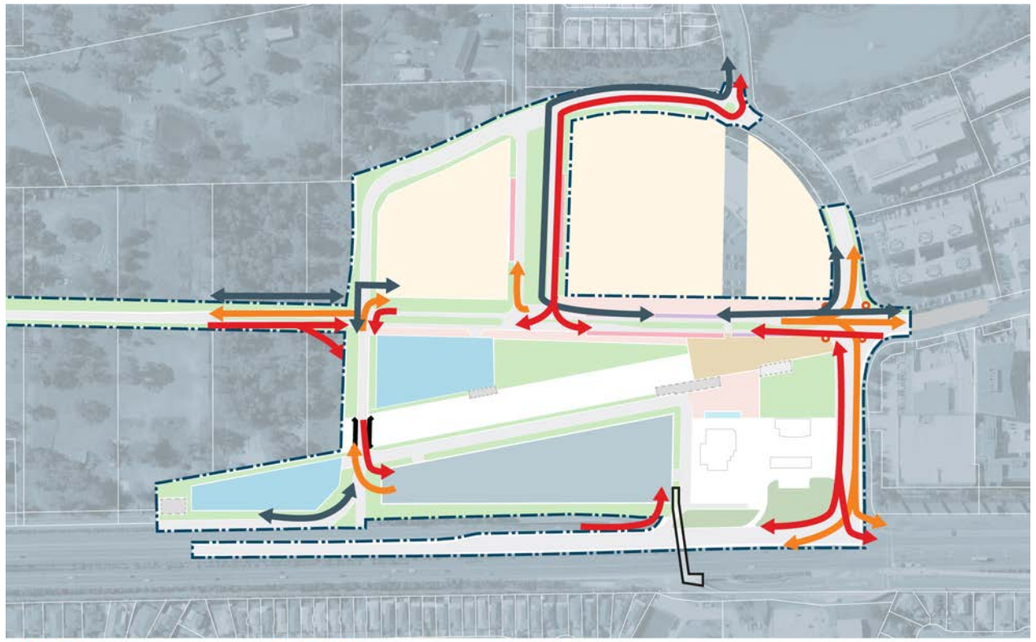
Scope exists to investigate opportunities to use nearby commercial and industrial car parking facilities in the vicinity of Norwest Station for commuter parking as there is a range of compatible land uses in the Norwest Business Park within reasonable walking distance to the proposed station location.

Shared parking does not necessarily require the provision of additional car parking spaces, however it would result in increased car based access to and from the station, albeit most likely outside of peak periods.

9.5.6 Bella Vista Station

The proposed Bella Vista Station would mainly serve the north western part of the Bella Vista business park as well as the existing Bella Vista and Glenwood suburbs and the future developments in the Balmoral Road release area.

Figure 9.5 Bella Vista Station traffic access routes



Existing road network

The following roads are located immediately adjacent to the proposed station:

- Old Windsor Road is a 4-lane divided road with an 80km/h speed limit and is classified as a State Road under the care and control of RMS. The T-way is located along the western side of the road south from Celebration Drive and traverses across to the eastern side via a tunnel under Old Windsor Road just north of the Celebration Drive intersection.
- Celebration Drive is a two way, two lane road and is classified as a Collector Road serving both retail and commercial land uses in the western section of the Norwest Business Park. This road is currently maintained by The Hills Shire Council.
- Lexington Drive is a two way, two lane road and is classified as a Collector Road serving a number of commercial and retail developments along its length and connecting Celebration Drive with Norwest Boulevard. Along with Celebration Drive, Lexington Drive provides an alternative access to the eastern sections of the Norwest Business Park for traffic approaching from the north on Old Windsor Road. This road is currently maintained by The Hills Shire Council.

The following intersections are located adjacent to the proposed station:

- Old Windsor Road / Celebration Drive (traffic signals) – this intersection is a channelised T-intersection with Old Windsor Road provided with two through lanes in each direction. The southern approach has two right turn lanes into Celebration Drive. The northern approach comprises a left turn slip lane and a priority 'Bus Only' lane at the head of the left turn lane. Celebration Drive is provided with two right turn lanes, a priority 'Bus Only' lane and a left turn lane at the intersection. Access is also provided to and from the T-way into Celebration Drive.
- Lexington Drive / Celebration Drive (roundabout) – while the roundabout at this intersection has been designed to operate as a two lane roundabout, at the present time it effectively only operates as a single lane roundabout as each of the approaches are single lane only. The splitter islands at this intersection also act as pedestrian refuges with pedestrian paths.

NWRL traffic generation in 2021

Chapter 6 provides details on the transport interchange facilities proposed within the station precinct.

The majority of vehicle movements would be comprised of kiss-and-ride and park-and-ride movements. Buses would operate along the proposed Lexington Drive extension and provide connections from the Balmoral Road area and from within Bella Vista to the south of the station.

Figure 9.5 shows the approach and departure routes for cars and buses at Bella Vista Station.

Proposed NWRL road upgrades

Bella Vista Station is one of the designated park-and-ride sites for the NWRL. As part of the development of the station the following facilities are proposed:

Construction of a local access road as an extension of Lexington Drive to Balmoral Road. This road would generally provide one traffic lane and one parking lane in each direction on a divided carriageway.

Mid-block pedestrian crossings are proposed to be provided near the station entry.

Removal of the roundabout and signalisation of the intersection of Celebration Drive and Lexington Drive. The eastbound carriageway of Celebration Drive, between Old Windsor Road and Lexington Drive would also be widened to provide two lanes. Pedestrian crossings would be provided on all legs. This would affect the egress of vehicles from McDonalds and the adjacent service station as, currently, vehicles can exit either site, turn around at the roundabout and then turn from Celebration Drive to travel northbound or southbound on Old Windsor Road. Alternative options for this traffic could potentially include the following:

- Northbound – left into Celebration Drive, left into the Lexington Drive extension, left into Memorial Avenue to access Old Windsor Road or Sunnyholt Road. Alternatively, left into Celebration Drive, right into Lexington Drive, turn around at the Lexington Drive / Meridian Place roundabout returning to Celebration Drive and then right into Old Windsor Road.
- Southbound – left into Celebration Drive, right into Lexington Drive and, alternatively, turn around at the roundabout at the intersection of Lexington Drive / Meridian Place to return to Celebration Drive and then left into Old Windsor Road or proceed along Lexington Drive to Norwest Boulevard to enter Old Windsor Road at the grade separated interchange.
- The provision of 800 parking spaces in a multi-storey car park to the north east of the station. Access to the car parks would be via the proposed Lexington Drive extension or directly off Windsor Road (southbound).
- The provision of six bus bays (three on the eastern side and three on the western side), a taxi rank and 16 kiss-and-ride parking spaces to be provided on both sides of the proposed Lexington Drive extension adjacent to the station entry.
- New entry to the McDonalds outlet from Celebration Drive and reconfiguration of the existing car park.

Integrating Bella Vista Station

Bella Vista Station would function as a major park-and-ride station, with some 800 car spaces to be provided. South of Celebration Drive is the Bella Vista business park, forming part of the Norwest Business Park.

To the north, the surrounding residential area is currently sparsely developed east of Old Windsor Road, while to the west of Old Windsor Road there are established residential areas with limited road or pedestrian access to the east. Old Windsor Road forms a barrier to station access from the west and a grade-separated pedestrian bridge would link the station to the residential areas west of Old Windsor Road.

At Bella Vista, the NWRL proposed station access arrangements introduce a new north-south extension of Lexington Drive, providing access to the north as far as Balmoral Road through the corridor between Old Windsor Road and NWRL on the west, and Elizabeth Macarthur Creek. This corridor offers a substantial opportunity for land use change to be influenced by NWRL. This is expected to take place in the medium to longer term 2036 to 2061 period.

The proposed extension of Lexington Drive (new road) is an important feature for integrating the station with future development to the north and north-east including Balmoral Road. This road would be used for local station access (including local buses accessing the station from the north), would support access to new urban development in the corridor, and would supplement Old Windsor Road by providing an alternative route towards Bella Vista and Norwest Business Parks.

Bella Vista Station would serve the northern part of the Bella Vista business park and therefore be a destination, as well as an origin station. Customers travelling by train to Bella Vista in the morning peak period would represent some 30% of peak period customers in 2021, increasing to around 40% by 2036. Most NWRL customers using Bella Vista as a destination would likely walk or catch buses to their final destination, and many would have destinations south of Celebration Drive, in the Bella Vista and Norwest business parks.

Accordingly, the station precinct master plan proposes the signalisation of the Celebration Drive / Lexington Drive intersection to improve pedestrian access to and from the station. However, some would use buses to access locations more remote from the station such as Woolworths head office (approximately 900 m) or RESMED / Norbrik (1.5 – 2.0 km).

Bus stops and kiss-and-ride parking would be located on the Lexington Drive extension, north of Celebration Drive.

This area, bounded by Norwest Business Park in the south, Windsor Road to the east, Elizabeth Macarthur Estate to the north and the proposed NWRL and Old Windsor Road to the west, is currently undergoing residential development. The Balmoral Road Release Area is expected to yield approximately 6,000 dwellings by 2021 and a population of approximately 12,000. The development will require upgrading of Memorial Avenue to accommodate the increased traffic movements wanting to access the road from these developments.

The precincts around both Kellyville Station and Bella Vista Station have been designed to accommodate pedestrian, cycle, bus and car based access to the release area. There would be the opportunity to link the release area to these stations with the provision of new local bus services as the area develops to increase the catchment of both stations.

Pedestrian and cyclist provisions

The major pedestrian movements are anticipated to be south of the station towards the commercial area and west of the station to residential areas. In order to facilitate these movements the following pedestrian facilities would be provided:

- Pedestrian crossing on all legs of the Celebration Drive / Lexington Drive intersection as part of the signalisation works (subject to RMS approval).
- Retention of the pedestrian crossings at the southern and eastern legs of the Celebration Drive / Old Windsor Road intersection.
- Retention of pedestrian paths along Celebration Drive, Lexington Drive and Old Windsor Road.
- Pedestrian bridge across Old Windsor Road.

Car access

Bella Vista Station would include 800 park-and-ride spaces with access via the Lexington Drive extension or directly off Old Windsor Road (southbound). On-street parking would also be available on the Lexington Drive extension north of the station and 16 short term (kiss-and-ride) parking spaces would be provided on both sides of Lexington Drive extension close to the station entry.

It is anticipated that this level of parking would generate traffic to the station principally from the Glenwood, Balmoral Road and Kellyville areas, with a significant number of commuters also accessing the station from as far as Quakers Hill and Acacia Gardens. Those commuters from suburbs west of Old Windsor Road are anticipated to access the station along Sunnyholt Road (for Stanhope Gardens, Acacia Gardens and Quakers Hill) with a smaller volume using Miami Street or Norwest Boulevard.

Most on-street parking would not be affected by construction activities. The 522 off-street car parking spaces in the Totally Home Centre would be lost as a result of the stage 1 major civil construction works. However, this parking would no longer be required for staff and customer parking once the Totally Home Centre ceases trading.

Traffic assessment

The performance indicators for each of the key intersections surrounding the Bella Vista Station precinct are provided in **Table 9.8**.

In relation to the possible future arrangement of the T-way in proximity to the intersection of Memorial Avenue and Old Windsor Road, two scenarios were examined:

- Scenario 1 – where a combined T-way and east-west link road intersection are provided at a location about 70 metres back from the Windsor Road stop line.
- Scenario 2 – where a new T-way intersection is located adjacent to the Memorial Avenue / Old Windsor Road intersection as is the case today at Samantha Riley Drive.

Table 9.8 Bella Vista Station – AM Peak Hour Intersection Performance (2021)

Location	Without NWRL		With NWRL	
	LoS*	DoS**	LoS*	DoS**
Old Windsor Road / Memorial Avenue / Sunnyholt Road (scenario 1)	F	1.27	F	1.43
Old Windsor Road / Memorial Avenue / Sunnyholt Road (scenario 2)	F	1.34	F	1.31
Old Windsor Road / Balmoral Road / Miami Street	C	0.86	D	0.90
Old Windsor Road / Celebration Drive	F	1.32	F	1.70
Celebration Drive / Lexington Drive / Lexington Drive extension	C	0.61	C	0.68
Lexington Drive extension / Balmoral Road	A	0.21	A	0.24

* Overall intersection performance
** Worst performing lane.

Note: LINSIG analysis based on earlier design arrangements.

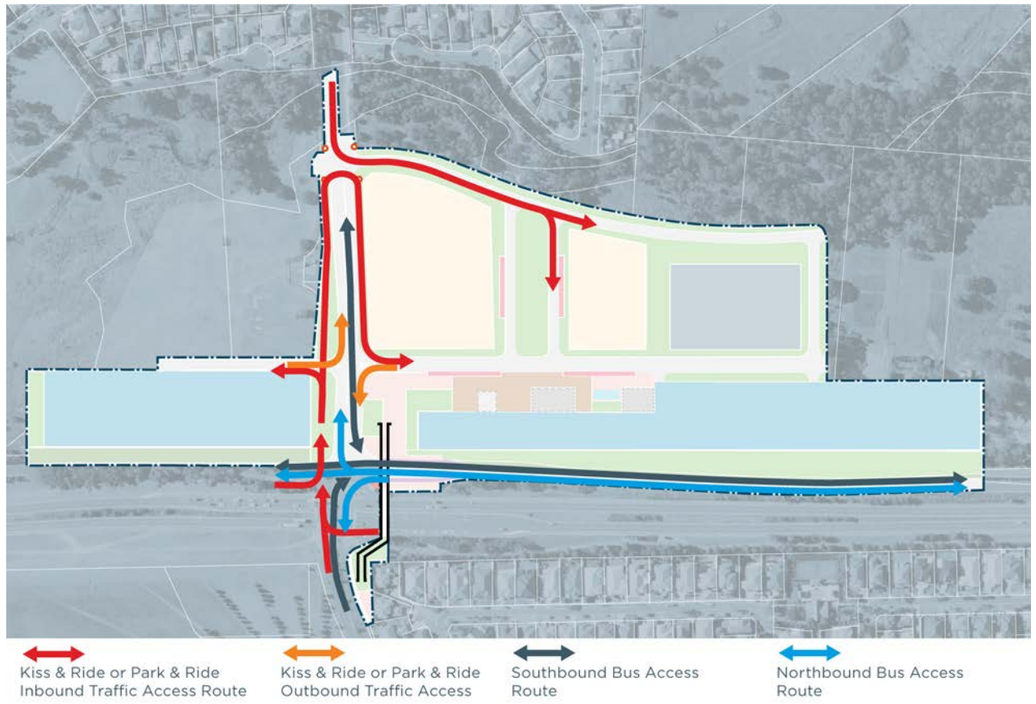
The modelling results indicate:

- Both the Old Windsor Road intersections with Memorial Avenue / Sunnyholt Road and Celebration Drive currently operate above existing capacity. This would not change with the NWRL. The congestion is primarily a result of general traffic growth.
- In relation to Memorial Avenue (Scenario 2), the T-way adjacent to Old Windsor Road with NWRL slightly improves the intersection operation overall (DoS 1.31 vs 1.43).
- The Old Windsor Road / Balmoral Road intersection is predicted to operate within but near practical capacity in both scenarios, although it would operate slightly nearer capacity with inclusion of the NWRL station at Bella Vista.
- The new intersections formed by the Lexington Drive extension, including the intersection with Balmoral Road are predicted to operate well within capacity and to a satisfactory LoS.

9.5.7 Kellyville Station

The proposed Kellyville Station is located near the intersection of Old Windsor Road and Samantha Riley Drive and would mainly serve the Beaumont Hills, Kellyville and Stanhope Gardens areas which are currently being served by buses.

Figure 9.6 Kellyville Station traffic access routes



Existing road network

The following roads are located adjacent to the proposed station:

- Old Windsor Road is classified as a State Road and is under the care and control of the RMS. In the vicinity of the proposed station, it is provided with two through lanes in each direction on a divided carriageway, with turn bays at intersections.
- Samantha Riley Drive is a regional road under the care and control of The Hills Shire Council and has two through lanes in each direction on a divided carriageway.
- Newbury Avenue is a local road under the care and control of Blacktown City Council and provides a single traffic lane in each direction with parking lanes.
- The North West T-way is located between the proposed station and Old Windsor Road.

The following intersections are located adjacent to the proposed station:

- Old Windsor Road / Samantha Riley Drive / Newbury Avenue (traffic signals) – this intersection provides the connection from the residential areas of Stanhope Gardens to the

west and Kellyville to the east of Old Windsor Road. Samantha Riley Drive has its stop line set back to provide for the T-way. It has a two lane left turn comprising a single through lane to Newbury Avenue and single right turn lane.

- Newbury Avenue is provided with a left turn slip lane, a short through lane to Samantha Riley Drive and a right turn lane.
- Windsor Road / Samantha Riley Drive (traffic signals) – this intersection provides two through lanes on a divided carriageway in each direction along Windsor Road with separate right and left turn lanes at the intersection.

NWRL traffic generation in 2021

Chapter 6 contains details on the transport interchange facilities proposed within the station precinct.

The majority of vehicle movements would be park-and-ride and kiss-and-ride traffic generated from the surrounding suburbs on both sides of Windsor Road. This traffic would generally use Samantha Riley Drive and Newbury Avenue to access the station.

Figure 9.6shows the approach and departure routes for cars and buses at Kellyville Station.

Proposed NWRL road upgrades

Kellyville Station is proposed as one of the major park-and-ride stations for the NWRL with a total parking capacity of 1,360 vehicles in at-grade and multi-storey car parks. Access to the station is expected to occur along Samantha Riley Drive, Old Windsor Road, Lexington Drive extension and Newbury Avenue. Proposed new station access roads are consistent with the plans for the Balmoral Road release area. The following traffic management facilities are proposed to be provided:

- Construction of the station precinct access road, running parallel to Old Windsor Road, off Samantha Riley Drive. The road in the vicinity of the station would provide a single traffic lane and parking lane in each direction. This road would provide only left in and left out access at its intersection with Samantha Riley Drive.
- Provision of traffic signals at the intersection of Samantha Riley Drive and the new road close to Elizabeth Macarthur Creek, providing all movements.
- Kiss-and-ride and taxi parking would be provided in the station access road. Buses would operate via the T-way with pick up and set down at the existing T-way stops.
- Provision of at-grade and multi-storey car parks on both sides of the station access road as well as north of Samantha Riley Drive, under the rail viaduct.

Integrating Kellyville Station

Kellyville Station would be a major park-and-ride station, with 1,200 commuter parking spaces located both north and south of Samantha Riley Drive, under the rail viaduct and south east of the station. The station's commuter car park would also incorporate an additional 160 parking spaces replacing existing T-way parking.

Bus would be a relatively minor access mode to the station, although the provision of local bus routes would link residential areas like Beaumont Hills to the north east and Stanhope Gardens to the west, with the station, then continuing to Bella Vista via the existing T-way.

In 2021, more than 15% of station customers are expected to walk or cycle to the station. Recognising that Old Windsor Road is a substantial barrier to pedestrian access from the west, a pedestrian bridge over Old Windsor Road is planned to provide safe and convenient access between Stanhope Gardens and the new station.

The location of commuter car parking supplies at Kellyville Station, south and north of Samantha Riley Drive, would result in park-and-ride commuters approaching from a number of directions, including from the north east via Samantha Riley Drive, from the north west and south via Old Windsor Road, and from the west via Newbury Avenue.

While the operation of the station would divert some car trips from the Old Windsor Road corridor as commuters shift from car to train, there would be a concentration of station traffic in the vicinity of Old Windsor Road and Samantha Riley Drive. The proposed restriction of movements at the intersection on Samantha Riley Drive closest to Old Windsor Road to left-in / left-out only, is expected to assist in mitigating any negative traffic impacts from vehicles accessing or egressing the station precinct.

Pedestrian and cyclist access

Pedestrian and cycle access to the proposed station would be facilitiated by the provision of a footbridge over Old Windsor Road and the T-way for the Stanhope Gardens residential area.

Bus access

Existing bus services in the vicinity of the proposed station are currently confined to the Transitway and along Samantha Riley Drive.

Kellyville Station would be a major park-and-ride station, with buses expected to be a relatively minor access mode to the station. However, local bus services would link residential areas like Beaumont Hills to the north east and Stanhope Gardens to the west, with the station, then continuing to Bella Vista via the existing T-way.

Buses would approach from the west via Newbury Avenue, the north via the T-way or the east via Samantha Riley Drive and then proceed on to the T-Way stopping at the existing 'Riley' bus stop to provide interchange with the NWRL at Kellyville Station. The 'Riley' T-way stop would be retained in its current location with direct pedestrian access to the station. The stop would also continue to also serve bus services operating to Blacktown and Parramatta, with interchange possible between rail and bus at Kellyville Station.

Car access

Kellyville Station is proposed as one of the major park-and-ride stations for the NWRL with a total parking capacity of 1,360 vehicles in at-grade and multi-storey car parks. There is currently a car park area with a capacity of approximately 140 vehicles provided for the 'Riley' T-way bus stop. As a result of NWRL construction, some of this parking may be relocated and incorporated into the proposed station commuter parking area for use by NWRL and T-way passengers. ten kiss-and-ride parking spaces would be provided in the station access road.

During construction it would be necessary to relocate most (all except about 50 spaces) of the Riley T-way car parking to accommodate the station construction works. The relocated parking is most likely to be provided on a site within the rail corridor immediately north of Samantha Riley Drive on a section of the future permanent end-state parking with capacity for approximately 150 cars, giving a total of up to 200 spaces. The residual 50 (approximately) existing T-way spaces would remain in situ, with access via the existing roundabout, until the entire 1,360 permanent end-state parking spaces have been completed within the rail corridor immediately north and south of the station.

As the existing T-way car park is heavily utilised during weekdays with some overflow parking on the access road and the car park circulation road, the intention is to maintain a total of about 200 spaces throughout the period of construction. Vehicular drop offs (kiss-and-ride) around the area are currently low, and it is considered that the impact during construction would be minimal.

Traffic assessment

The performance indicators for each of the key intersections surrounding the Norwest Station precinct are provided in **Table 9.9**.

Table 9.9 Kellyville Station – AM Peak Hour Intersection Performance (2021)

Location	Without NWRL		With NWRL	
	LoS*	DoS**	LoS*	DoS**
Old Windsor Road / Samantha Riley Drive / Newbury Avenue	F	1.15	F	1.30
Samantha Riley Drive / New Station Road	A	0.33	B	0.64
Old Windsor Road / Windsor Road	B	0.68	B	0.57

* Overall intersection performance
** Worst performing lane

The modelling results indicate:

- The Old Windsor Road / Samantha Riley Drive / Newbury Avenue intersection is predicted to operate beyond its existing available capacity irrespective of whether the NWRL is completed. While the station generates local traffic it does exacerbate this congestion. However, the primary cause is the background traffic growth.
- To improve the operation of this intersection to a more adequate standard, it is likely that additional capacity would need to be provided, eg by upgrading the intersection arrangement to include a further through lane in each direction on Old Windsor Road, as well as an additional right turn lane on Newbury Avenue.
- The Old Windsor Road / Windsor Road intersection is predicted to operate well within capacity and with a satisfactory LOS.
- The new intersection formed between Samantha Riley Drive and the proposed new station precinct road is also predicted to operate satisfactorily for the forecast future traffic volumes.

9.5.8 Rouse Hill Station

The proposed Rouse Hill Station is located adjacent to the Rouse Hill Town Centre and Windsor Road. This station would operate as a major bus-rail interchange station with no commuter parking proposed and would mainly serve Rouse Hill, Beaumont Hills and Kellyville Ridge which are currently being served by buses.

Figure 9.7 Rouse Hill Station traffic access routes

Existing road network

The following roads are located adjacent to the proposed station:

- Windsor Road is a State Road provided with two through lanes in each direction on a divided carriageway.
- White Hart Drive is a local road and has two lanes in each direction on a divided carriageway. It provides access to a number of car park entrances located on the southern and eastern sides of the Rouse Hill Town Centre.
- Rouse Hill Drive is a Collector Road which has not been declared a public road. It has two lanes in each direction on a divided carriageway and provides access to car park entrances on the northern side of the Rouse Hill Town Centre.
- Commercial Road is a Collector Road which provides access from Windsor Road to the residential developments of Beaumont Hills and Rouse Hill. In the section between Windsor Road and Caddies Boulevard, there are two lanes in each direction on a divided carriageway.
- Tempus Street is a local road which has not been declared a public road.
- The North West T-way and bus interchange is currently located in the footprint of the proposed station.

The following intersections are located adjacent to the proposed station.

- Windsor Road / White Hart Drive (traffic signals) – the T-way runs adjacent to this intersection and parallel to Windsor Road. It is incorporated into the traffic signal operation for the intersection. Windsor Road is provided with three through lanes in each direction, two right turn lanes on the southern approach and a left turn lane on the northern approach.
- White Hart Drive has two right turn and two left turn lanes at the intersection.
- Windsor Road / Schofields Road / Rouse Hill Drive (traffic signals) – Windsor Road is provided with three through traffic lanes and two right turn lanes in each direction at the intersection. Schofields Road has a left turn lane, two through lanes and two right turn lanes at the intersection.
- Rouse Hill Drive has two left turn lanes, a 'Bus Only' lane, two through lanes and a right turn lane on the approach to the intersection.
- Windsor Road / Commercial Road (traffic signals) – Windsor Road has two through lanes in each direction at the intersection with a two lane right turn bay provided for the southern approach and a left turn slip lane for the northern approach.

NWRL traffic generation in 2021

Chapter 6 has details on the transport interchange facilities proposed within the station precinct.

The majority of the movements would be kiss-and-ride traffic generated from the areas to the north of Rouse Hill and on the eastern side of Windsor Road, including the existing residential areas of Rouse Hill toward Annangrove Road and the new release areas of Box Hill in the future and extending as far as Nelson and Oakville. This traffic would generally approach the station precinct via the arterial and collector road system, including Windsor Road, Annangrove Road / Withers Road and Commercial Road. A small volume of traffic would be generated from the Merriville Road area.

As a major centre, it is not proposed to provide commuter parking facilities at Rouse Hill Station. However, some park and ride is expected to occur with commuters parking on streets surrounding the Town Centre up to a distance of about one kilometre from the station. This traffic is anticipated to be generated from the northern residential areas of Rouse Hill around the Mile End Road area.

Figure 9.7 shows the approach and departure routes for cars and buses at Rouse Hill Station.

Proposed NWRL road upgrades

As the proposed station occupies the existing bus interchange area there would be a change in the way buses operate through the centre. Bus services would move through a linear T-way interchange to the west of the station entry, between the station and Windsor Road. Specific changes to the road network at Rouse Hill include:

- Provision of southbound and northbound bus access via a 'Bus Only' T-way interchange on the western side of the station which would connect to the existing T-way at the intersection with White Hart Drive and continues north through the intersection of Rouse Hill Drive and Windsor Road.
- Provision of a pedestrian crossing across Tempus Street at Market Square to facilitate pedestrian access from the town centre to the station precinct.
- Pedestrian access across the T-way carriageway midway between the offset bus bays via a zebra crossing to enable access to the station.
- The provision of a taxi rank in Market Lane adjacent to the shopping centre. This location would provide easy access for taxis in either direction.
- Extension of the T-way across Rouse Hill Drive to the north towards Commercial Road to facilitate travel to the north for buses to service the extension of the Rouse Hill Town Centre, Rouse Hill residential areas, Annangrove Road Light Industrial area and beyond to Box Hill as development of that area progresses.
- Provision for kiss-and-ride access via Tempus Street.

Tempus Street would continue to operate as a two way low speed road without bus access. Tempus Street would retain the left in / left out restriction at White Hart Drive and Rouse Hill Drive.

Integrating Rouse Hill Station

Rouse Hill Station would be located at a major centre, which would continue to serve as a major bus hub for T-way and local services to the North West Growth Centre , to Parramatta and Blacktown, and to surrounding residential areas.

While the NWRL would have an important role in bringing workers and shoppers to Rouse Hill Town Centre (in addition to its outbound commuter function), buses would also have an important role in serving the Rouse Hill Town Centre as buses would better serve much of the centre's catchment.

Based on experiences at other centres, it is expected that 17% to 20% of bus patronage to Rouse Hill in peak periods would be bound for the centre rather than the station. NWRL, meanwhile, would replace M2 express bus services presently operating between Rouse Hill and the City. Accordingly, the Rouse Hill interchange needs to serve Rouse Hill Town Centre as well as the intermodal needs of station customers bound for other locations.

More than athird of NWRL customers at Rouse Hill are expected to walk or cycle to the station in the morning peak, with a significant number of customers exiting the station in the same period, with many of those walking to their destination in the town centre. Providing a pedestrian-friendly interchange is thereforea critical element to the station's success. Scope exists for a future pedestrian bridge over Windsor Road to connect the Northern Frame development with the Area 20 precinct as it develops.

The station precinct master plan features a compact transport interchange, and bus station arrangements that integrate well with the town centre's 'main street' urban design approach. Management of bus movements, while segregated from other traffic movements, is intended to create a 'street style' station precinct, which manages the need for bus passengers to cross roadways to access the station, or the town centre.

Extensive bus routes would operate to and from the Rouse Hill Station and many of these routes would be extended beyond the station precinct to serve the growing Northern Frame area. By terminating buses from the north in a new bus layover adjacent to the T-way, south of White Hart Drive, and those from the south in a new layover between the future Northern Frame development and Windsor Road, a highly compact bus interchange is able to be created.

Pedestrian and cyclist access

Marked pedestrian crossings are currently provided on all legs of the Windsor Road / Rouse Hill Drive signalised intersection. Marked pedestrians crossings are also on all but the northern leg of the Windsor Road / White Hart Drive intersection. These crossing facilities would be maintained during operation of the station and would enable access to the station precinct.

Pedestrian access between the station and the town centre would be provided by way of a pedestrian crossing across Tempus Street at Market Square. Zebra crossings would also be provided to the north and south of Rouse Hill Drive in the vicinity of Main Street.

Car access

As no park-and-ride facilities would be provided at Rouse Hill Station, it is expected that most park-and-ride patrons from the Rouse Hill area and the growth centre beyond would use the station car parks at either Cudgegong Road Station (1,000 spaces) or Kellyville Station (1,360 spaces). However, 25 kiss-and-ride spaces would be provided in Tempus Street, adjacent to the station entrance.

During major civil construction works it is likely that both of the existing leased parking areaslocated in the area between Windsor Road and the town centre and north of Rouse Hill Drive would be displaced . There are approximately 170 spaces in the first area, around Tempus Street, either time restricted (along the western side of Tempus Street) or restricted access (in the car park at the southern end of the street) and approximately 240 informal spaces located to the north of Rouse Hill Drive, adjacent to Windsor Road.

Some of the affected parking could be relocated by others to other vacant parts of Rouse Hill Town Centre, possibly as part of the next stage of the development. In addition, some of the affected parking could be relocated to other locations in the vicinity of the Town Centre, having regard to planned redevelopment activities by others.

Vehicular drop offs may be restricted on Tempus Street adjacent to the construction site. However, bus and town centre customers would be able to kiss-and-ride in streets other than Tempus Street without compromising accessibility.

Traffic assessment

The performance indicators for each of the key intersections surrounding the Rouse Hill Station precinct are provided in **Table 9.10**.

Table 9.10 Rouse Hill Station – AM Peak Hour Intersection Performance (2021)

Location	Without NWRL		With NWRL	
	LoS*	DoS**	LoS*	DoS**
Windsor Road / Commercial Road	E	1.15	E	1.19
Windsor Road / Rouse Hill Drive / Schofields Road	F	1.15	F	1.14
Windsor Road / White Hart Drive	D	0.99	D	0.97
Windsor Road / Sanctuary Drive	A	0.68	A	0.68

* Overall intersection performance
** Worst performing lane

The modelling results indicate:

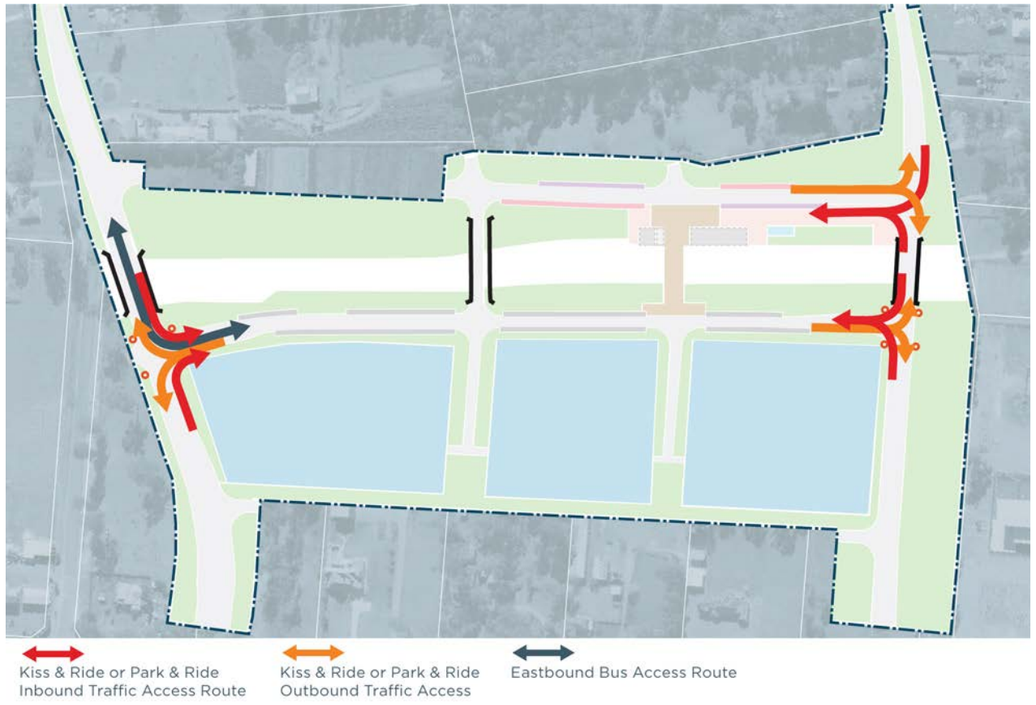
- The Windsor Road / Rouse Hill Drive / Schofields Road intersection would operate with a LoS of F, irrespective of the NWRL, indicating unsatisfactory levels of delay. Both the Windsor Road northern approach and the right turn from Schofields Road are also predicted to have a DoS of over 0.9, again irrespectively of whether the NWRL is completed.

- The key contributing factor to this congestion is the predicted traffic growth for the Windsor Road corridor itself, and in particular the right turn movement from Schofields Road to Windsor Road.
- A number of potential measures may be available to improve the capacity of the Windsor Road / Schofields Road intersection, such as converting a through lane on Schofields Road to a right turn lane, and possibly rationalising the intersection phasing
- The Windsor Road / White Hart Drive intersection is predicted to have a LoS of D, both with or without the inclusion of the NWRL, suggesting that this intersection would be near to capacity. The Windsor Road north approach is predicted to operate with a DoS of over 0.9 in both scenarios, while the right turn from Windsor Road south approach into White Hart Lane is also predicted to have a DoS of beyond 0.9 with inclusion of the NWRL. These DoS values suggest these movements would operate beyond practical capacity and may need improvement.
- The Windsor Road / Commercial Road intersection is predicted to operate beyond capacity, irrespective of whether the NWRL scheme is developed. The highest DoS is recorded for the left turn from Commercial Road into Windsor Road southbound, and this movement is also a principal contributor to delay at this intersection. Other than the Commercial Road left turn, all other movements are predicted to operate with a DoS value of less than 0.9, indicating satisfactory performance. Consequently, with the potential exception of the Commercial Road left turn slip lane, this intersection is able to accommodate the predicted future demands.
- The Windsor Road / Sanctuary Drive intersection is predicted to operate with an acceptable LoS, while the predicted DoS is also within practical capacity limits.

9.5.9 Cudgegong Road Station

The proposed Cudgegong Road Station would primarily serve the residents of the release areas of North West Growth Centre which includes Riverstone, Marsden Park, Vineyard, Box Hill, Riverstone East, North Kellyville, Alex Avenue and Schofields release areas.

Figure 9.8 Cudgegong Road Station traffic access routes



Existing road network

The following roads are located adjacent to the proposed station:

- Schofields Road is a two lane arterial road with narrow sealed shoulders and a rural character. It currently carries approximately 11,000 vehicles per day and is signposted as 80 km/h for most of its length. Schofields Road connects to Windsor Road via an all movement signalised intersection.
- Tallawong Road and Cudgegong Road are local north-south roads connecting Schofields Road to Guntawong Road. Most intersections in this area are priority controlled at the present time.

The following intersections are located near the proposed station:

- Schofields Road / Cudgegong Road (priority controlled) – at the present time both Schofields Road and Cudgegong Road are two lane rural roads with unsealed shoulders. The RMS upgrade works for Schofields Road would see this intersection signalised.
- Schofields Road / Tallawong Road (priority controlled) – as for the Cudgegong Road intersection both Schofields Road and Tallawong Road are two lane rural roads with unsealed shoulders. The RMS upgrade works for Schofields Road would also see this intersection signalised.

NWRL traffic generation in 2021

Chapter 6 provides details on the transport interchange facilities proposed within the station precinct.

The park-and-ride catchment for Cudgegong Road Station would be extensive, with traffic approaching from the areas to the west and north, including Schofields, Riverstone, Marsden Park, and Vineyard and some areas to the south including The Ponds.

Kiss-and-ride traffic would be generated from the residential areas to the north, south and west of the station and would access the station precinct via Schofields Road and either Tallawong Road or Cudgegong Road.

Buses would be mainly servicing the residential areas to the north and west of the station and travelling through to the Rouse Hill interchange.

Figure 9.8 shows the approach and departure routes for cars and buses at Cudgegong Road Station.

Proposed NWRL road upgrades

Cudgegong Road Station is the western most station on the NWRL and is located in a developing area (Area 20). It would perform an important role as both a park-and-ride station and bus interchange station. The development of a local road system parallel to the rail line and connecting Cudgegong Road and Tallawong Road would provide access to the station and to the proposed car parks south of the rail corridor. Bridges would be provided across the rail corridor for both Cudgegong Road and Tallawong Road. The following traffic management measures are proposed as part of the operation of Cudgegong Road Station:

- Widening of both Cudgegong Road and Tallawong Road from Schofields Road to just north of the rail corridor to provide two traffic lanes in each direction.
- Provision of a local access road either side of the rail corridor, with south spine road linking Tallawong Road and Cudgegong Road. The north spine road would not connect to Tallawong Road on day one. These roads would provide one traffic lane and one parking lane in each direction.

- Provision of bus ranks on both sides of north spine road near the station entry.
- Provision of taxi ranks and kiss-and-ride spaces on the northern and southern sides of the northern access road, either side of the station entry.
- Provision of traffic signals at the intersection of the south spine road with both Cudgegong Road and Tallawong Road (subject to RMS approval).
- Provision of at-grade car parks to the south of the rail corridor, near Tallawong Road and Cudgegong Road, with entries and exits via north-south running car park access roads. This would provide approximately 1,000 off-street commuter parking spaces.

Integrating Cudgegong Road Station

Cudgegong Road Station would be the major park-and-ride station serving the North West Growth Centre with 1,000 park-and-ride spaces at opening of the NWRL. The station would be located north of Schofields Road between Tallawong Road and Cudgegong Road. These roads would provide access for both kiss-and-ride and park-and-ride customers, and a small town centre is planned, mainly on the northern side of the station.

East-west access streets would be established on the north and south sides of the station, linking Tallawong Road and Cudgegong Road. The station would have its 'front door' to these east-west streets.

Some North West Growth Centre bus routes would pass by the station on their way to and from Rouse Hill, operating via the northern east-west station access street and making use of on-street bus stops. Some regional bus routes would operate on Schofields Road. It is not intended that these routes would be diverted to the station, as this would weaken their regional transport function.

Bus would initially be a relatively minor access mode, although this is expected to grow over time as the North West Growth Centre develops. Kiss-and-ride is expected to be more important, at least initially, with more than a fifth of station customers using kiss-and-ride spaces in the east-west station access streets.

The future scale of commuter demand to the station would be heavily influenced by possible extensions of the NWRL beyond Cudgegong Road. Should the line not be extended, commuter demand could increase significantly in the longer term as journey opportunities increase and the design of the commuter parking would allow for future expansion if required.

Pedestrian and cyclist access

Both the Area 20 Indicative Layout Plan and the Cudgegong Road Station precinct have been designed with pedestrian accessibility to and from the proposed station in mind.

On the western side of the station precinct pedestrian access would be accommodated as follows:

- Southbound along the footpaths on both sides of Cudgegong Road, then right into the northern station access road.
- Southbound along the footpaths on both sides of Cudgegong Road, then right into the southern station access road via the proposed traffic signals.
- Northbound along the western footpath in Cudgegong Road, then left into the southern station access road via the proposed traffic signals.

In addition to these road-based access links there is scope to investigate shared pedestrian and cycle connections between the proposed station and the western precinct within Area 20.

Indicative layout plans for the land on the western side of the proposed rail station have yet to be finalised. It is envisaged that both road-based and dedicated pedestrian and cycle links would be provided to maximise accessibility.

Car access

Given its strategic location relative to the North West Growth Centre, it is proposed to provide a significant 1,000 space park-and-ride facility at Cudgegong Road Station. In addition to those utilising the dedicated commuter car parking facilities, some of those accessing the station by park-and-ride would inevitably park on-street. Where necessary, NWRL would work with the local Council to develop strategies to manage demand for on-street parking in order to reduce impacts on local residents. Fifteen kiss-and-ride spaces would be provided on the northern access road

During construction there would be little impact on parking as there is minimal demand for on-street parking in the vicinity of the construction site.

Traffic assessment

The performance indicators for each of the key intersections surrounding the Cudgegong Road Station precinct are provided in **Table 9.11**.

Table 9.11 Cudgegong Station – AM Peak Hour Intersection Performance (2021)

Location	Without NWRL		With NWRL	
	LoS*	DoS**	LoS*	DoS**
Schofields Road / Cudgegong Road	B	0.75	B	0.72
Schofields Road / Tallawong Road	A	0.58	B	0.77
Cudgegong Road / Station Access	N/A	N/A	A	0.32
Tallawong Road / Station Access	N/A	N/A	A	0.15

* Overall intersection performance
** Worst performing lane

The modelling results indicate:

- The new traffic signals servicing the station access road at Cudgegong Road and Tallawong Road are forecast to operate well with space capacity in the opening year.
- The Schofields Road / Cudgegong Road intersection approaches capacity in the AM peak hour, with the critical movement being the eastbound through movement on Schofields Road. Provision of an additional eastbound traffic lane (similar to the layout at the adjacent Schofields Road / Tallawong Road intersection) would increase the capacity of the intersection and reduce the DoS to approximately 0.8.

9.5.10 Tallawong Stabling Facility

Access to the stabling facility is proposed to be provided from Tallawong Road. The Tallawong Road access would allow all traffic movements to and from Tallawong Road with a driveway entry providing the fourth leg of the intersection with the station access road located on the southern side of the rail corridor.

Access to the site would be restricted to staff and service vehicles. Approximately 200 – 300 full-time equivalent jobs would be required in order to operate and maintain the North West Rail Link including the operation and maintenance of rolling stock, stations and tracks. This is subject to future operator requirements. Workers would travel to and from the facility in shifts and therefore outside network peak periods. Even in the event that all of the 200 – 300 workers were based at the Tallawong Stabling Facility, the peak period traffic impacts on surrounding intersections would be negligible.

9.5.11 Services Facilities

Epping Services Facility

The Epping Services Facility would be located to the west of Beecroft Road to the north of Carlingford Road. The facility would require occasional maintenance access via Beecroft Road and would also be used for rail personnel (not heavy equipment) to access the tunnels during track / tunnel maintenance periods.

Cheltenham Services Facility

The Cheltenham Services Facility would be located adjacent to Cheltenham Oval between Castle Howard Road and the M2 Motorway. The facility would require occasional maintenance access via local roads and may also be used for rail personnel (not heavy equipment) to access the tunnels during track / tunnel maintenance periods. Castle Howard Road would be widened in certain locations in order to facilitate this access.

9.6 Potential impacts – construction

Potential construction traffic impacts would arise primarily from the addition of heavy vehicles and light vehicles (cars and utes) onto surrounding roadways. These vehicle movements may increase traffic congestion and impact on intersection performance, as well as impact on bus services, pedestrians and cyclists. Existing on and off street car parking may also be affected from construction works and / or construction worker vehicle parking.

At road crossings, traffic impacts and disruption would be minimised by staging construction works in live traffic situations. That is, traffic flow would be maintained while works are being undertaken such as would be the case in the vicinity of construction at Balmoral Road. The NWRL would be in cutting in this location and it would be necessary to bridge Balmoral Road over the rail line. In other locations it may be necessary to temporarily close sections of road for safety and construction purposes. This may be the case at the Norwest Station construction site where Brookhollow Avenue may need to be closed for periods of time, in order to excavate the western end of the station box.

There would be the need to temporarily close roads and lanes across the NWRL project. These proposals would be documented in the Construction Traffic Management Plans and submitted to the Traffic and Transport Liaison Group for consideration and approval. At Castle Hill Station, for example, it is proposed to maintain bus pick up and set down in Old Northern Road between Old Castle Hill Road and Terminus Street. A section of Old Northern Road would be closed to traffic as it would be used as part of the NWRL construction site for truck access and egress. In other locations north of Bella Vista Station, discussions have been held with RMS to temporarily share sections of the T-way for truck access and egress.

9.6.1 Vehicle movement forecasts and access routes

Construction would require a range of vehicle movements involving light vehicles, heavy vehicles and specialised vehicles. Truck movements would be primarily for the delivery of materials to the construction sites.

The site truck movements would normally be uniformly distributed between approximately 7am to 6pm on most weekdays. On certain days, such as large concrete pours, there may however be spikes in the frequency of arrivals and departures. The time profile for construction traffic movements would be subject to change as construction planning proceeds. The construction program and subsequent management plans would include measures to manage activities and minimise traffic impacts, particularly during the surrounding road network peak periods and other sensitive times.

A summary of the proposed access route and anticipated daily heavy vehicle and light vehicle movements associated with material deliveries, waste removal, and the arrival and departure of construction workers has previously been provided in Table 7-18.

9.6.2 Epping Services Facility

Road network

The Epping Services Facility worksite would be located on the western side of Beecroft Road about 100 metres north of the intersection with Carlingford Road. The site proposed for the Epping Services Facility currently is provided with a short deceleration lane to the entry located on the northern end of the site. A separate entry / exit access point currently exists onto Ray Road.

Beecroft Road is a busy, 60 km/h divided (with narrow median) four lane arterial road carrying approximately 32,000 vehicles per day. It has a southbound clearway in the AM peak (6 – 10am) and a northbound clearway in the PM peak (3 – 7pm).

Carlingford Road is a busy, 60 km/h undivided four lane arterial road carrying approximately 27,000 vehicles per day, and providing a main traffic link between Pennant Hills Road and Epping Road. There are "no parking" and "no stopping" restrictions in place on the approaches and departures to the intersections at Ray Road and Beecroft Road.

Ray Road is a local Collector Road providing access from the residential areas to the north-west of Epping to the Epping Town Centre and rail station. It is provided with one traffic lane and one parking lane in each direction and has a signposted speed limit of 50 km/h.

There are no road improvements by others planned in the vicinity of the site.

Heavy vehicle routes

Figure 9.9 shows the worksite and the proposed heavy vehicle routes to be used during construction. Access and egress to and from the site is proposed from two locations, being:

- Left in, left out from Beecroft Road.
- Right in, left out from Ray Road.

Road network operations and intersection performance

Table 9.12 shows the existing intersection performance and the anticipated intersection performance during construction.

The key findings are as follows:

- The intersection of Carlingford Road / Ray Road would continue to perform at saturation in both the AM and PM peaks regardless of the NWRL construction traffic. The DoS at this intersection shows a slight deterioration in the PM peak and slight improvement in the AM peak during the stations and rail systems construction period.
- In the PM peak the LoS at the intersection of Carlingford Road / Beecroft Road would deteriorate slightly from C to D from the introduction of construction traffic.
- The results for the proposed intersection at the site access on Ray Road suggests that the intersection would achieve a LoS A with a DoS of 0.30 in the AM peak which is acceptable.

Buses

There are no scheduled route bus services currently operating along the section of Beecroft Road north of Carlingford Road. However, the M54 service operates along Carlingford Road and Beecroft Road when travelling towards Epping Station and via Beecroft Road, Carlingford Road and Rawson Street on journeys from Epping Station. Route 546 and 549 services operate along Ray Road and Rawson Street on services to Epping, and via Beecroft Road, Carlingford Road and Ray Road on services from Epping. Route 541 services operate via Bridge Street and Beecroft Road on journeys to Epping Station, and via Beecroft Road, Carlingford Road and Rawson Street on journeys from Epping. There are no bus stops in the immediate vicinity of the proposed site.

Pedestrians and cyclists

There is a footpath provided on the western side of Beecroft Road with a concrete path provided from Carlingford Road to the proposed site entrance. Pedestrian volumes are relatively low. This pedestrian path would need to be closed during the construction phase and pedestrians redirected via Ray Road and Kandy Avenue.

Traffic counts highlight that there is a significant pedestrian movement across Carlingford Road during the peak hour, on both the eastern and western pedestrian crossings.

There are no marked cycle facilities on the sections of Beecroft Road, Carlingford Road or Ray Road and cyclist volumes are also low.

Parking, Taxis and kiss-and-ride

As there is no on-street parking in the section of Beecroft Road past the site and the section of Carlingford Road on the approaches to Epping, the impact on parking on these roads would be minimal.

There is a 'No Stopping' restriction in place on the eastern kerb line of Ray Road from the intersection with Carlingford Road to the proposed site access. Parking is permitted on the western side of Ray Road from just north of the Carlingford Road intersection. It is estimated that approximately 2 – 3 spaces may need to be removed at the site entrance to facilitate local traffic being able to pass any vehicles making the right turn into the site.

Commuters park on Ray Road at present to access Epping Station. The Epping Services Facility construction site may have some impact for on-street parking should workers need to drive to the site, however this would managed so that any on-street parking by construction workers is minimal.

Figure 9.9 Epping Services Facility heavy vehicle routes

Table 9.12 Epping Services Facility intersection performance

Location	Existing				During construction			
	LoS (AM)	DoS (AM)	LoS (PM)	DoS (PM)	LoS (AM)	DoS (AM)	LoS (PM)	DoS (PM)
Carlingford Road / Beecroft Road	D	0.92	C	0.91	D	0.94	D	0.93
Carlingford Road / Ray Road / Rawson Street	F	0.85	F	1.02	F	0.84	F	1.04
Ray Road / Site access	N/A	N/A	N/A	N/A	A	0.30	A	0.18

9.6.3 Cheltenham Services Facility

Road network

The Cheltenham Services Facility worksite is located between the M2 to the south, Cheltenham Oval to the east, Kirkham Street to the west and Castle Howard Road to the north. The latter is a low volume local road whilst the M2 is an urban motorway. Kirkham Street is a local Collector Road providing access across the M2 between Beecroft and Carlingford.

The M2 Motorway is currently being upgraded to provide three lanes in each direction and a continuous 100 km/h speed limit. These works include lengthening of the Kirkham Road bridge over the M2 and are scheduled to be completed in the first half of 2013.

The assessment of road and intersection impacts focuses on those intersections and roads in the immediate vicinity of the construction sites as these would be impacted by the proposed works. Near the Cheltenham Services Facility construction site, the Beecroft Road / Kirkham Street intersection is priority controlled with construction traffic encouraged to treat this as a left in / left out intersection. Most NWRL traffic would approach from the south and depart to the north. Total generation from stage 2 construction works would be about 35 movements in and 35 movements out each day. This would be an average of about one movement every 10 minutes, which would have negligible impacts on the intersection operation.

Heavy vehicle routes

Figure 9.10 shows the worksite and the proposed heavy vehicle routes to be used during construction. Heavy vehicle access and egress to and from the site is proposed to be a left in, right out (unsignalised) arrangement from Kirkham Street. An option exists for access and egress to and from the M2 Motorway as a left in, left out subject to consultation with the motorway operator and RMS.

Light vehicle access and egress to and from the site would be from Castle Howard Road at the existing access point for Cheltenham Oval.

Road network operations and intersection performance

Table 9.13 shows the existing intersection performance and the anticipated intersection performance during construction.

In both the AM and PM peaks, the worst LoS (under the 60 second delay scenario) would be B, indicating that the proposed new intersection would have minimal impact on the traffic on Kirkham Street.

Buses

There is currently one scheduled bus service (route 553) along Kirkham Street, operated by Sydney Buses. This is a limited service with approximately nine services a day, in each direction, in the vicinity of the proposed site entrance.

There are a significant number of bus services that operate along the M2 past the site.

Pedestrians and cyclists

Pedestrian and cyclist activity in the vicinity of the construction site is low. The existing footpath on the western side of Kirkham Street would be maintained.

Parking, Taxis and kiss-and-ride

On-street parking is not permitted on Kirkham Street in the vicinity of the proposed site access due to the narrow width of the road and, therefore, the impact on parking would be negligible.

Figure 9.10 Cheltenham Services Facility heavy vehicle routes

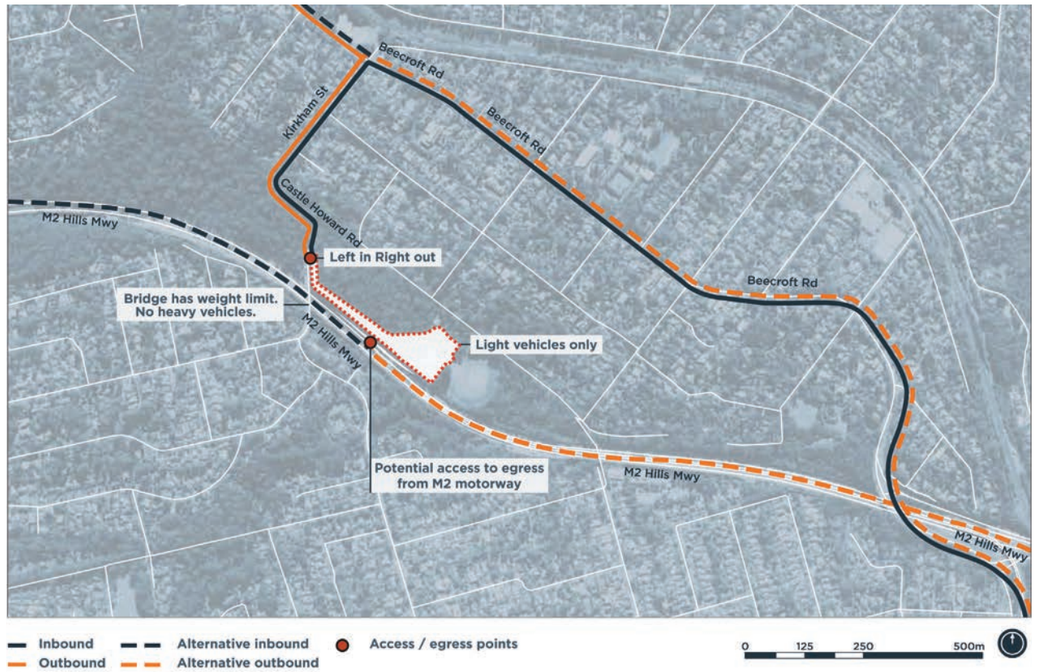


Table 9.13 Cheltenham Services Facility intersection performance

Location	Existing				During construction			
	LoS (AM)	DoS (AM)	LoS (PM)	DoS (PM)	LoS (AM)	DoS (AM)	LoS (PM)	DoS (PM)
Kirkham Street / Site Access (40 second delay)	N/A	N/A	N/A	N/A	A	0.34	A	0.22
Kirkham Street / Site Access (60 second delay)	N/A	N/A	N/A	N/A	B	0.40	B	0.26

9.6.4 Cherrybrook Station

Road network

The Cherrybrook Station site is located adjacent to, and to the north of, Castle Hill Road between Robert Road and Franklin Road. Castle Hill Road is a 60 km/h undivided four lane arterial road. It carries approximately 43,000 vehicles per day and does not exhibit a clear peak direction of traffic flow. Clearways operate during peak periods. It provides an important link to Pennant Hills Road (Cumberland Highway) from the Hills district. Signalised intersections on Castle Hill Road near the site are located at Edward Bennett Drive / Coonara Avenue to the east, and County Drive / Highs Road to the west.

Franklin Road, Robert Road and Glenhope Road are all local roads with priority junctions at Castle Hill Road. Adjacent to the site, Franklin Road and Robert Road have narrow two lane pavements. Robert Road is a narrow road of approximately 7.5 metres which provides only a single traffic lane if vehicles are parked on both sides of the road. Franklin Road provides a kerb and gutter on the western side of the road with a narrow two lane pavement (approximately 7 metres wide) and a narrow unsealed shoulder on the eastern side of the street. Glenhope Road provides two traffic lanes and parking lanes adjacent to the kerb although no edge marking is provided.

There are no road improvements by others planned in the vicinity of the site.

Heavy vehicle routes

Figure 9.11 shows the worksite and the proposed heavy vehicle routes to be used during construction. Construction vehicle access and egress to and from the site is proposed at:

- A signalised intersection at Glenhope Road / Castle Hill Road.
- Left in, left out, right out at a signalised intersection at Franklin Road for the duration of the construction period (heavy and light vehicles).
- A dedicated and temporary left turn slip lane and ingress driveway would be provided only for the duration of the construction period off Castle Hill Road to the west of the Franklin Road intersection.
- A light vehicle access and egress point would be provided from Robert Road.

Road network operations and intersection performance

Table 9.14 shows the existing intersection performance and the anticipated intersection performance during construction.

The key findings are as follows:

- In the AM peak the LoS at the Castle Hill Road / Edward Bennett Drive intersection improves from F to D during the construction period.
- The Glenhope Road / Castle Hill Road intersection continues to achieve an acceptable LoS during construction, with a slight deterioration from A to B in the PM peak.
- In the AM peak the LoS at the Castle Hill Road / Franklin Road intersection improves from C to B during the stations and rail systems construction period.
- The intersection of Castle Hill Road / Robert Road continues to function at acceptable levels during construction.

Figure 9.11 Cherrybrook Station heavy vehicle routes

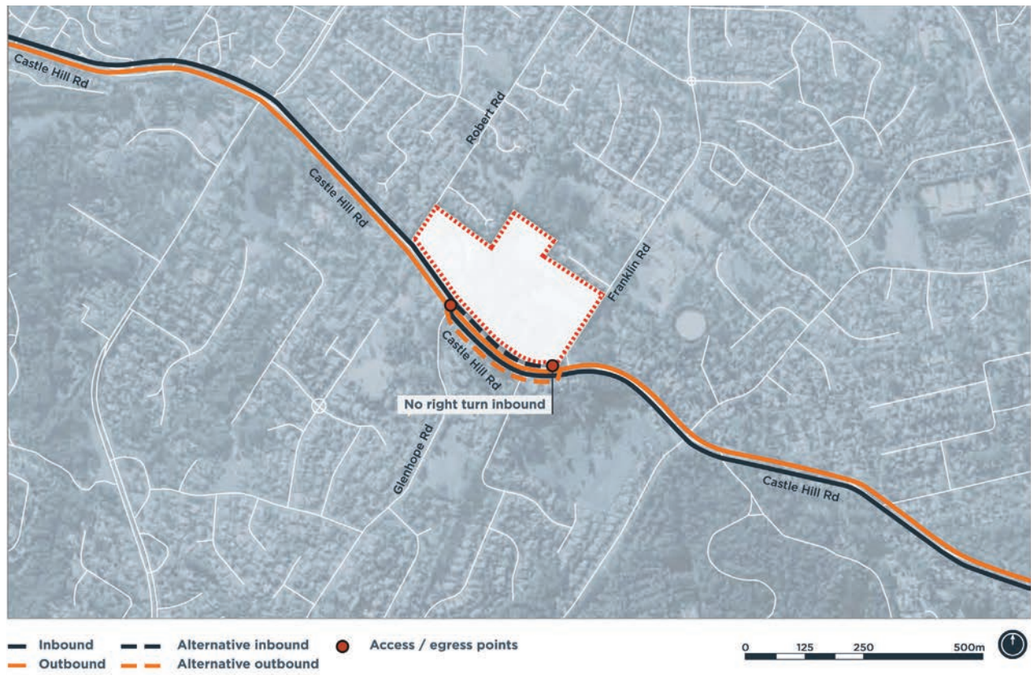


Table 9.14 Cherrybrook Station intersection performance

Location	Existing				During construction			
	LoS (AM)	DoS (AM)	LoS (PM)	DoS (PM)	LoS (AM)	DoS (AM)	LoS (PM)	DoS (PM)
Castle Hill Road / Coonara Avenue / Edward Bennett Drive	F	0.99	D	0.95	D	0.87	D	0.90
Castle Hill Road / County Drive / Highs Road	D	0.90	E	0.99	D	0.87	E	0.97
Castle Hill Road / Glenhope Road signalised	A	0.58	A	0.45	A	0.50	B	0.67
Castle Hill Road / Franklin Road signalised	C	0.93	A	0.41	B	0.86	A	0.51
Castle Hill Road / Robert Road	A	0.51	A	0.43	A	0.48	A	0.43

Buses
Bus routes in the immediate vicinity of the construction site are confined to Castle Hill Road and Franklin Road (school services only). School buses would continue to turn left out of Franklin Road to access Castle Hill Road. None of these services would be required to be re-routed during the construction period.

Pedestrians and cyclists
The section of the northern footpath on Castle Hill Road adjacent to the construction site between Franklin Road and the Glenhope Road access would be closed during construction. Traffic controllers would be available to manage potential conflicts with heavy vehicle access, especially at times of peak heavy vehicle movements.

Two schools are located on the eastern side of Franklin Road opposite the construction site, accessed via driveways off Franklin Road. A marked pedestrian path past the site on either side of Franklin Road would be provided to maintain efficient and safe pedestrian access.

Cycle routes in the area would be unaffected during the construction period. The additional truck movements may conflict with the small number of cyclists along Castle Hill Road. This would be managed through appropriate signage of the changed traffic conditions in the area.

Parking, Taxis and kiss-and-ride
There is no on-street parking in this section of Castle Hill Road and therefore the impact on parking would be minimal. On Franklin and Robert Roads, it would be necessary to restrict parking between Castle Hill Road and the northern boundary of the accesses to the site.

9.6.5 Castle Hill Station

Road network
The Castle Hill Station construction site is located in the middle of a busy town centre. Through traffic has been largely removed from the town centre via reassignment to a ring road system including Terminus Street and Pennant Street / McMullen Avenue. Traffic arrangements were reconfigured as part of the ring road development resulting in Old Northern Road between Crane Road and Terminus Street being a bus only road. It is used as a bus stop and as a layover facility. Old Castle Hill Road is also part of the bus interchange, catering for northbound services on the western side of the street and bus layover on the eastern side of the street.

The Castle Hill road network, characterised by a number of closely spaced intersections, is often congested in both peak and off-peak periods.

As part of the Castle Towers development works (separate from the NWRL project), it is proposed to upgrade Showground Road from Pennant Street to Carrington Road, from its current configuration of one traffic lane in each direction to provide two lanes in each direction. This work, likely to begin in 2012, would also provide signalisation of the Showground Road / Kentwell Avenue and Showground Road / Rowallan Avenue intersections.

Heavy vehicle routes
Figure 9.12 shows the worksite and the proposed heavy vehicle routes to be used during construction. Heavy vehicle access and egress to and from the site is proposed from the following locations:

- All movements at a signalised intersection to be provided at Old Northern Road / Terminus Street.
- Left out onto Crane Road at the intersection with Old Northern Road and Castle Street.
- Left in, left out from McMullen Avenue.

Road network operations and intersection performance
Table 9.15 shows the existing intersection performance and the anticipated intersection performance during construction.

Overall, there would be minimal impacts to the traffic network around Castle Hill from the introduction of construction vehicles and the redistribution of bus traffic. Specifically, the key findings are as follows:

- In the AM peak, the two intersection immediately north and south of then Old Northern Road access point (Crane Road / Old Northern Road / Old Castle Hill Road intersection and Terminus Street / Old Northern Road intersection) would operate at the same LoS and a similar DoS.
- The LoS at the Old Northern Road / McMullen Avenue intersection would deteriorate slightly in the AM peak from C to D.
- The LoS at the Old Castle Hill Road / Pennant Street / McMullen Avenue intersection would deteriorate in the PM peak from E to F.
- The LoS at the Castle Street / Pennant Street intersection would deteriorate in the PM peak from C to E.

Buses
It is proposed to retain one way traffic flow along Old Castle Hill Road during construction. It is also proposed to reduce the area of the construction site slightly by moving the eastern (Old Northern Road) boundary to the west to allow two lanes within the existing bus interchange to be retained for buses. By retaining (and extending slightly) the existing southbound bus stop on the eastern side of Old Northern Road, it is possible to manage bus layover both on Old Northern Road between the bus stop and Terminus Street, and on Old Castle Hill Road where bus layover currently occurs. The proposal would involve:

- Erection of the NWRL construction site boundary fence approximately in the centre of Old Northern Road to allow for one bus stop lane and one “through” bus lane.
- Construction of a shared bus and construction vehicle entrance at new traffic signals at the corner of Old Northern Road and Terminus Street.
- Extension of the existing southbound bus stop and passenger shelter on Old Northern Road (eastern side) to a length of approximately 50 metres to accommodate up to 3 buses.
- Provision of a shared exit from the bus interchange and construction site at the intersection of Old Northern Road and Crane Road, with truck movements to be controlled by traffic controllers.
- Extension of the existing bus layover area on the eastern side of Old Castle Hill Road to run the full kerb length between Old Northern Road / Castle Street / Crane Road and the pedestrian crossing north of the Eric Felton Street roundabout.
- Provision of a new pedestrian crossing across Old Northern Road and Old Castle Hill Road at the northern legs of the Old Northern Road / Old Castle Hill Road / Crane Road / Castle Street intersection and kerb adjustments at the apex of Old Northern Road and Old Castle Hill Road to improve pedestrian safety.
- Move the existing taxi stand in Old Castle Hill Road south by approximately 15 metres to allow provision of a single bus drop off stand immediately south of the Castle Towers loading dock entrance.

This arrangement would allow changes to bus routes to be kept to a minimum.

Further analysis and consultation with The Hills Shire Council, owners of Castle Towers and other key stakeholders would be undertaken to ensure that the changes proposed can be effectively managed.

Pedestrians and cyclists
The Castle Towers shopping centre, along with other retail uses in the town centre precinct, attracts a significant amount of pedestrian activity around the construction site.

During construction, the following temporary pedestrian and cyclist impacts would occur:

- The footpath on the western side of Old Northern Road, between the Terminus Street / Old Northern Road intersection and Old Castle Hill Road/Crane Road, would be closed to pedestrian movement. The eastern footpath along this section of road would remain open during the construction works. Alternatively, pedestrians could walk via Terminus Street and Crane Road to access the Old Castle Hill Road / Castle Street / Old Northern Road intersection.
- The pedestrian routes through Arthur Whitling Park would be temporarily closed during the construction period. Pedestrians wishing to access Old Castle Hill Road from the Brisbane Road area would be required to walk via either the eastern footway along Old Northern Road, Crane Road or McMullen Avenue. The western footpath of Old Northern Road between Terminus Street and McMullen Avenue will remain open.

Pedestrian crossing facilities would be provided across both Old Castle Hill Road and Old Northern Road at the intersection with Old Northern Road / Crane Road / Castle Street for the duration of construction.

Parking, Taxis and kiss-and-ride

The changes described above under 'buses' would involve moving the existing taxi stand in Old Castle Hill Road south by approximately 15 metres to allow provision of a single bus drop off stand immediately south of the Castle Towers loading dock entrance.

Taxi and kiss-and-ride users would be largely unaffected during construction. The small number of drop offs which currently occur on Old Northern Road between Terminus Street and Old Castle Hill Road would be shifted to other streets within the town centre, such as Old Castle Hill Road, Crane Road or Castle Street.

Figure 9.12 Castle Hill Station heavy vehicle routes

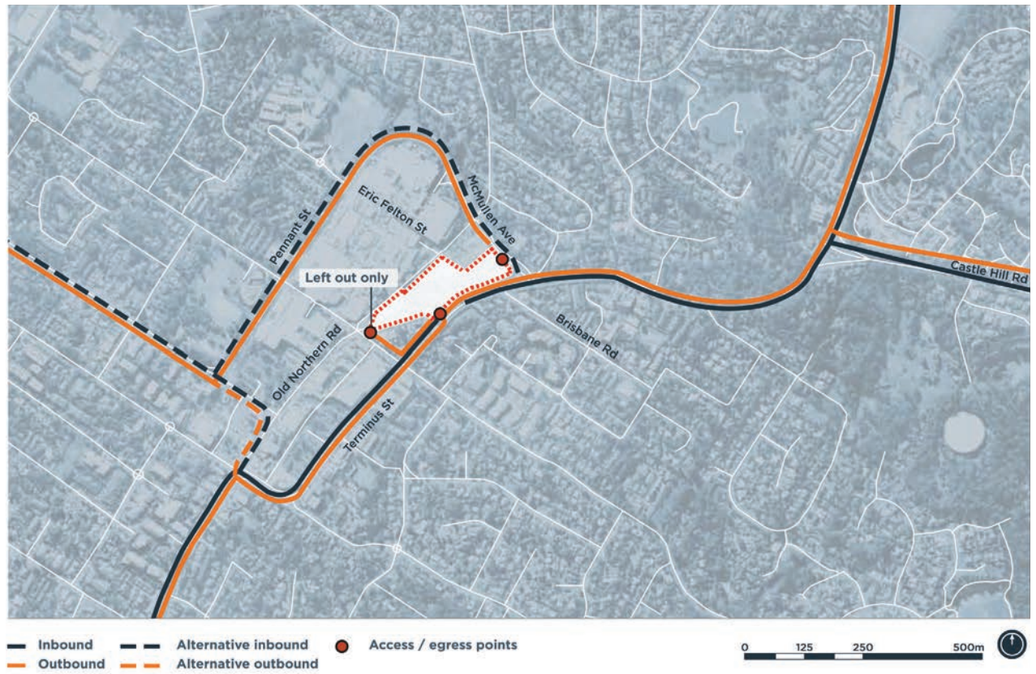


Table 9.15 Castle Hill Station intersection performance

Location	Existing				During construction			
	LoS (AM)	DoS (AM)	LoS (PM)	DoS (PM)	LoS (AM)	DoS (AM)	LoS (PM)	DoS (PM)
Old Northern Road / McMullen Avenue	C	0.97	B	0.81	D	0.98	B	0.84
Crane Road / Terminus Street	D	0.93	D	0.93	D	0.90	C	0.84
Old Castle Hill Road / Castle Street / Crane Road / Old Northern Road	C	0.88	C	0.69	C	0.70	C	0.69
Old Castle Hill Road / Pennant Street / McMullen Avenue	D	0.96	E	0.97	C	0.88	F	1.02
Pennant Street / Showground Road	B	0.75	C	0.93	B	0.76	B	0.89
Showground Road / Old Northern Road	B	0.70	B	0.61	B	0.65	A	0.61
Castle Street / Pennant Street	C	0.79	C	0.84	C	0.81	E	0.98
Old Northern Road / Terminus Street construction access	A	0.72	A	0.52	B	0.90	A	0.61
McMullen Avenue / construction access	N/A	N/A	N/A	N/A	A	0.05	A	0.04

9.6.6 Showground Station

Road network

Showground Road is a 60 km/h four lane arterial with a central median of variable width between Carrington Road and Windsor Road. It carries approximately 45,000 vehicles per day. The road drops from Gilbert Road to a bridge over Cattai Creek before rising to Victoria Avenue. There is also a horizontal curve on this section of road.

Carrington Road is a major collector road serving the Hills Shire Council offices, Council Works Depot and the Castle Hill industrial area. The western section of the road, between Victoria Avenue and the edge of the commercial / industrial development near Ashford Avenue, is a B-Double route.

RMS is currently investigating the widening of the section of Showground Road between Carrington Road and Pennant Street from its current two lanes to a four lane roadway.

Heavy vehicle routes

Figure 9.13 shows the worksite and the proposed heavy vehicle routes to be used during construction. Heavy vehicle access and egress to and from the site is proposed from two locations, being:

- All movements at a new signalised intersection on Showground Road.
- All movements from Carrington Road (as a secondary access and egress point).

Road network operations and intersection performance

Table 9.16 shows the existing intersection performance and the anticipated intersection performance during construction.

The key findings are as follows:

- The Green Road / Victoria Avenue / Showground Road intersection would continue to operate over capacity in both the AM and PM peaks with a LoS of F. There would be a slight deterioration in the DoS as a result of construction.
- The proposed Showground Road access and egress point would operate with a LoS of B in the AM peak and A in PM peak.
- The new construction access point from Carrington Road would operate with a LoS of A in both the AM and PM peaks.

As development in the area continues, traffic forecasts and precinct planning would continue to evolve and supplementary analysis of future proposals may be required.

Buses

Three bus routes operate along Showground Road, Carrington Road and Victoria Avenue in the vicinity of the construction site. None of these services would be required to be re-routed during the construction period, with negligible impacts on bus travel times anticipated.

Special Event buses for Sydney Olympic Park / Royal Easter Show (Route 5A) commence their journeys at this location. An alternative location for bus ranks would need to be determined.

The existing bus stops on Carrington Road, 50 metres west of Middleton Avenue, may be required to be relocated east of Middleton Avenue to maintain access for through and construction traffic on Carrington Road.

Figure 9.13 Showground Station heavy vehicle routes

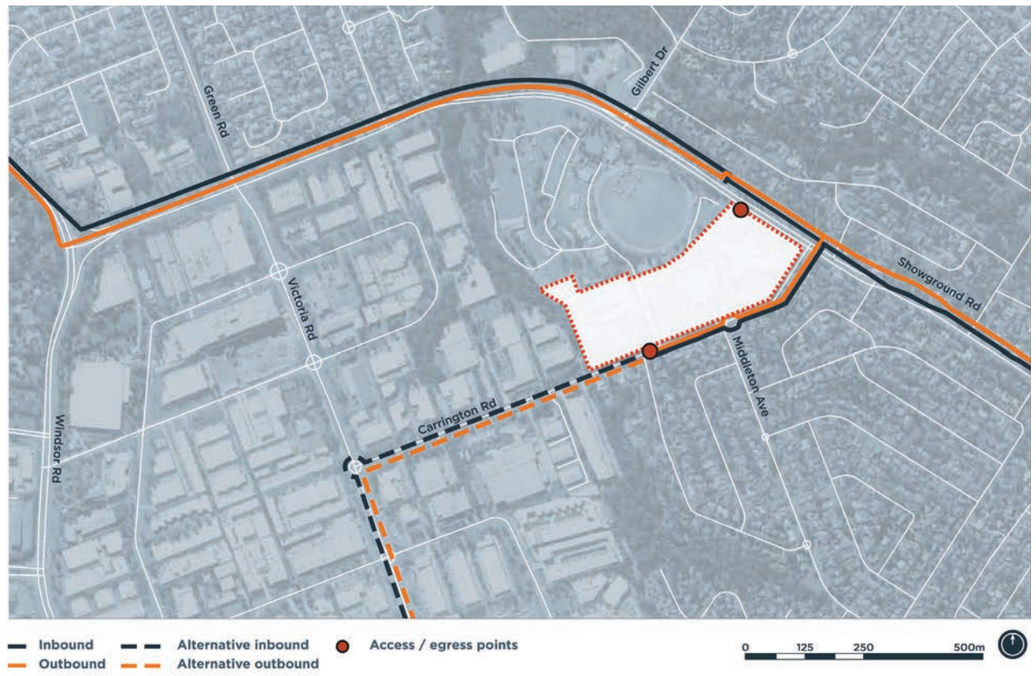


Table 9.16 Showground Station intersection performance

Location	Existing				During construction			
	LoS (AM)	DoS (AM)	LoS (PM)	DoS (PM)	LoS (AM)	DoS (AM)	LoS (PM)	DoS (PM)
Windsor Road / Showground Road	C	0.88	C	0.92	C	0.89	C	0.89
Green Road / Victoria Avenue / Showground Road	F	1.00	F	1.00	F	1.01	F	1.05
Construction access / Showground Road	N/A	N/A	N/A	N/A	B	0.65	A	0.76
Gilbert Road / Showground Road	D	0.99	B	0.88	C	0.91	C	0.94
Carrington Road / Showground Road	B	0.88	D	1.00	B	0.70	C	0.83
Doran Drive / Carrington Road	A	0.41	A	0.50	N/A	N/A	N/A	N/A
Construction access near Cattai Creek / Carrington Road	N/A	N/A	N/A	N/A	A	0.42	A	0.44

Pedestrians and cyclists

An existing pedestrian route from Carrington Road through the Castle Hill Showground to Showground Road would be closed during construction.

The existing cycle path which runs alongside Cattai Creek and under Showground Road into Fred Caterson Reserve to the north would remain unaffected during construction.

The northern footpath of Carrington Road at the site access point, opposite Ashford Avenue, would be managed appropriately through the provision of a marked pedestrian path across the site entrance and traffic control as necessary during the construction period, to allow the safe movement of pedestrians.

Parking, Taxis and kiss-and-ride

Approximately 200 off-street parking spaces would be lost during construction. Alternative parking could be provided within the Showground precinct during the construction phase. This would require liaison with The Hills Shire Council and the Castle Hill Show Society regarding location and usage patterns. Potential Easter Show and Sydney Olympic Park special events related car parking and bus arrangements in the vicinity of the Showground Station construction site are being investigated and would be detailed further in subsequent Construction Traffic Management Plans.

On-street parking is unlikely to be affected, except where 'No Stopping' zones are extended at the new site access point on Carrington Road.

9.6.7 Norwest Station

Road network

Norwest Boulevard is a 70 km/h divided four lane arterial with a wide, landscaped central median. It is the only arterial access route for most of the Norwest area and is characterised by high commuter peak flows. Major intersections are controlled by two-lane roundabouts. There are limited alternative routes in the area and private vehicle traffic is the major travel mode.

Brookhollow Avenue is local street servicing a number of commercial properties with parking on both sides of the road and speed control devices comprising a contrasting pavement and landscaped medians.

Century Circuit is a local road which provides access from Norwest Boulevard to the Norwest Shopping Centre, indoor swimming centre and commercial properties adjacent to the shopping centre.

RMS is currently undertaking widening of Norwest Boulevard at the intersection with Windsor Road to provide three right turn lanes out of Norwest Boulevard and two left turn lanes in from Windsor Road.

At road crossings traffic impacts and disruption would be minimised by staging construction works in live traffic situations. The need for cut and cover works under Norwest Boulevard have been avoided by moving the location of the station box.

Heavy vehicle routes

Figure 9.14 shows the worksite and the proposed heavy vehicle routes to be used, during construction. The primary heavy vehicle access and egress is proposed to be via all movements intersections to and from Brookhollow Avenue. Access and egress would also be required to and from Norwest Boulevard from time to time operating as a left in, left out arrangement.

Road network operations and intersection performance

Table 9.17 shows the existing intersection performance and the anticipated intersection performance during construction.

There would be minimal impacts on the surrounding intersection performance with the introduction of construction traffic associated with the station and rail systems construction, with all intersections operating at the same LoS. The analysis assumes that Brookhollow Avenue, at its western intersection with Norwest Boulevard, remains open during peak periods.

Buses

During construction, access to and from the westbound bus stop in Norwest Boulevard east of Century Circuit would be maintained. This stop is currently an indented bus bay which would continue to accommodate arriving and departing buses at all times. The potential for buses to pull up safely at this location, adjacent to the NWRL construction site would be investigated as part of the Construction Traffic Management Plan and Construction Traffic Control Plans for the site. The eastbound bus bay and stop would be retained during the works.

Pedestrians and cyclists

Access to the indented westbound bus stop in Norwest Boulevard would be maintained during construction to and from the east, however, the southern footpath along the frontage to the construction site would be closed. The northern footpath along Norwest Boulevard would remain open at all times. A pedestrian underpass under Norwest Boulevard is provided to the east of the site. Barricades may need to be erected as part of the site works to direct pedestrians to use this underpass to access the northern and southern pathway (away from the construction site frontage).

The western and southern footpaths along the Brookhollow Avenue frontage of the construction site would be closed throughout the duration of construction. Pedestrian access would be possible via the footpath on the other side of Brookhollow Avenue during the station and rail systems construction works.

Parking, Taxis and kiss-and-ride

The Brookhollow Avenue carriageway is generally 11 metres wide and it may be necessary to restrict kerbside parking along Brookhollow Avenue during the station site works. This kerbside restriction would extend along one side of the Brookhollow Avenue frontage to the end of the construction site. There will be no on-street restrictions along Norwest Boulevard as a result of construction activities. On-street parking is not permitted along Norwest Boulevard. The only off-street parking that would be lost is within the commercial land uses to be acquired by the project on the northern side of Norwest Boulevard.

Figure 9.14 Norwest Station heavy vehicle routes

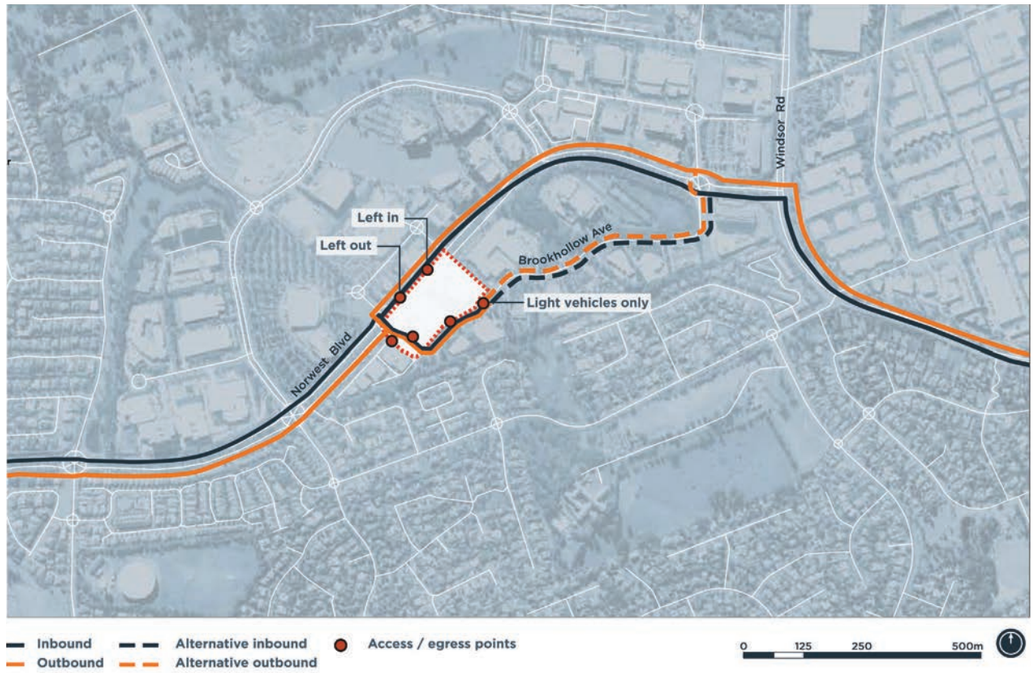


Table 9.17 Norwest Station intersection performance

Location	Existing				During construction			
	LoS (AM)	DoS (AM)	LoS (PM)	DoS (PM)	LoS (AM)	DoS (AM)	LoS (PM)	DoS (PM)
Norwest Boulevard / Windsor Road	E	1.00	E	0.96	E	1.00	E	0.99
Norwest Boulevard / Brookhollow Avenue (east)	A	0.71	D	0.90	A	0.72	D	0.91
Norwest Boulevard / Solent Circuit	A	0.43	A	0.50	A	0.44	A	0.42
Norwest Boulevard / Brookhollow Avenue (west)	A	0.71	A	0.60	A	0.72	A	0.61

Note: Brookhollow Avenue intersections modelled as roundabouts

9.6.8 Bella Vista Station and Balmoral Road

Road network

Celebration Drive is a Collector Road within Bella Vista serving both retail and commercial land uses. The road has two traffic lanes with heavily-used on-street parking and significant pedestrian volumes. It is a cul-de-sac at its north-eastern end. An all-movement signalised intersection provides access to Old Windsor Road.

At this location the T-way is located on the western side of Old Windsor Road. An underpass immediately north of Celebration Drive transfers the T-way from the western to the eastern side of Old Windsor Road for the alignment to the north.

There are no planned road improvements by others in the vicinity of the site.

Heavy vehicle routes

Figure 9.15 shows the worksite and the proposed heavy vehicle routes to be used during construction. Heavy vehicle access and egress to and from the site is proposed from the following locations:

- Left in, right out from the end of Celebration Drive.
- All movements at the existing Celebration Drive / Lexington Drive roundabout during low traffic periods only.
- Right in, left out from Balmoral Road through the Balmoral Road construction site.

Road network operations and intersection performance

Table 9.18 shows the existing intersection performance and the anticipated intersection performance during construction.

The key findings are as follows:

- The LoS at the Celebration Drive / Lexington Avenue roundabout is anticipated to improve from E to D in the AM peak and from B to A in the PM peak. Whilst there would be the introduction of construction traffic, this is balanced by the removal of vehicles entering and exiting the former Totally Home Centre.
- In the PM peak the LoS at the Old Windsor Road / Celebration Drive intersection slightly deteriorates from D to E.

Buses

Bus routes in the area surrounding the construction site are largely confined to the T-way which runs adjacent to Old Windsor Road. Two services connect from Norwest Boulevard to Lexington Drive and Brighton Drive adjacent to the construction site. None of these services would need to be re-routed during the construction period.

The Celebration T-way station on the western side of Old Windsor Road, directly opposite Celebration Drive, would continue to operate as normal during the station construction.

Pedestrians and cyclists

Pedestrian and cycle routes surrounding the construction site would generally remain unaffected during construction, particularly the shared use path which runs on the eastern side of Old Windsor Road. Pedestrian access across the site access road (northern side of the Celebration Drive / Lexington Avenue roundabout) may be closed intermittently. Pedestrian volumes in the vicinity of the construction site would be reduced with closure of the Totally Home Centre.

Parking, Taxis and kiss-and-ride

Parking in the vicinity of the construction site is in the form of unrestricted, on-street parking in the residential areas to the west and east of the construction site and private parking in commercial buildings to the south of the site.

Most on-street parking would not be affected by construction activities.

Figure 9.15 Bella Vista Station and Balmoral Road heavy vehicle routes

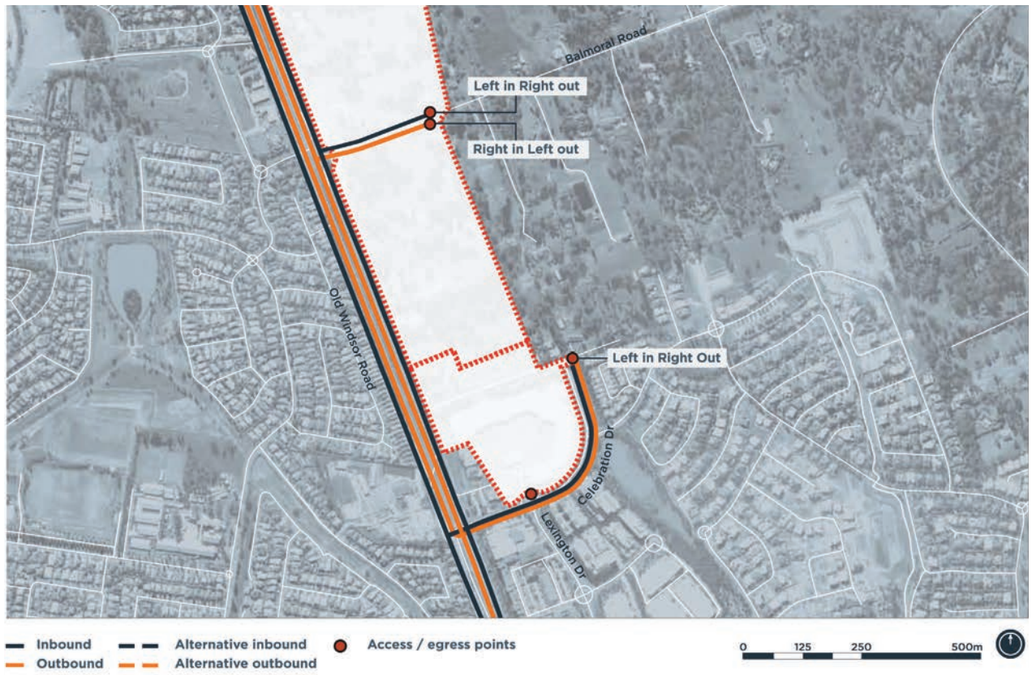


Table 9.18 Bella Vista Station intersection performance

Location	Existing				During construction			
	LoS (AM)	DoS (AM)	LoS (PM)	DoS (PM)	LoS (AM)	DoS (AM)	LoS (PM)	DoS (PM)
Old Windsor Road / Celebration Drive	E	0.96	D	0.99	E	0.92	E	0.96
Celebration Drive / Lexington Avenue	E	0.99	B	0.89	D	0.99	A	0.85
Old Windsor Road / Balmoral Road	C	0.30	C	0.27	A	0.26	A	0.20
Old Windsor Road / Miami Street	C	0.86	C	0.92	C	0.86	B	0.89

9.6.9 Balmoral Road and Memorial Avenue

Road network

Memorial Avenue is a 60 km/h two lane arterial road with sealed shoulders. The Old Windsor Road / Memorial Avenue / Sunnyholt Road intersection is a major intersection where all movements are permitted. A separate signalised intersection, immediately east of Old Windsor Road, provides for the T-way to cross Memorial Avenue. A major T-way bus stop ("Burns") and car park exists at this location.

The Old Windsor Road / Miami Street intersection is controlled by traffic signals with left in / left out only access to Balmoral Road on the eastern side of Old Windsor Road opposite this intersection. The T-way crosses Balmoral Road immediately east of the intersection and this movement is incorporated into the traffic signals. The "Balmoral" bus stop is on the northern side of Balmoral Road.

Some road improvements are expected to occur on Balmoral Road to the east of the site as residential development progresses in the area.

Heavy vehicle routes

Figure 9.16 shows the worksite and the proposed heavy vehicle routes to be used during construction. Heavy vehicle access and egress to and from the sites are proposed from both Balmoral Road and Memorial Avenue.

Road network operations and intersection performance

Table 9.19 shows the existing intersection performance and the anticipated intersection performance during construction.

The key findings are as follows:

- The Old Windsor Road / Memorial Avenue intersection is forecast to operate over capacity with the introduction of construction vehicles during the AM peak with a DoS of 1.08.
- The improvements in LoS during construction are due in part to the modelling software's improved signal phasing.

Buses

Existing bus services in the vicinity of the construction site mainly operate along the T-way. The T-way would remain fully operational during the construction period including the Burns T-way station. No services would need to be re-routed and therefore there should be negligible impact on travel times. There may be the need for periodic closures of the T-way around Burns Station and this would be managed to minimise any impact on bus services. The provision of a temporary road would be required in order to route the buses around the construction site whilst ensuring minimal disruption to bus operations and passenger access to the T-way station.

The Balmoral T-way station would be unaffected by the NWRL construction, as the station is located outside the construction footprint.

Access is also proposed via the T-Way on either side of Memorial Avenue.

Pedestrians and cyclists

There are no intensive land uses in the area immediately surrounding the construction site and as a result the majority of pedestrian traffic is related to the T-way bus stops. The regional cycleway is on the western side of Old Windsor Road at this location. There is a pedestrian / cycle path located along the eastern side of Old Windsor Road between Memorial Avenue and Celebration Drive which would remain functional during construction works. Cyclists and pedestrians may need to be directed to the pathway located on the western side of Old Windsor Road at Memorial Avenue and Celebration Drive on some occasions. Both of these intersections are provided with crossing facilities to enable this to occur.

Parking, Taxis and kiss-and-ride

Construction works would impact parking at the Burns T-way bus station car park (159 spaces). These works would be managed in order to minimise the number of car spaces which would be temporarily unavailable at any time due to construction works.

Figure 9.16 Balmoral Road and Memorial Avenue heavy vehicle routes

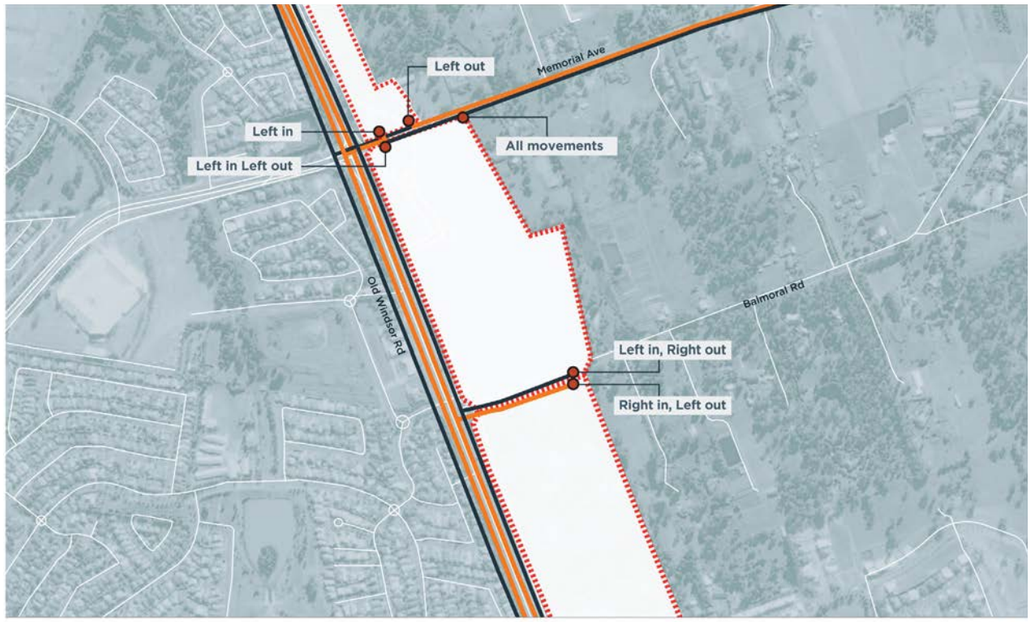


Table 9.19 Balmoral Road and Memorial Avenue intersection performance

Location	Existing				During construction			
	LoS (AM)	DoS (AM)	LoS (PM)	DoS (PM)	LoS (AM)	DoS (AM)	LoS (PM)	DoS (PM)
Old Windsor Road / Balmoral Road	C	0.30	C	0.27	A	0.26	A	0.20
Old Windsor Road / Miami Street	C	0.86	C	0.92	C	0.86	B	0.89
Old Windsor Road / Memorial Avenue	F	0.98	F	0.97	F	1.08	F	0.96
Memorial Avenue / Burns Road T-way	A	0.49	B	0.48	A	0.48	B	0.65

9.6.10 Kellyville Station

Road network

Samantha Riley Drive is a 60 km/h four lane regional road. The Old Windsor Road / Samantha Riley Drive / Newbury Avenue and Windsor Road / Samantha Riley Drive intersections are major junctions where all movements are permitted. The Old Windsor Road junction also incorporates the T-way crossing of Samantha Riley Drive. A separate roundabout, immediately east of Old Windsor Road, provides for access to the T-way car park.

There are no road improvements planned by others at the present time.

Heavy vehicle routes

Figure 9.17 shows the worksite and the proposed heavy vehicle routes to be used during construction. Heavy vehicle access and egress to and from the site is proposed at an all movements intersection at Samantha Riley Drive utilising the existing roundabout. Left in, left out access and egress would also be available at Memorial Avenue to the south of the site. Access is also proposed via the section of the T-Way to the south of Samantha Riley Drive.

Road network operations and intersection performance

Table 9.20 shows the existing intersection performance and the anticipated intersection performance during construction.

The modelling results indicate that, whilst the Old Windsor Road / Samantha Riley Drive has a LoS of F, the introduction of construction vehicles would result in minor impacts to the intersection performance.

Buses

Existing bus services in the vicinity of the construction site mainly operate along the T-way and along Samantha Riley Drive. It is expected that the T-way would remain fully operational during the construction period including the Riley T-way station. No services would need to be re-routed and therefore there should be negligible impact on travel times.

The main impact on the T-way at this location would be on the car parking and access from the car parks to the T-way station, although truck access is proposed via a short section of the T-Way either side of Memorial Avenue. As described below a portion of the car park would need to be relocated to accommodate the construction of the NWRL station. In addition passengers accessing the T-way station from the relocated car parks would be required to use the footpath on the southern side of Samantha Riley Drive between the roundabout and the T-way station.

Pedestrians and cyclists

There are no intensive land uses in the area immediately surrounding the construction site. Therefore the majority of pedestrian traffic is related to the T-way bus stop. A regional cycleway is on the western side of Old Windsor Road, which would remain unaffected.

Pedestrian and cycle routes would remain largely unaffected during construction. Some modification to pedestrian paths around the bus stop and along Samantha Riley Drive would occur.

Parking, Taxis, kiss-and-ride

The only parking to be affected by construction is the Riley T-way station car park with 141 spaces. It would be necessary to relocate most (all except around 50 spaces) of the car parking to accommodate the station construction works.

The relocated parking would likely be provided on a site within the rail corridor immediately north of Samantha Riley Drive on a section of the future permanent end-state parking with capacity for approximately 150 cars, giving a total of at least 200 spaces. Access to this area would initially be confined to a left-in / left out entry on Samantha Riley Drive immediately east of the T-way and rail corridor. The existing roundabout would allow exiting cars to execute a U-turn to then proceed west on Samantha Riley Drive towards Old Windsor Road.

The residual 50 (approximately) existing T-way spaces would remain in situ, with access via the existing roundabout, until the entire 1,360 permanent end-state spaces have been completed within the rail corridor immediately north and south of the station.

As the existing T-way car park is heavily utilised during weekdays with some overflow parking on the access road and the car park circulation road, the intention is to maintain a total of around 200 spaces throughout the period of construction.

Vehicular drop offs (kiss-and-ride) around the area are currently low, and is considered that the impact during construction would be minimal.

Figure 9.17 Kellyville Station heavy vehicle routes

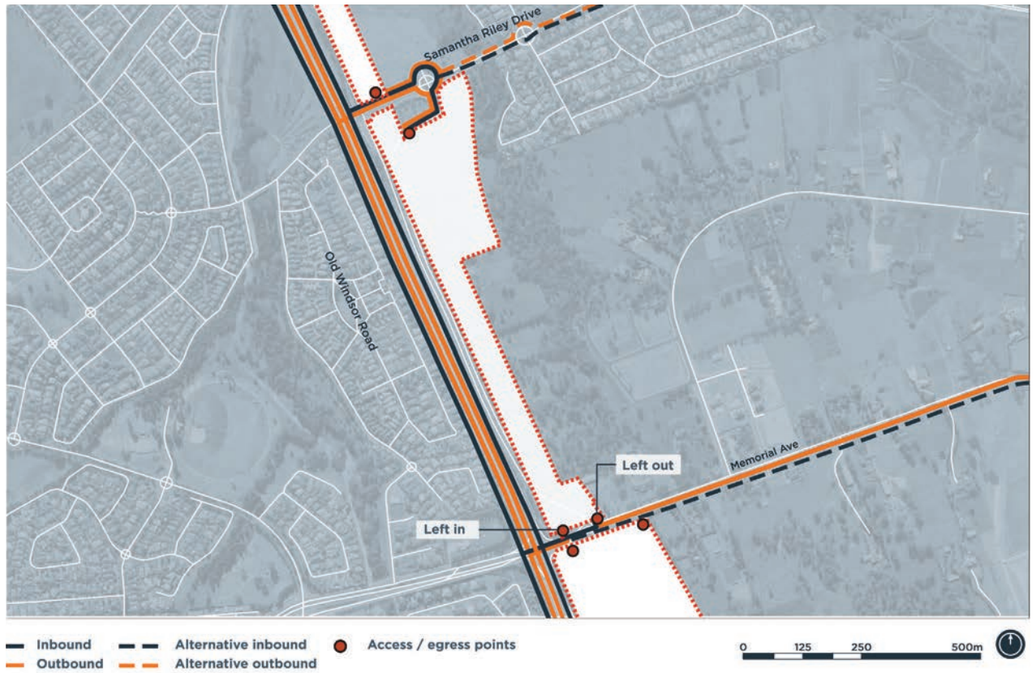


Table 9.20 Kellyville Station intersection performance

Location	Existing				During construction			
	LoS (AM)	DoS (AM)	LoS (PM)	DoS (PM)	LoS (AM)	DoS (AM)	LoS (PM)	DoS (PM)
Old Windsor Road / Samantha Riley Drive	F	0.96	F	0.99	F	0.98	F	0.98
Windsor Road / Old Windsor Road	B	0.73	C	0.88	B	0.68	C	0.85

9.6.11 Rouse Hill Station

Road network

The Rouse Hill Station construction site is located adjacent to Rouse Hill Town Centre and Windsor Road. White Hart Drive and the privately-owned Rouse Hill Drive are located to the south and north of the site respectively, both intersecting with Windsor Road.

All movement signalised intersections provide access from Windsor Road at White Hart Drive and Rouse Hill Drive / Schofields Road. The White Hart Drive intersection incorporates north-south T-way movement. Bus access at the northern end of the bus interchange is in the form of a channelised intersection on Rouse Hill Drive some distance from the traffic signals. A southbound bus-only left-in entry is also provided directly from Windsor Road immediately south of Rouse Hill Drive.

The key planned road network changes of relevance to the proposed works are:

- Upgrade of Schofields Road west of Windsor Road.
- Closure of Rouse Hill Drive as a general traffic through route as part of the proposed GPT "Northern Frame" redevelopment.

Heavy vehicle routes

Figure 9.18 shows the worksite and the proposed heavy vehicle routes to be used during construction. Access through the site would be in the form of a one-way road with access proposed as a left in from White Hart Drive and egress as a left out onto Rouse Hill Drive. Access is also proposed via the section of the T-Way to the south of Sanctuary Drive, and the section of the T-Way north of White Hart Drive.

Road network operations and intersection performance

Table 9.21 shows the existing intersection performance and the anticipated intersection performance during construction.

In general, the modelling shows that there would be minimal impacts to the surrounding intersection performance from the introduction of construction vehicles. In the AM peak period, there would be a slight deterioration in the LoS (from A to B) at the Windsor Road / White Hart Drive intersection.

Buses

As the Rouse Hill Station construction site would occupy the existing bus interchange, all bus stops and layover areas would be required to be relocated for the duration of the works. The preferred option is detailed below.

Buses travelling north along the T-way would proceed across White Hart Drive, turn right into a two way southern access, set down or pick up passengers, turn right into Tempus Street, turn left into White Hart Drive and travel via Caddies Boulevard and Commercial Road.

Buses travelling south along Windsor Road would turn left into White Hart Drive, left into Tempus Street, left into the two way southern access, then left onto the T-way to head south towards Parramatta.

Bus layover during construction is proposed to be accommodated in a northern bus layover facility located to the north of Rouse Hill Drive. Buses wishing to layover having set down passengers at the southern end of the construction site would turn left into White Hart Drive, left into Caddies Boulevard, left into Commercial Road and access the bus layover site via a driveway on Commercial Road located about 40 metres back from the Windsor Road intersection. Buses departing the layover area would turn left onto Windsor Road via a bus only egress driveway located midway between the Commercial Road and Rouse Hill Drive intersections.

Pedestrians and cyclists

Informal east-west pedestrian routes through the existing T-way interchange would be lost during the construction period. Pedestrians would be redirected via either Rouse Hill Drive or White Hart Drive, which would result in a diversion of approximately 200 metres. The key pedestrian desire lines from the T-way interchange are east through the town centre to the car parks and residential areas, with only a minor pedestrian movement west towards Windsor Road. The impact of the construction activity on these pedestrian routes would be minor.

The key cycle route in the precinct is the shared use path on the western side of Old Windsor Road, which would be unaffected by the construction.

There are a number of cycle lockers located within the existing interchange area. An alternative location for these would be identified as the construction program is further developed.

Parking, Taxis and kiss-and-ride

There may be scope to return some of the car parking displaced for bus interchange purposes as part of the stage 1 construction works. Taxi and kiss-and-ride activity would continue in Tempus Street external to the construction site.

Cumulative impacts

The cumulative impacts of the stage 2 construction works are addressed in Chapter 20. In the vicinity of the Rouse Hill Station construction site, the two cumulative issues are the construction works associated with the eastern section of Schofields Road and the proposed Northern Frame expansion to the Rouse Hill Town Centre. The upgrade of the eastern end of Schofields Road would be completed before viaduct construction and station fit out works begin at Rouse Hill and a s a consequence there are expected to be negligible cumulative impacts. The NWRL construction program and methodology has been developed in consultation with the proponents of the Northern Frame expansion. Whilst there could be some works occurring simultaneously at Rouse Hill, the impacts would be mitigated through the proposed routing of buses and trucks which would avoid Rouse Hill Drive. Truck access would be focussed on the arterial road network.

Figure 9.18 Rouse Hill Station heavy vehicle routes

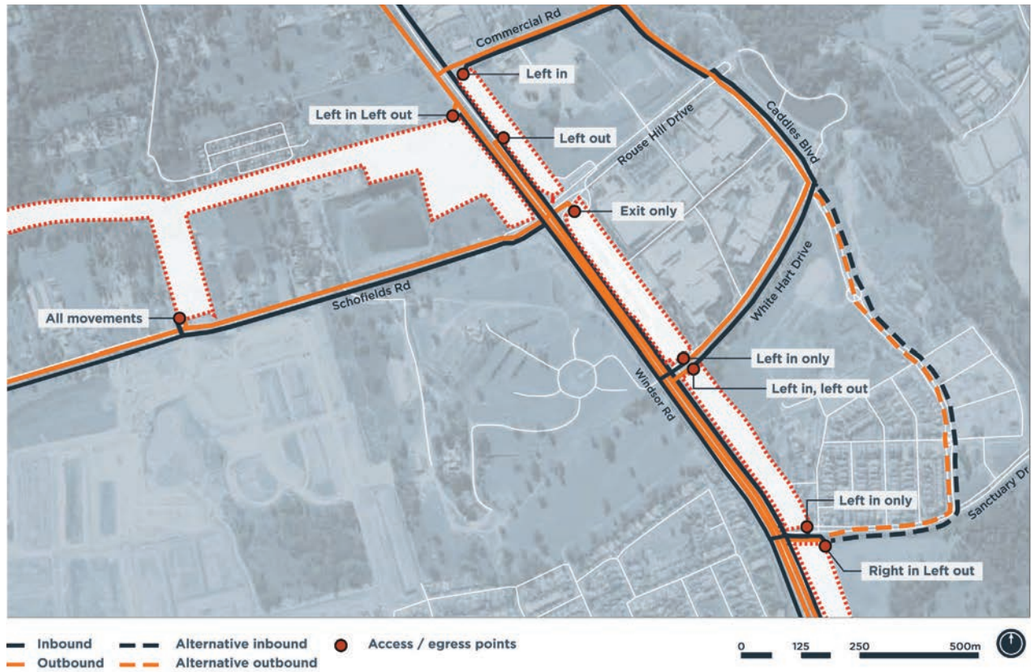


Table 9.21 Rouse Hill Station intersection performance

Location	Existing				During construction			
	LoS (AM)	DoS (AM)	LoS (PM)	DoS (PM)	LoS (AM)	DoS (AM)	LoS (PM)	DoS (PM)
Windsor Road / Schofields Road / Rouse Hill Drive	C	0.82	C	0.82	C	0.84	C	0.87
Windsor Road / White Hart Drive	A	0.66	B	0.71	B	0.63	B	0.71

9.6.12 Windsor Road Viaduct

Road network

The major construction site to support the viaduct over Windsor Road is located on the north western side of Windsor Road / Rouse Hill Drive / Schofields Road intersection. The intersection of Windsor Road / Commercial Road is located north of the proposed construction site. All movements are allowed at both of these intersections.

The key planned road network changes of relevance to the proposed works are as follows:

Upgrade of Schofields Road west of Windsor Road (substantial commencement late 2012).

Closure of Rouse Hill Drive as general traffic through route as part of the proposed GPT "Northern Frame" redevelopment.

Heavy vehicle routes

Figure 9.19 shows the worksite and the proposed heavy vehicle routes to be used during construction. Access and egress to and from the site would be in the form of a left in, left out arrangement from Windsor Road.

Road network operations and intersection performance

Table 9.22 shows the existing intersection performance and the anticipated intersection performance during construction.

The modelling indicates that there would be minimal impacts to the surrounding intersection performance from the introduction of construction vehicles.

Buses

There would be some changes to the approach and departure routes for buses accessing, in the first instance, a temporary bus interchange just north of White Hart Drive. These are described in more detail in Section 9.6.11.

At this stage, bus layover during construction is proposed to be accommodated in a temporary facility at the northern end of the construction site between Commercial Road and Rouse Hill Drive, with access for buses off Commercial Road (westbound) and egress onto Windsor Road (southbound). This would be further investigated as the construction program develops.

Pedestrians and cyclists

The shared pedestrian footpath and cycleway located on the western side of Windsor Road would be retained during construction. There is no pedestrian footpath located along the northern side of Schofields Road in the vicinity of the construction site.

Parking, Taxis and kiss-and-ride

There are no on-street parking spaces along Schofield Road or Windsor Road in the vicinity of the construction site. No spaces would be displaced as a result of the works in this vicinity.

Figure 9.19 Windsor Road viaduct heavy vehicle routes

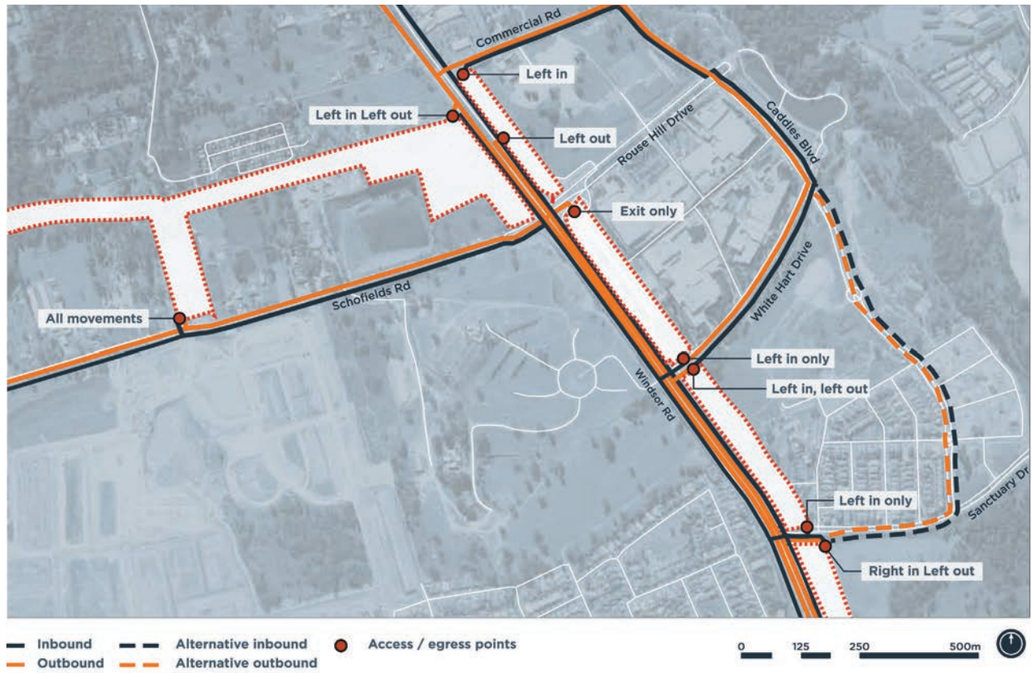


Table 9.22 Windsor Road viaduct intersection performance

Location	Existing				During construction			
	LoS (AM)	DoS (AM)	LoS (PM)	DoS (PM)	LoS (AM)	DoS (AM)	LoS (PM)	DoS (PM)
Windsor Road / Schofields Road / Rouse Hill Drive	C	0.82	C	0.82	C	0.84	C	0.87

9.6.13 Cudgegong Road Station and Tallawong Stabling Facility

Road network

Schofields Road is a two lane arterial with narrow sealed shoulders and a rural character. It currently carries a relatively low traffic volume and is signposted as 80 km/h. Tallawong Road and Cudgegong Road are local north-south roads connecting Schofields Road to Guntawong Road. Most intersections in this area are priority controlled.

RMS has plans to upgrade Schofields Road from west of Windsor Road to the intersection with Hambledon Road, with construction works expected to commence toward the end of 2012. The initial stage of construction would provide for two lanes in each direction on Schofields Road on a divided carriageway, with future provision to provide three lanes in each direction. This work will also incorporate the realignment of Tallawong Road to align with Ridgeline Drive on the southern side of Schofields Road approximately 90 metres east of the existing intersection. Similarly, the road upgrade necessitates a realignment of Cudgegong Road about 37 metres to the west at its intersection with Schofields Road.

Heavy vehicle routes

Figure 9.20 shows the worksite and the proposed heavy vehicle routes to be used during construction. Access and egress to and from the sites would be provided from:

- Schofields Road at the location of the potential expansion of Terry Road.
- Cudgegong Road.
- Tallawong Road.

Road network operations and intersection performance

Table 9.23 shows the existing intersection performance and the anticipated intersection performance during construction.

The key findings are as follows:

- The LoS at The Ponds Boulevard / Schofields Road intersection would deteriorate slightly from B to C in both the AM and PM peaks.
- The LoS at the Cudgegong Road / Schofields Road intersection would deteriorate slightly from A to B in the AM peak.

Buses

There is one bus route, operated by Busways, along Tallawong Road – Schofields Road (Route T75) that may need to be re-routed for part of the construction period. This service could potentially be re-routed via Cudgegong Road should it be required to close Tallawong Road for any length of time. Access along either Tallawong Road or Cudgegong Road would be provided at all times during construction.

Pedestrians and cyclists

Pedestrian and cyclist activity in the vicinity of the Schofields Road construction sites is low. Pedestrian and cycling routes would remain largely unaffected.

Parking, Taxis and kiss-and-ride

There is little demand for on-street parking in the vicinity of the Schofields Road construction sites and therefore the impact on parking would be minimal.

Figure 9.20 Cudgegong Road Station and Tallawong Stabling Facility heavy vehicle routes

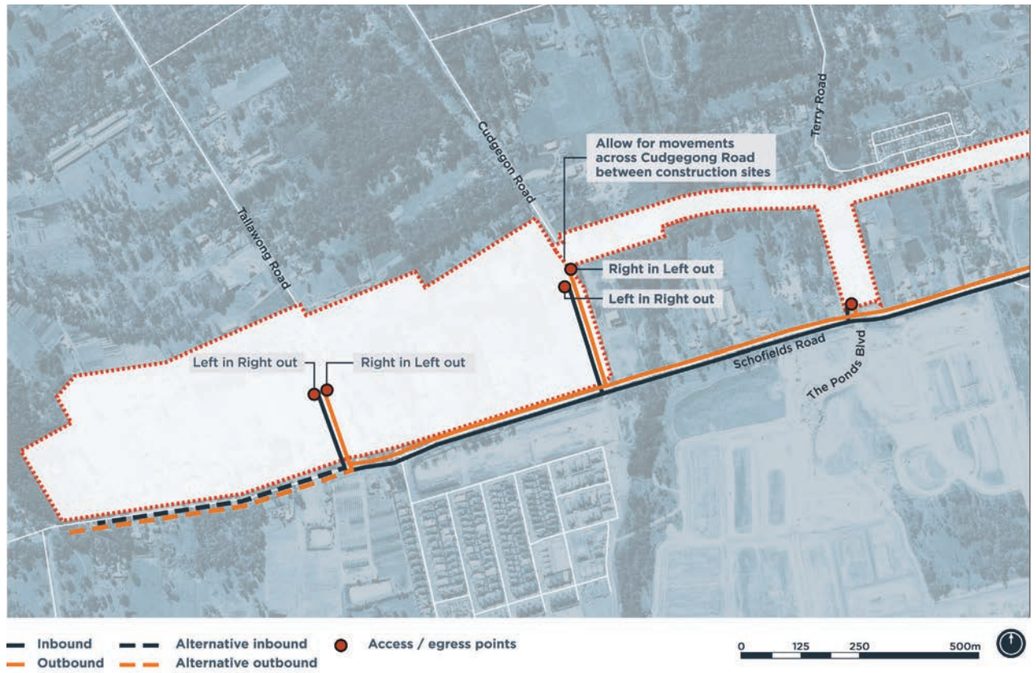


Table 9.23 Cudgegong Road Station and Tallawong Stabling Facility intersection performance

Location	Existing				During construction			
	LoS (AM)	DoS (AM)	LoS (PM)	DoS (PM)	LoS (AM)	DoS (AM)	LoS (PM)	DoS (PM)
The Ponds Boulevard / Schofields Road	B	0.31	B	0.32	C	0.47	C	0.57
Cudgegong Road / Schofields Road	A	0.33	A	0.27	B	0.42	A	0.35
Tallawong Road / Schofields Road	C	0.33	B	0.30	C	0.46	B	0.57

9.7 Mitigation Measures

9.7.1 Operation

An OEMP would be developed in the future detailing the processes to manage environmental impacts during the operation of the project.

Mitigation measures have been developed to avoid, reduce and manage identified potential operational impacts. These mitigation measures are presented **Table 9.24**.

Table 9.24 Traffic and Transport Operational Mitigation Measures

No.	Mitigation Measures	Applicable Areas
OpT1	Advisory and way finding signage would be used to provide multi modal guidance to, from and within the station precincts.	Stations
OpT2	Maximising pedestrian accessibility to the stations with a view to reducing car based travel to and from the stations.	Stations
OpT3	Provision of cycle storage facilities at stations to increase the opportunity and catchment for non-motorised forms of transport to and from the stations.	Stations
OpT4	Provision of commuter car parking at selected stations to reduce total car based trip lengths and encourage the use of rail.	Stations
OpT5	Permanent Variable Message Signs, where feasible and reasonable, would be provided to advise drivers of any potential delays, traffic diversions, speed restrictions, or alternative routes.	Wider road network

9.7.2 Construction

The Construction Environmental Management Framework, provided in Appendix B, details the environmental, stakeholder and community management systems and processes for the construction of the NWRL.

Mitigation measures have been developed to avoid, reduce and manage identified potential operational and construction traffic impacts. These mitigation measures and their application to the NWRL are presented in **Table 9.25** below.

Table 9.25 Traffic and Transport Construction Mitigation Measures

No.	Mitigation Measures	Applicable Sites
T1	Directional signage and line-marking would be used to direct and guide drivers, cyclists and pedestrians past construction sites and on the surrounding network. This would be supplemented by permanent and portable Variable Message Signs, where reasonable and feasible, to advise drivers of any potential delays, traffic diversions, speed restrictions, or alternative routes.	1 – 17
T2	The public would be notified of proposed traffic changes by newspaper, radio, project web site and other forms of community liaison.	1 – 17
T3	Co-ordination would occur with TfNSW and RMS via the Transport Management Centre's Traffic Operations Manager in the event of incidents or undue congestion.	1 – 17
T4	Management of pedestrian, cyclist and vehicular access to and past construction sites would occur to ensure safe entry and exit procedures. Depending on the location, this may require manual supervision, physical barriers, temporary traffic signals and modification to existing signals or, on occasions, police presence.	1 – 17
T5	Access to existing properties and buildings would be maintained.	1 – 17
T6	Traffic controllers would manage heavy vehicle movements at worksites, and monitor the need for pedestrian control.	1 – 17
T7	All trucks would enter and exit the worksites in a forward direction, where feasible and reasonable.	1 – 17
T8	The management of buses at key transport interchanges such as Castle Hill and Rouse Hill would be reviewed during detailed construction planning to minimise impacts on existing services.	5 and 14
T9	The T-way operations including car parking would be maintained at all times during the construction of the NWRL. This includes maintained existing sight lines to T-way bus stops and within T-way car parks, where possible. Where this is not possible, suitable alternative measures would be implemented (eg CCTV with active surveillance) where reasonable and feasible.	9 – 14
T10	The need for, and provision of, alternative remote parking locations and shuttle bus transfers for daytime and night time construction staff would be considered for all construction sites during detailed construction planning.	1 – 17
T11	Special event bus services for Sydney Olympic Park (Royal Easter Show, and Major Sporting and Entertainment Events) would be managed, in particular, in Carrington Road at the Showground Station site, to ensure minimal disruption.	6
T12	The Traffic and Transport Liaison Group established for the NWRL would consider individual events and any other special event needs, and make reasonable and feasible short-term adjustment to the construction phase activities and / or review and update detailed Construction Traffic Management Plans.	1 – 17
T13	Site traffic would be managed, where reasonable and feasible, to avoid significant movements in the AM peak in the critical southbound direction and in the PM peak in the critical northbound direction on Beecroft Road at Epping.	1
T15	Access would be maintained to sections of the pedestrian bush track at Cheltenham which would not be affected by construction works. Additionally, the provision of an alternative track would be considered during construction planning.	3
T16	Access to the Bella Vista Station site during the daytime would be at a location off Celebration Drive to the east of the Lexington Avenue intersection, to minimise traffic impacts at the Celebration Drive / Lexington Avenue intersection.	8

No.	Mitigation Measures	Applicable Sites
T17	If construction of NWRL occurs before the Schofields Road upgrade, interim upgrading of the road would be undertaken (unless otherwise agreed with RMS) with improved pavement quality and wider sealed shoulders to accommodate heavy vehicle usage.	15 – 17
T18	A dilapidation report would be prepared prior to construction for all affected local roads from the construction access / egress point to the arterial road.	1 – 17
T19	An alternative pedestrian route via Ray Road and Kandy Avenue would be appropriately signposted for pedestrian movements between Epping Town Centre and the Beecroft Road M2 Motorway overbridge.	1
T20	Truck movements on Ray Road would be restricted during the AM and PM peak periods. During these times, truck access and egress to and from the site would be via Beecroft Road only.	1
T21	Staff working at the Epping Services Facility would be discouraged from parking on local roads and encouraged to: ▪ Use public transport. ▪ Car share. ▪ Park in a designated off-site area and access the site via shuttle bus.	1
T22	Where schools occur in the immediate vicinity of the construction sites, heavy vehicle movements would be minimised (where reasonable and feasible), between 8:00-9:30 am and 2:30-4:00 pm Monday to Friday (on school days).	1 – 17
T23	Access and egress via Norwest Boulevard would be intermittent and only outside peak periods.	7
T24	Signage would be established at Epping to direct pedestrians via the alternative pedestrian route along Ray Road and Kandy Avenue.	1
T25	Construction traffic to and from the Cheltenham Services Facility would be directed to treat Beecroft Road / Kirkham Street intersection as left in / left out only.	3
T26	Alternative access to the Showground would be developed and detailed in the relevant Construction Traffic Management Plan.	6
T27	Alternative car parking would be provided, in consultation with The Hills Shire Council and the Castle Hill and Hills District Agricultural Society, for car spaces lost within the Showground precinct.	6
T28	Provision for buses to safely pull up to the indented bus bay located on Norwest Boulevard east of Century Circuit would be investigated as part of the relevant Construction Traffic Management Plan.	7
T29	Alternative car parking would be provided for car spaces lost at the Burns T-way bus stop. The alternative parking may be accommodated at the Balmoral Road T-way bus stop.	10
T30	Alternative car parking would be provided for car spaces lost at the Riley T-way bus stop. The alternative parking is likely to be provided to the north of Samantha Riley Drive.	11
T31	An alternative location for the cycle lockers at Rouse Hill would be identified during detailed construction planning.	14
T32	Alternative car parking would be provided for car spaces lost at the Rouse Hill Station Construction site.	14
T33	Either Cudgegong Road or Tallawong Road would remain open to traffic and bus services to maintain a route from Guntawong Road to Schofields Road.	17

Site 1 - Epping Services Facility, Site 2 – NOT USED, Site 3 - Cheltenham Services Facility, Site 4 - Cherrybrook Station, Site 5 - Castle Hill Station, Site 6 - Showground Station, Site 7 - Norwest Station, Site 8 - Bella Vista Station, Site 9 - Balmoral Road, Site 10 - Memorial Avenue, Site 11 - Kellyville Station, Site 12 - Samantha Riley Drive to Windsor Road, Site 13 - Old Windsor Road to White Hart Drive, Site 14 - Rouse Hill Station, Site 15 - Windsor Road Viaduct, Site 16 - Windsor Road Viaduct to Cudgegong Road, Site 17 - Cudgegong Road Station and Tallawong Stabling Facility, and Tunnels