GTAconsultants

Penrith Station Upgrade

Traffic, Transport and Access Impact Assessment

Client // Transport for NSW
Office // NSW
Reference // 15S1664200
Date // 26/10/15

Penrith Station Upgrade

Traffic, Transport and Access Impact Assessment

Issue: A 23/10/15

Client: Transport for NSW
Reference: 15S1664200
GTA Consultants Office: NSW

Quality Record

Issue	Date	Description	Prepared By	Checked By	Approved By	Signed
A	23/10/15	Final	Ronaldo Manahan	Brett Maynard	Brett Maynard	

GTAconsultants
Melbourne | Sydney | Brisbane
Canberra | Adelaide | Perth
Gold Coast | Townsville

Table of Contents

Figures

Tables

Appendices

Glossary of Terms

Term	Meaning
Term	Meaning
AADT	Annual Average Daily Traffic
ABS	Australian Bureau of Statistics
AS	Australian Standards
ASA	Asset Standards Authority
BTS	Bureau of Transport Statistics (a division of Transport for NSW)
CBD	Central Business District
CEMP	Construction Environmental Management Plan
Council	Penrith City Council
CPTED	Crime Prevention Through Environmental Design
CTMP	Construction Traffic Management Plan
DCP	Development Control Plan
DDA	*Disability Discrimination Act 1992*
DP&E	New South Wales – Department of Planning and Environment
DSAPT	Disability Standards for Accessible Public Transport
FAT	Family Accessible Toilet
Fruin	John J Fruin, who pioneered studies on pedestrian flows and crowding levels. Fruin defined six levels of crowding for queueing areas, walkways and stairways, and given in terms of Levels of Service (LOS).
GAC	Gate Attendant Controller
ha	hectare
HPAA	High Pedestrian Activity Area
HV	Heavy vehicles
I & S	Infrastructure and Services, a division of Transport for NSW (formerly Transport Projects Division)
JTW	Journey to Work
km	kilometres
LEP	Local Environmental Plan
LGA	Local Government Area
LOS	Level of Service – a qualitative measure of flow and crowding, with LOS A as the 'most pleasant' and F the 'least pleasant' in terms of pedestrian flow and crowding.
m	metres
min	minutes
mm	millimetres
NSW	State of New South Wales
OOHW	Out of Hours Works
PCC	Penrith City Council
Penrith Interchange	Penrith Station and adjacent transport interchange, including bus interchange and taxi ranks

continued

Term	Meaning
pmm	pedestrians per metre per minute – a measure of pedestrian flow rate
Rail Possession	Possession is the term used by railway building/maintenance contractors to indicate that they have taken possession of the track (usually a block of track) for a specified period, so that no trains operate for a specified time. This is necessary to ensure the safety of workers and rail users.
RailCorp	Rail Corporation New South Wales (now Sydney Trains)
REF	Review of Environmental Factors
RMS	Roads and Maritime Services (formerly Roads and Traffic Authority)
Roads Act	*Roads Act 1993*
TAP	Transport Access Program – an initiative of Transport for NSW to provide a better experience for transport customers by delivering accessible, modern, secure and integrated transport infrastructure.
TCP	Traffic Control Plan
TfNSW	Transport for New South Wales
TGSI	Tactile Ground Surface Indicator
TMC	Transport Management Centre – a unit within Transport for NSW which monitors and manages the NSW State road network.
TT&AIA	Traffic, Transport and Access Impact Assessment (this report)
TVM	Ticket Vending Machine
TZ	Travel zone – a geographical unit used as a basis for travel data analysis and statistics.

Executive Summary

Background

Transport for New South Wales (TfNSW), through the Infrastructure and Services Division, is proposing to upgrade Penrith Station, including transport interchange facilities in the station precinct, as part of the Transport Access Program (TAP), which is a NSW Government initiative involving transport facility upgrades throughout NSW.

The main objective of the TAP is to provide better access to, within and around public transport interchanges, railway stations and surrounding station precincts, along with improvements in station amenities and general customer facilities.

Penrith Station, located in Western Sydney, has been earmarked for a station upgrade to improve the customer experience and accessibility, including modal interchange facilities.

Proposed Upgrade

The proposed upgrade works at Penrith Station includes the following indicative key scope items:

- existing pedestrian footbridge retained for unpaid access across the railway and extended further south
- new stairs on both the northern and southern entrances of the pedestrian footbridge
- new paid concourse accessible from the pedestrian footbridge with relocated ticket gates, new Customer Information Window, Family Accessible Toilet, store room and stairs to platforms
- three replacement lifts to provide access to the platforms/interchange
- new canopies for the existing footbridge and new stairs, lift landings, paid concourse, in addition to replacing platform canopies affected by the works
- reconfiguration of the southern transport interchange which would involve:
    - upgraded bus interchange with reversed traffic flow to include set-down, pick-up and layover spaces for buses, and shelters for weather protection for customers
    - relocated kiss and ride and taxi rank (with shelters) on Belmore Street
    - landscaping, paving and lighting for the interchange and forecourt area
- extension of the south-western commuter car park with approximately 25 spaces (to offset some of the commuter parking removed for the long-term bus layover)
- establishment of a new Bus Driver's Amenities Room and Customer Service Manager's Office in the existing Platform 3 heritage building
- ancillary works including services diversion and/or relocation, alterations to traffic signals, station power supply upgrade, minor drainage works, adjustments to fencing, lighting and seating, improvements to station communication systems with new infrastructure (including lighting, CCTV cameras, Passenger Information Display boards and Opal card readers) and wayfinding signage.

Existing Conditions

Penrith Station is currently the 33rd busiest station in the Sydney Trains network. It is accessed by more than 15,000 rail users during an average weekday in 2014, with about 5,000 of them using the station during the 3.5-hour AM peak period (6–9:30am).

Penrith Station is serviced by both the Western and the Blue Mountains railway lines.

Pedestrian access to Penrith Station is provided via an entry point from Jane Street–Belmore Street to the south, and one on Lord Sheffield Circuit in the Thornton residential development to the north.

In addition to the station, existing transport facilities at the adjacent interchange include:

- bus interchange, with capacity for 18 bus stands and serviced by Blue Mountains Bus Company, Busways and the NightRide buses, with associated shelters and bus driver amenities
- taxi facility with capacity for 13 taxis (in three ranks)
- bicycle parking facilities comprising racks in the form of public art installations in the southern plaza and inverted U-rails at the southern landing of the footbridge (total of 13 spaces), 32 secure bicycle lockers located to the south of the station (Belmore Street), 8 lockers to the north (Lord Sheffield Circuit) and 10 inverted U-rails at the multi-storey commuter car park to the north of the interchange, for a total capacity of 63 bicycles
- kiss and ride zone on Jane Street, with capacity for up to 15 vehicles
- various commuter car park areas to the southwest, southeast and northwest of the station, including a 1,000-space multi-storey car park.

Site observations indicate that the demand for unrestricted parking is high, and commuter car parks in the precinct are practically fully occupied by around 8am.

A high proportion of pedestrians and customers accessing the station currently have to cross the travel paths of buses in the interchange.

Operational and Construction Impacts

TfNSW predicts that daily rail patronage at Penrith Station will increase by 46 per cent between 2011-16 and 2031-36. The pedestrian improvements (including new overhead pedestrian concourse) would provide adequate capacity to accommodate this expected growth, while also enabling direct and safe travel routes, with an overall improved user experience and connectivity.

Pedestrian capacity assessment using Fruin Theory concludes that peak pedestrian activity would continue to operate at acceptable levels of service when considering existing and forecast patronage and improved walkway capacity within the station.

The opportunity to reduce conflicts between pedestrians and buses would improve customer experience, as well as consolidate interchange facilities, including bus bays and the taxi rank.

Changes to bus interchange access arrangements are anticipated to have minor impacts on traffic operations, with future levels of service at the access and egress intersections expected to remain at similar levels compared with existing conditions.

The proposed relocation of the taxi rank to the north side of Jane Street (where the kiss and ride zone is currently located) would reduce the available capacity from the current 13 to 8, with limited opportunities to cater for potential taxi overflow. The relocation will also require additional manoeuvres through Penrith City Centre to access the taxi rank.

It is recommended that further consultation with the NSW Taxi Council and Penrith City Council be undertaken during the next phases of design in order to ascertain the adequacy of the proposed taxi rank capacity and identify any management measures that could be considered to accommodate potential taxi overflow. Investigation into other measures to mitigate the

potential taxi overflow issues (e.g. location/s for an alternate/ overflow rank and/or options to increase capacity of the proposed rank) would also need to be undertaken during the next phases of design.

The relocation of the kiss and ride zone to Belmore Street (adjacent to the old Station Master's Residence) would also reduce the capacity from the existing 15 to 7 vehicle spaces.

It is recommended that consideration be made during the next phases of design for a portion of the existing eastern commuter car park to be converted to peak period short stay (15 min) parking (in a similar manner to the existing peak period short-stay parking facility being used as a kiss and ride area). This could potentially be within the area adjacent to the existing accessible car parking spaces and the location of the bicycle lockers.

Construction vehicles would use designated approach and departure routes, with appropriate measures to maintain safety for all users at all times, especially at the site accesses, within the site and through local areas. Construction traffic generation is expected to be limited and have a negligible impact on existing traffic conditions. It is anticipated that the primary construction activity would occur via Jane Street, Belmore Street and North Street, linking with Mulgoa Road and The Northern Road (Parker Street) to the M4 Western Motorway or the Great Western Highway. Construction access from the north would be via Coreen Avenue to Lord Sheffield Circuit, through Combewood Avenue.

The following impacts to pedestrians/ transport customers are anticipated as a result of construction activities:

- potential increased levels of platform congestion as a result of areas being hoarded off for constructing the overhead concourse expansion
- impacts to transport and access on the southern side of the interchange resulting from the temporary relocation of bus bays and the taxi rank
- the likelihood of longer walking distances resulting from diversions in the bus interchange area and the taxi bays associated with interchange works
- potential for increased congestion during peak periods resulting from constrictions on the platforms, the existing overhead concourse and along walkways in the station forecourt arising from narrower movement areas
- reduced commuter car parking capacity
- higher road safety risk levels associated with construction vehicle-pedestrian interaction, particularly in the south eastern commuter car park and on Lord Sheffield Circuit.

These impacts are considered to be manageable, with the Construction Environmental Management Plan to be prepared by the contractor outlining how the potential hazards relating to pedestrian and vehicle access would be addressed.

Notwithstanding the likely limited impacts of construction on the operation of the surrounding transport network, a Construction Traffic Management Plan and Traffic Control Plans (TCPs) would likely need to be prepared and submitted to the RMS/ TMC and/or Penrith City Council's Traffic Committee, to appropriately manage the use of the designated construction routes and site interfaces. On-street parking impacts as a result of construction workers or localised construction activities would need to be appropriately managed, given the high demand for existing parking by rail users accessing Penrith Station.

1. Introduction

1.1 Background

Transport for New South Wales (TfNSW), through the Infrastructure and Services Division, is proposing to upgrade Penrith Station including transport interchange facilities in the station precinct, as part of the Transport Access Program (TAP), which is a NSW Government initiative involving a number of public transport facility upgrades throughout NSW.

The main objective of the program is to provide better access to, within and around public transport interchanges, railway stations and surrounding station precincts, along with improvements in station amenities and general customer facilities. This would assist in ensuring an enhanced experience for public transport customers by delivering accessible, modern, secure and integrated transport infrastructure.

The planning and delivery of transport infrastructure as part of TAP would focus on the following:

- upgrading existing railway stations to improve access, particularly for those with a disability, the elderly and parents with prams
- providing modern buildings and facilities for all modes that meet the needs of a growing population
- providing transport interchanges that support an integrated network and allow seamless transfers between all modes for all customers
- improving safety and security measures, such as extra lighting, help points, fences and other security features
- improving signage and wayfinding.

The TAP has funding to deliver a series of projects ranging from small works such as ramp and access upgrades, through to larger projects including new stations, whole of station upgrades, transport interchanges and multi-deck commuter car parks.

Transport for NSW engaged GTA Consultants to prepare a Traffic, Transport and Access Impact Assessment (TT&AIA) for the proposed Penrith Station Upgrade (the 'Proposal') to inform the preparation of a Review of Environmental Factors (REF) for the Proposal.

1.2 Project Objectives

The overall objectives of the transport interchange upgrade projects include:

- improving the customer experience (specifically by provision of canopies, improved interchange facilities and a high standard of urban design)
- improving accessibility and compliance with the Disability Discrimination Act (DDA) and the Disability Standards for Accessible Public Transport (DSAPT)
- improving modal access facilities and integration with surrounding precinct
- where possible, increasing station capacity to address identified congestion issues (if any) and to accommodate patronage growth to 2036
- upgrading transport modal interchange facilities and equipment to current standards
- improving amenity for customers, including general access to the station and precinct facilities
- facilitating future unmanned station operation through rationalisation of all station systems, including security, ticketing and passenger information display

- reviewing precinct facilities for life expired elements and recommending appropriate action
- balancing the cost of ownership and maintenance with capital cost
- minimising construction stage impacts on passengers and station operations.

Specific design objectives include:

- verifying compliance with functional and operational requirements
- promoting efficient and effective wayfinding
- minimising pedestrian conflict, congestion and crowding points
- minimising queuing at station and interchange facilities
- increasing accessibility for commuters with mobility impairment
- accommodating growth of patronage and changing travel and working patterns
- improving station functionality, covering improved access to ticketing, platform clearance rates and station control (including congestion and pinch points).

1.3 Penrith Station Upgrade

The proposed Penrith Station Upgrade is designed to improve pedestrian access and circulation to and from and within Penrith Station, increase its ability to cope with the predicted future patronage demands, provide efficient transport interchange operations and capacity, including for buses, as well as improve pedestrian flow, passenger information services and wayfinding between transport modes.

The proposed upgrade works at Penrith Station includes the following indicative key scope items:

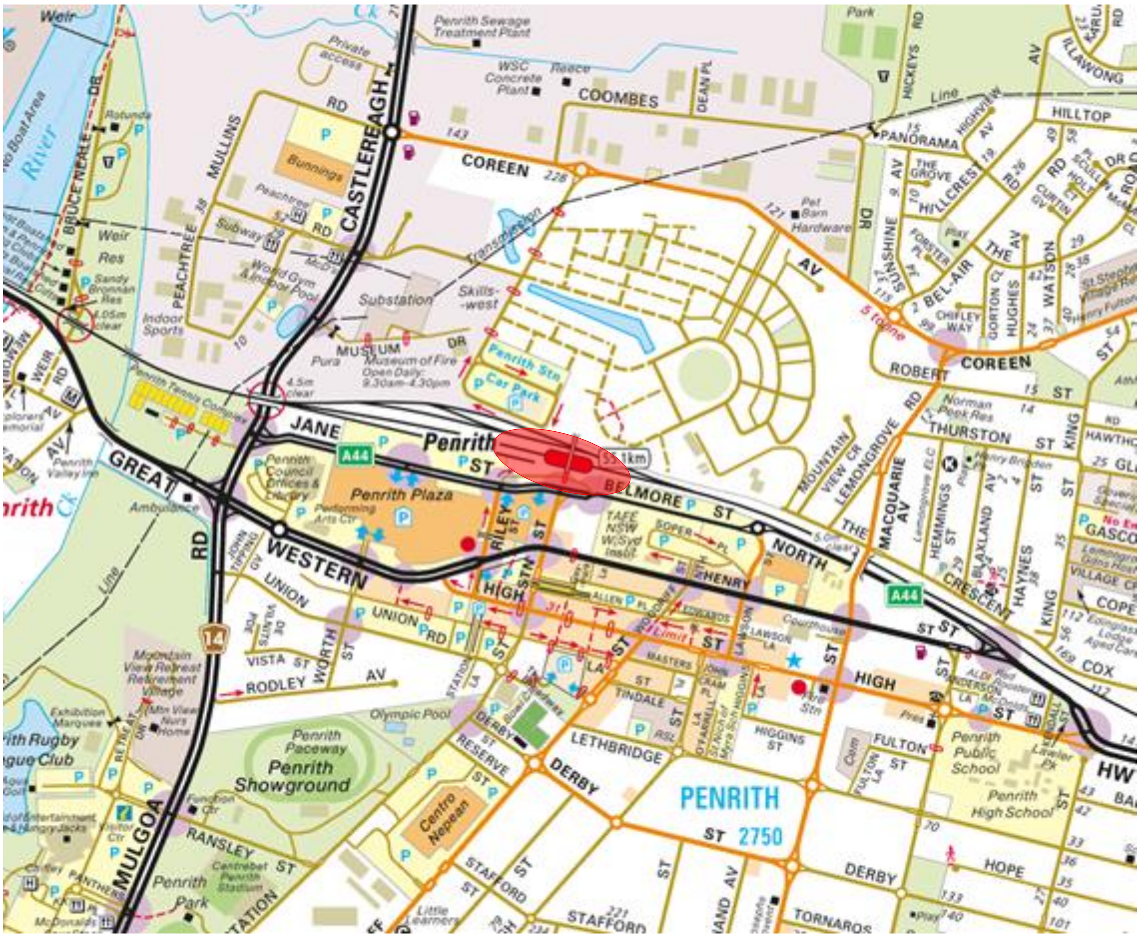
- existing pedestrian footbridge retained for unpaid access across the railway and extended further south
- new stairs on both the northern and southern entrances of the pedestrian footbridge
- new paid concourse accessible from the pedestrian footbridge with relocated ticket gates, new Customer Information Window, Family Accessible Toilet, store room and stairs to platforms
- three replacement lifts to provide access to the platforms/interchange
- new canopies for the existing footbridge and new stairs, lift landings, paid concourse, in addition to replacing platform canopies affected by the works
- reconfiguration of the southern transport interchange which would involve:
    - upgraded bus interchange with reversed traffic flow to include set down, pick up and layover spaces for buses, and shelters for weather protection for customers
    - relocated kiss and ride and taxi rank (with shelters) on Belmore Street
    - landscaping, paving and lighting for the interchange and forecourt area
- extension of the south-western commuter car park with approximately 25 spaces (to offset some of the commuter parking removed for the long-term bus layover)
- establishment of a new Bus Driver's Amenities Room and Customer Service Manager's Office in the existing Platform 3 heritage building
- ancillary works including services diversion and/or relocation, alterations to traffic signals, station power supply upgrade, minor drainage works, adjustments to fencing, lighting and seating, improvements to station communication systems with new infrastructure (including lighting, CCTV cameras, Passenger Information Display boards and Opal card readers) and wayfinding signage.

1.4 Study Area

Penrith Station is located in the suburb of Penrith, in the Penrith City Local Government Area (LGA), about 55km to the west of the Sydney central business district. The Penrith Station Precinct is located to the north of Penrith City Centre.

The location of Penrith Station in the context of the surrounding area is shown in Figure 1.1.

Figure 1.1: Penrith Station and its Surrounding Environs



Basemap source: Sydway

This assessment focuses on the area currently occupied by the station and overhead concourse, the bus interchange, the taxi rank and the kiss and ride zone.

1.5 Study Scope

This TT&AIA report has been prepared as part of the REF for the Proposal, and sets out an assessment of the anticipated traffic, transport and access impacts of the proposed Penrith Station Upgrade works in consideration of the following:

- existing traffic and transport conditions and facilities in the vicinity
- operational traffic impacts associated with the proposed facilities
- construction impacts associated with the Proposal
- identification of potential mitigation measures required as a result of any impacts.

This assessment has been prepared noting the following:

- Stakeholder consultation was not conducted as part of this study.
- Assumptions were made in regard to the proposed construction activities.
- Pedestrian, traffic and parking observation surveys were conducted during the weekday AM and PM peak periods with the primary aim of capturing commuter and rail customer behaviour.
- Intersection modelling was completed as part of this project, focusing on traffic impacts of the proposed reversal of bus access and egress arrangements on the Belmore Street/ Station Street and Jane Street/ Riley Street intersections. It is noted that the proposed station upgrade is expected to generate only minor additional traffic.

1.6 References

In preparing this report, reference has been made to the following:

- an inspection of the site and its surrounds
- Penrith City Council Local Environmental Plan (LEP) 2010
- Australian Standard, Parking Facilities, Part 1: Off-Street Car Parking AS 2890.1:2004
- Australian Standard, Parking Facilities, Part 5: On-Street Parking AS 2890.5:1993
- Australian Standard, Parking Facilities, Part 6: Off-Street Parking for People with Disabilities AS 2890.6:2009
- traffic and car parking surveys as referenced in the context of this report
- the Study Brief prepared by TfNSW
- *Penrith Station Precinct - Station Capacity and Interchange Upgrade: Concept Plan Project Report* (AECOM, December 2013)
- plans for the proposed development prepared for TfNSW
- other documents and data as referenced in this report.

2. Existing Conditions

2.1 Station Context

Penrith Station is located in Penrith City Centre on the outer edge of western Sydney, approximately 55km west of the Sydney CBD.

The railway station is served by Sydney Trains' T1 Western Line and the Blue Mountains Line. It is currently the 33rd busiest station within the Sydney Trains network, with about 15,000 passengers recorded entering or exiting the station during an average weekday in 2014.

Within the interchange precinct is Penrith Station, the bus interchange to the south, taxi ranks adjoining the bus interchange, several at-grade commuter car parks to the south, a multi-storey commuter car park and an adjoining at-grade commuter car park to the north, and passenger access between these facilities, including an overhead concourse divided into a paid area linking the platforms and an unpaid area providing stair and lift access across the railway corridor.

The forecourt to the south also provides bicycle parking.

The station buildings include Sydney Trains operational facilities and two convenience/ retail shops.

2.1.1 Surrounding Land Uses

To the south of the railway corridor in Penrith is the city centre's main retail precinct, including the 90,000-square metre Westfield Penrith (Penrith Plaza) shopping centre, and a number of smaller retail outlets along Station Street, Henry Street and High Street. There are also a number of commercial/office developments in the precinct to the south of Penrith Station.

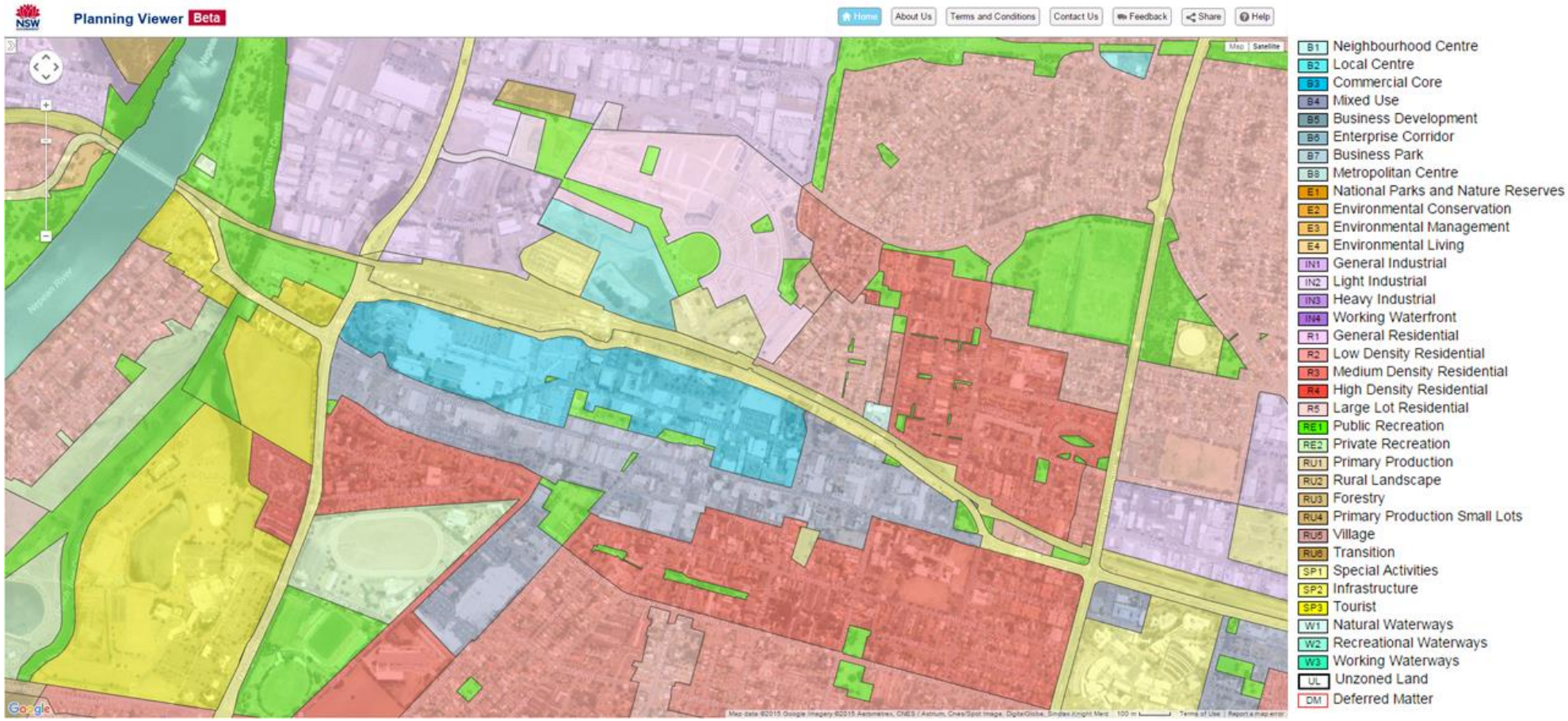
To the north of the railway corridor is Thornton, a 40-hectare residential subdivision that will accommodate about 1,100 new residential dwellings and a village centre with retail, commercial and community uses which complement Penrith City Centre. The area to the north of the railway station includes a 1,000-car space multi-level commuter car park that opened in 2013.

To the northwest lie industrial lands.

Figure 2.1 shows the land uses surrounding Penrith Station, while Figure 2.2 shows the designated land zoning in the precinct.

Figure 2.1: Land Uses Surrounding Penrith Station

Figure 2.2: Land Zoning Surrounding Penrith Station



Source: NSW Government Planning Viewer, accessed via https://maps.planningportal.nsw.gov.au/Map on 25 September 2015.

2.1.2 Road Access

The access roads to Penrith Station include:

- Jane Street, Belmore Street, Riley Street and Station Street to the south
- Coreen Avenue via Lord Sheffield Circuit to the north.

Belmore Street– Jane Street

Belmore Street and Jane Street form a two-way classified State Road configured with two traffic lanes in each direction with localised widening for turn bays. The route forms part of the Great Western Highway (Route A44), linking (via North Street) with The Northern Road (Route A9) to the east and Mulgoa Road/ Castlereagh Road to the west.

In the vicinity of Penrith Station, Belmore Street and Jane Street are aligned in an east-west direction forming signalised intersections with Riley Street and Station Street, and a roundabout with the North Street/ Lawson Street intersection to the east. The signalised Riley Street intersection also provides bus and taxi access to Penrith Station.

Time restricted (1/4P) parking is provided on the northern side of Jane Street between Riley Street and Station Street, which functions mainly as a kiss and ride zone for the interchange. There is a posted speed limit of 50 km/h and kerbside parking is not permitted in the section adjacent to the interchange. Pedestrian footpaths are provided on both sides of the road.

Belmore Street is a continuation of Jane Street eastward. The beginning of Belmore Street is east of the Station Street signals. It forms signalised intersections with Station Street and the existing location of the bus interchange egress point about 125 m to the east of Station Street. It continues to the Lawson Street roundabout, providing access to the eastern commuter car park, then links with North Street east of the Lawson Street roundabout.

Jane Street is shown in Figure 2.3 and Figure 2.4.

Figure 2.3: Jane Street (looking west)

Figure 2.4: Jane Street (looking east)

Riley Street

Riley Street is a local road oriented in a north-south direction to the south of Penrith Station. It is used by a number of buses serving suburbs to the west, including the Lower Blue Mountains, to access Penrith Station and Interchange.

Riley Street runs through Westfield Penrith, with overhead shopping centre connectivity above Riley Street. Riley Street is a one-way (south to north), one-lane road with short-stay parallel

kerbside parking and a taxi zone on the eastern side and a bus zone, emergency vehicle parking area and short-stay kerbside parking on the western side. At the intersection with Jane Street, egress ramps from the Westfield Penrith basement car parking straddle both sides of the single-lane road.

On the east side of Riley Street are dining establishments with outdoor seating

Riley Street has a posted speed limit of 40 km/h, being within the designated Penrith City Centre 40 km/h High Pedestrian Activity Area (HPAA).

Station Street

Station Street is a local two-way road with two lanes in each direction, linking Penrith Station with Jamison Road, about 1.5 km to the south. In the vicinity of the interchange, between Henry Street and Belmore Street/ Jane Street, Station Street has a posted speed limit of 40 km/h, being within the designated Penrith City Centre HPAA.

Coreen Avenue

Coreen Avenue runs in an east–west orientation about 600 m north of the railway corridor. It is a regional road with generally one travel lane and a kerbside parking lane in each direction. It carries about 12,000 vehicles a day. Coreen Avenue provides access to the north side of Penrith Station and associated commuter car parking facilities, via Sydney Smith Drive and Lord Sheffield Circuit, through the Thornton residential development.

The section of Coreen Avenue at the Thornton development has a posted speed limit of 60 km/h.

Lord Sheffield Circuit

Lord Sheffield Circuit is a local road within the Thornton residential development north of the transport interchange. It is generally configured with one travel lane and one parking lane in each direction. It surrounds Smiths Paddock, an open space feature of Thornton, and provides links to commuter car parking facilities further to the south west. It will also provide access to the northern plaza in Thornton.

Sections of Lord Sheffield Circuit are currently closed to general traffic; in particular sections that link with current construction zones. A section of Lord Sheffield Circuit adjacent to the station entry is a designated No Stopping zone, however site observations reveal heavy drop-off and pick-up activity, particularly during peak hours.

There is a designated 10 km/h Shared Zone along the section of Lord Sheffield Circuit around the commuter car park. The remainder of Lord Sheffield Circuit is within the 50 km/h area as part of the Thornton residential development.

Other sections surrounding the commuter car parking facilities are also used for long-stay kerbside parking, indicating capacity issues with the commuter car parks.

Lord Sheffield Circuit links with the external road network via Sydney Smith Drive and via Combewood Avenue to Coreen Avenue, and via Thornton Drive to Castlereagh Road.

2.2 Travel Modes

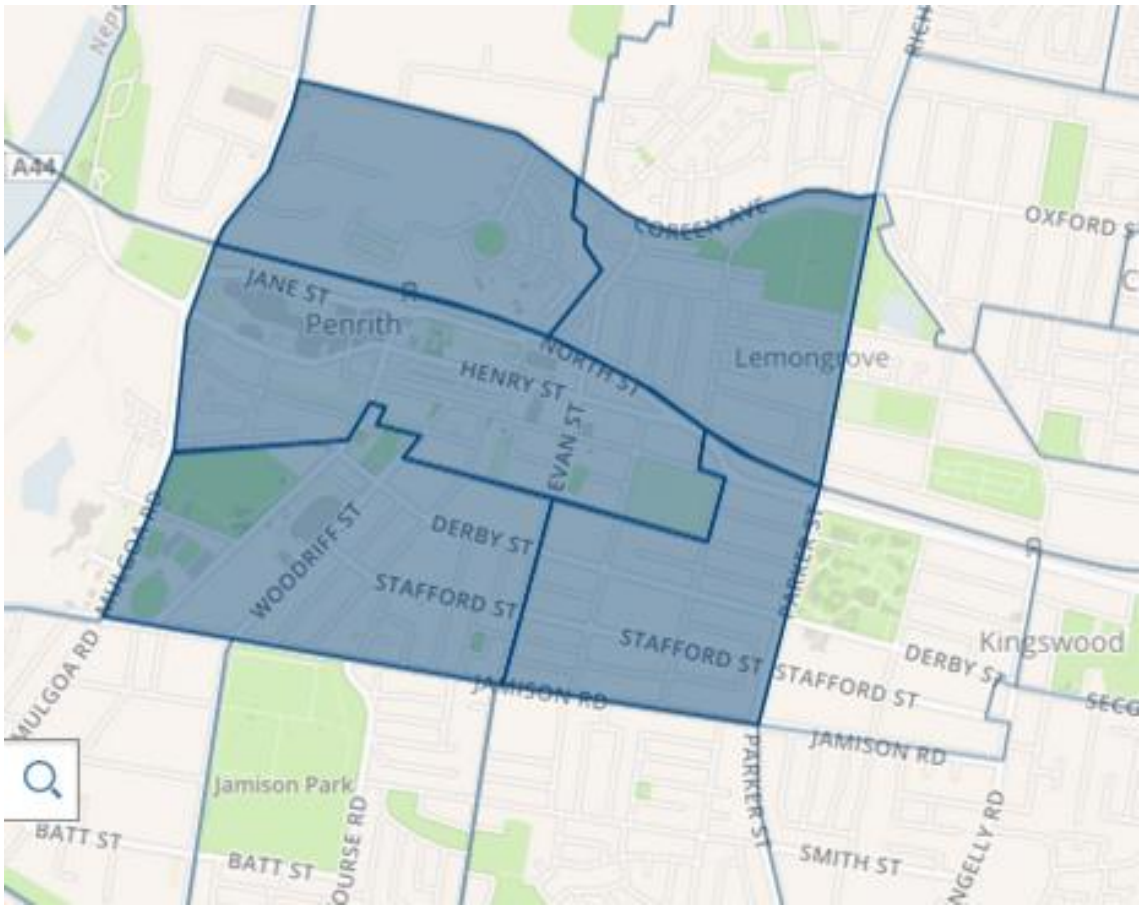
The *Journey to Work* (JTW) data published by the Bureau of Transport Statistics (BTS) from 2011 Census data by the Australia Bureau of Statistics provides the most robust picture of travel patterns to/ from Penrith Station, particularly during peak periods.

The smallest geographical area for which JTW data is available is a Travel Zone (TZ). JTW data was analysed for the Penrith Station catchment, to better understand the current travel patterns for people who live and work in the area.

2.2.1 Travel to Penrith Station

Figure 2.5 shows the travel zones comprising the catchment of work trips for employed workers likely to be using Penrith Station during the peak periods.

Figure 2.5: Travel Zones – Work Trips to Penrith



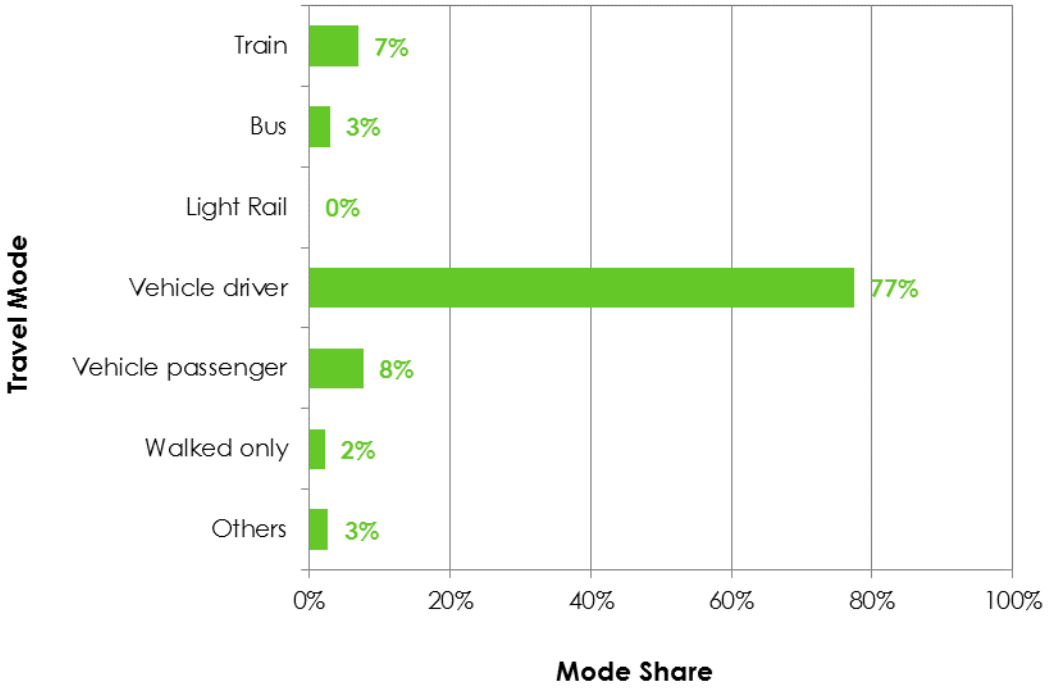
Source: Bureau of Transport Statistics, http://visual.bts.nsw.gov.au/jtwbasic/, accessed 25 September 2015.
Covers Travel Zones TZ 4977, TZ4978, TZ4979, TZ4981 and TZ4982.

The BTS 2011 JTW data indicates that a total of 13,858 people work in the selected employment areas from the map showing the selected Travel Zones in Figure 2.5.

Travel Modes to Penrith

Figure 2.6 shows the distribution of travel modes by the workers employed in the travel zones in Figure 2.5, which indicates that more than three-quarters of Penrith workers (77 percent) travelled by car to work, with only 820 people, or about 7 per cent travelling by train.

Figure 2.6: Journey to Work Travel Modes by Workers to Selected Travel Zones

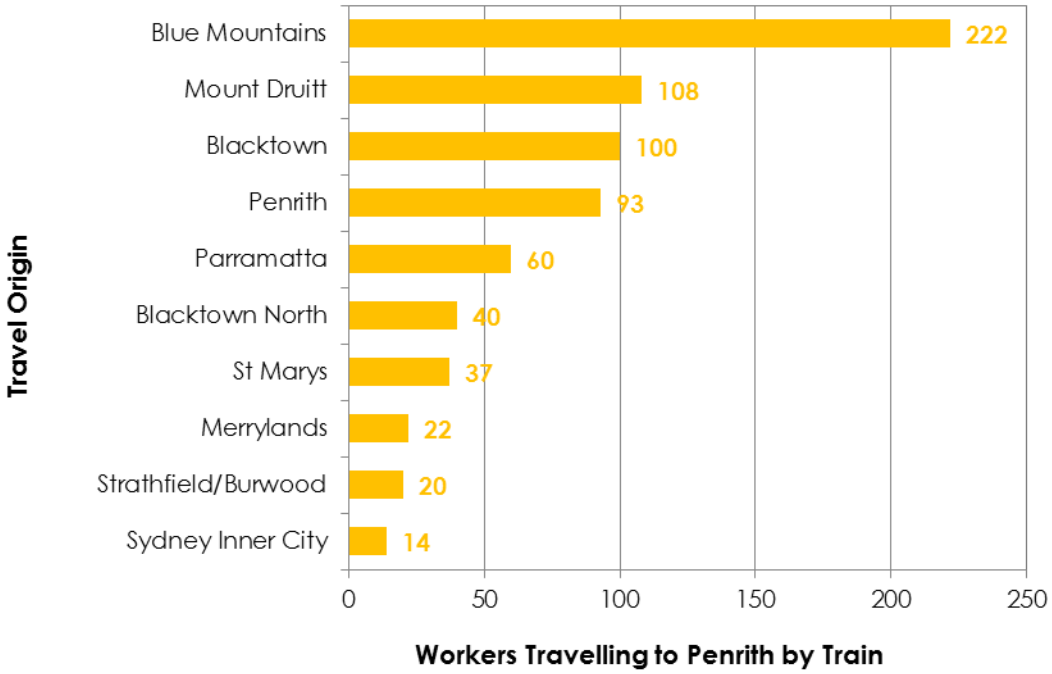


Data source: Bureau of Transport Statistics, http://visual.bts.nsw.gov.au/jtwbasic/, accessed 25 September 2015
Covers Travel Zones TZ 4977, TZ4978, TZ4979, TZ4981 and TZ4982.

Travel Origins to Penrith Station

Figure 2.7 shows the top origins of the 820 workers travelling to the selected travel zones in Penrith by train. These areas mostly include those in the Blue Mountains, Penrith and Blacktown localities.

Figure 2.7: Top Origin Areas for Workers Commuting to Penrith by Train



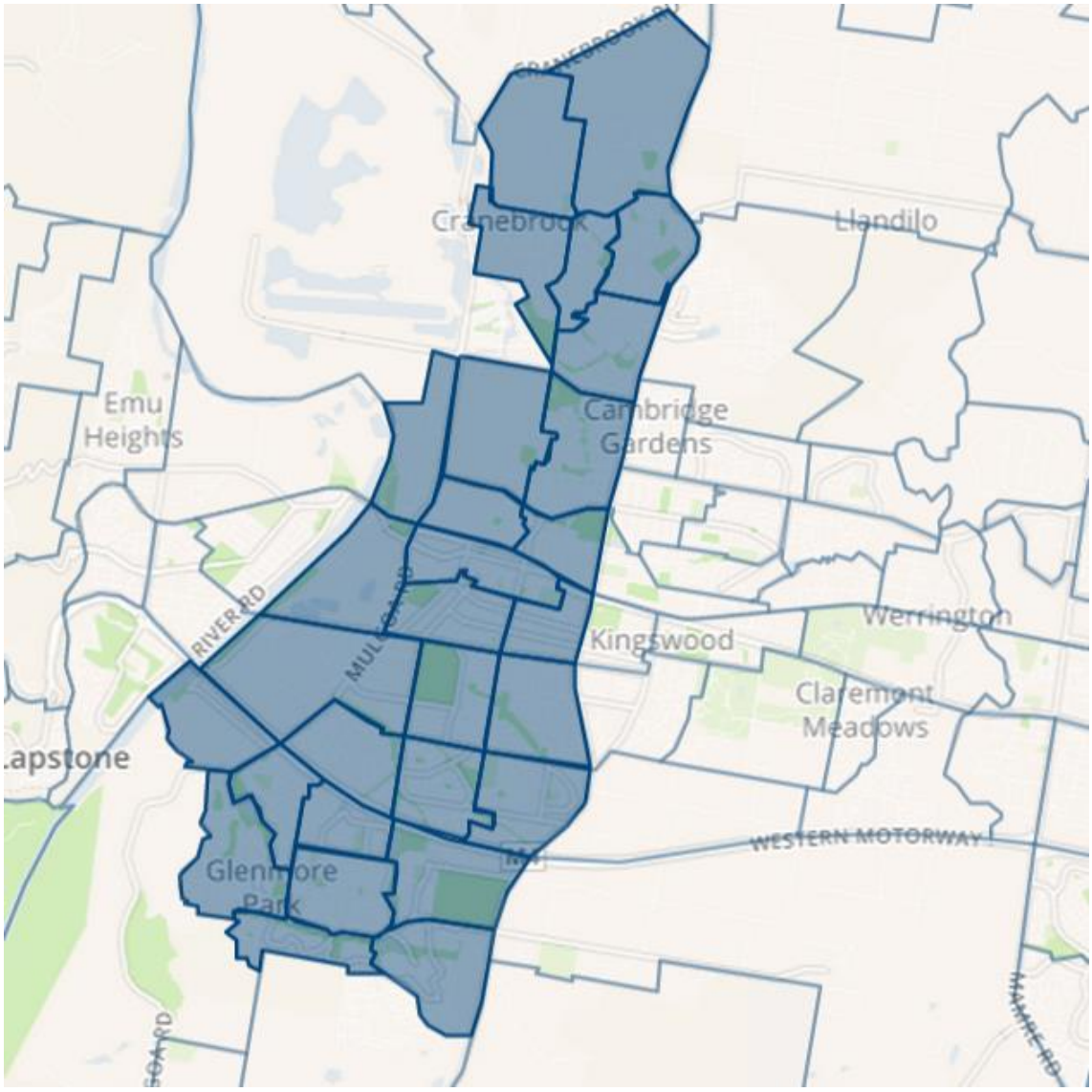
Data source: Bureau of Transport Statistics, http://visual.bts.nsw.gov.au/jtwbasic/, accessed 25 September 2015

2.2.2 Travel from Penrith Station

It is envisaged that the catchment for residents travelling from Penrith Station for work trips during the peak hours, given the surrounding land uses, would likely encompass a wider area compared with the work trips to Penrith discussed above. This residential catchment potentially covers areas to the north and south of the city centre, including Glenmore Park, Orchard Hills, Cranebrook, South Penrith, Jamisontown, Londonderry and parts of Orchard Hills and Llandilo.

Figure 2.8 shows the travel zones comprising the catchment of work trips for employed residents in Penrith likely to be using Penrith Station during the peak periods that have been included in the JTW analysis.

Figure 2.8: Travel Zones – Work Trips from Penrith



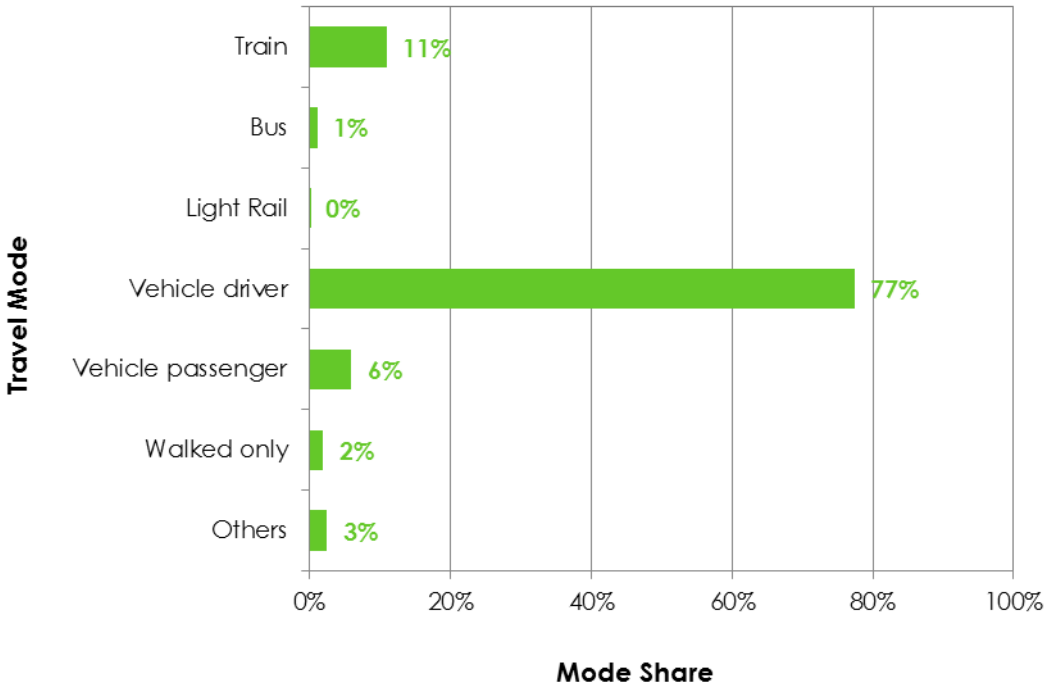
Source: Bureau of Transport Statistics, http://visual.bts.nsw.gov.au/jtwbasic/, accessed 25 September 2015.
Covers Travel Zones 4979, 4940, 4974, 4976, 4978, 4977, 4981, 4941, 4942, 4945, 4943, 4944, 4982, 4975, 4980, 4933, 4930, 4931, 4935, 4932, 4934, 4937, 4936, 4912, 4915, 4918, 4916, 4910 and 4914.

Travel Modes From Penrith

Data from BTS indicate that of the 30,000 or so resident workers in the selected travel zones included in Figure 2.8, more than three-quarters (77 percent) travelled by car to work, and 3,016 people, or about 11 per cent travelled by train.

The JTW travel mode shares of these resident workers are shown in Figure 2.9.

Figure 2.9: Journey to Work Travel Modes by Residents from Selected Travel Zones



Data source: Bureau of Transport Statistics, http://visual.bts.nsw.gov.au/jtwbasic/, accessed 25 September 2015

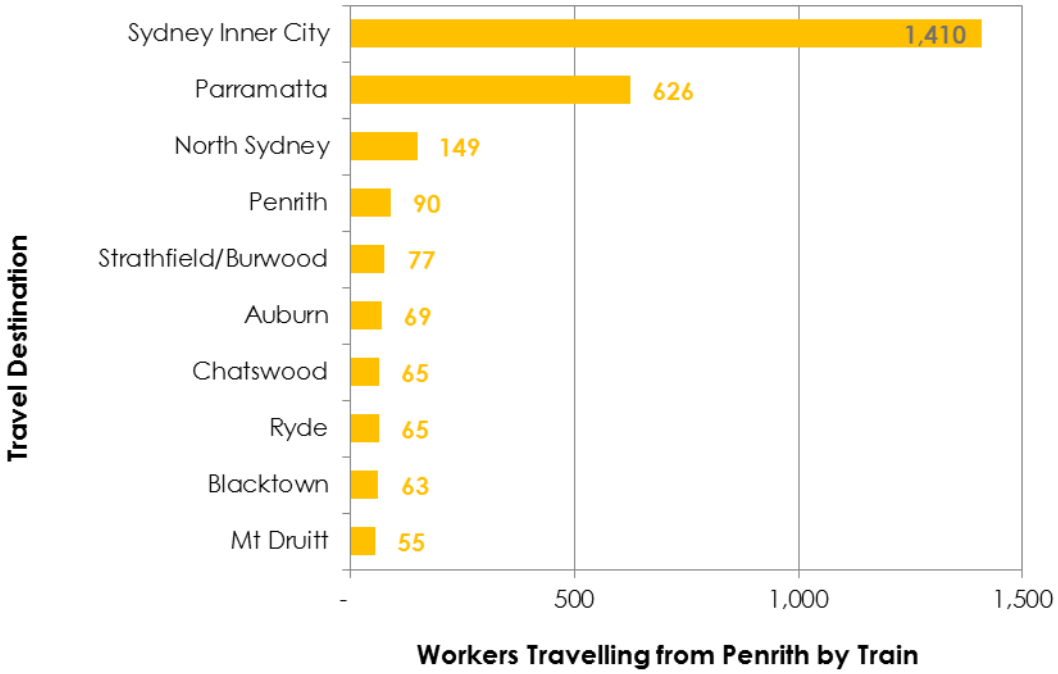
Travel Destinations from Penrith Station

The BTS data also provides the destination areas for these workers travelling by train from the selected travel zones, which provides an indication of these destinations for workers using Penrith Station[1].

Figure 2.10 shows the top destinations of the 3,000 or so workers travelling from the selected travel zones in Penrith by train. Of these, the Sydney CBD is the destination of almost half of these workers, and Parramatta about 20 per cent.

[1] It is noted that this analysis only provides a high-level picture of the likely destinations of Penrith Station work trips, as the residents in the travel zones may also use other nearby stations along the line, e.g. Kingswood. This would depend on external factors such as commuter car park availability and train timetables.

Figure 2.10: Top Destination Areas for Workers Commuting from Penrith by Train



Data source: Bureau of Transport Statistics, http://visual.bts.nsw.gov.au/jtwbasic/, accessed 25 September 2015

2.3 Existing Interchange Facilities

Penrith Station, as well as the surrounding precinct provides a number of transport facilities, including a bus interchange, taxi ranks, kiss and ride, time-restricted and unrestricted parking (generally used by commuters) and bicycle parking. There are also two convenience/ retail tenancies within the Platform 3 station building.

The existing facilities are indicatively shown in Figure 2.11.

A spot count of the movement of vehicles within the interchange was conducted between 3:45 and 4pm, during which 6 taxi departures, 12 bus departures, 2 community vehicles (community buses) and 3 private vehicles were recorded.

Figure 2.11: Existing Station and Transport Interchange Facilities

2.4 Public Transport Services

2.4.1 Passenger Rail Services

Penrith Station is serviced by the T1 Western line, Blue Mountains Line (including services to Katoomba and Lithgow), as well as NSW TrainLink western services to localities such as Bathurst, Orange, Dubbo and Broken Hill. The train journey between Penrith Station and Central Station takes approximately 50 minutes during peak periods.

Train frequencies during the weekday AM, weekday PM and Saturday peak hours are shown in Table 2.1.

Table 2.1: Train Service Frequencies

Direction	Peak Period Frequency		
	AM Peak (8–9am)	PM Peak (5–6pm)	Saturday Peak (12–1pm)
Eastbound (Central)	5–15 minutes	5–25 minutes	15–20 minutes
Westbound (Emu Plains/Blue Mountains)	10–20 minutes	5–10 minutes	15–20 minutes

A summary of the facilities provided at Penrith Station is detailed in Figure 2.12.

Figure 2.12: Penrith Station Facilities

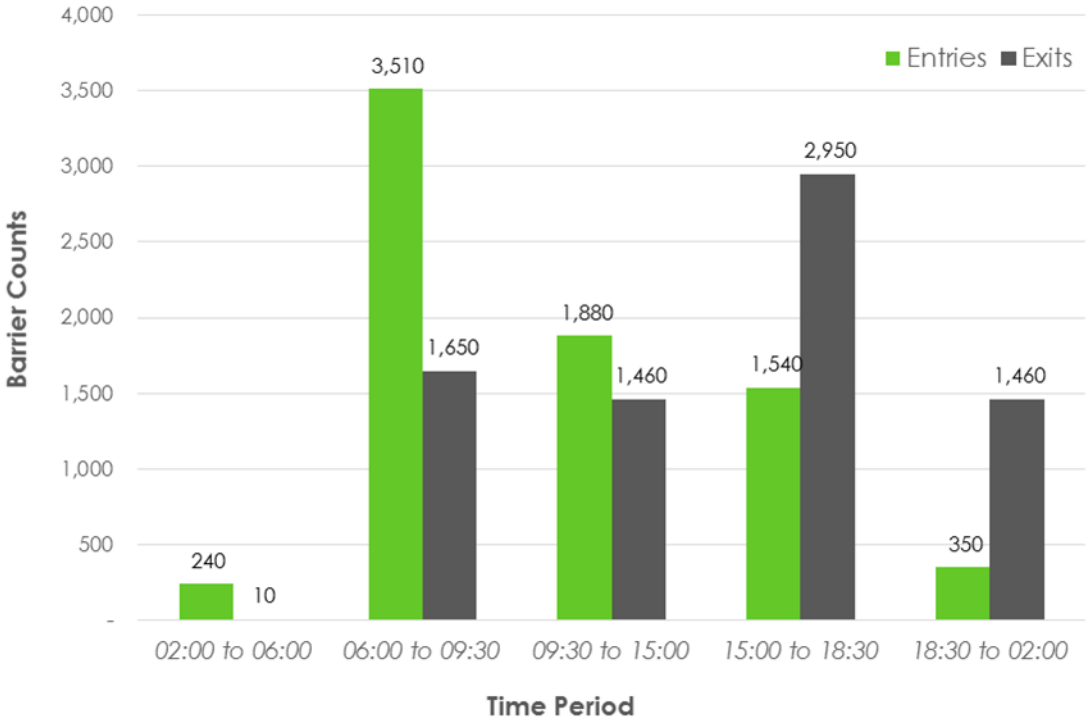
Source: Sydney Trains, http://www.sydneytrains.info/stations/station_details.htm, accessed 24 August 2015.

2.4.2 Rail Patronage

In 2014, Penrith Station was the 33rd busiest railway station in the Sydney Trains network. It had a patronage of 5,160 entries and exits in the 3.5-hour morning peak between 6–9:30am, with station entries being more than twice that of station exits[2]. In terms of total 24-hour movements, it had 15,040 total entries and exits.

The typical pattern of railway station patronage on a weekday at Penrith in 2014 is shown in Figure 2.13.

Figure 2.13: Penrith Station Patronage, 2014



Data source: Bureau of Transport Statistics, http://www.bts.nsw.gov.au/ArticleDocuments/223/Train%20Station%20Barrier%20Counts%202004-2014.zip.aspx, accessed 11 August 2015.

From Figure 2.13, it is can be seen that Penrith Station is busiest during the morning (6–9:30am) and afternoon (3–6:30pm) commuter peak periods, which reflects its primary use as both a commuter station to/ from Sydney CBD/ Parramatta and key employment zones. There is also a significant proportion of morning peak trips to Penrith (and afternoon trips from Penrith), from a combination of school student movements during these peak periods and Penrith being an employment centre as well.

Off-peak patronage at Penrith Station typically caters for shopping trips to the retail precinct to the south of the interchange.

Historical barrier count data for Penrith Station has also been gathered from information published by the Bureau of Transport Statistics, covering the years 2004 to 2014, and given in terms of key time periods during the day[1]. The barrier counts for the 3.5-hour morning peak between 6–9:30am, as well as the totals for the day (24 hours), are shown in Table 2.2.

[2] Source: http://www.bts.nsw.gov.au/ArticleDocuments/223/Train%20Station%20Barrier%20Counts%202004-2014.zip.aspx

Table 2.2: Penrith Station Barrier Counts 2004-2014

Year	Time Period					
	6–9:30am			24 hours		
	In	Out	In + Out	In	Out	In + Out
2004	3,500	1,530	5,030	9,250	9,240	18,490
2005	3,500	1,530	5,030	9,250	9,240	18,490
2006	3,470	1,520	4,990	9,190	9,170	18,360
2007	2,870	1,290	4,160	7,140	7,130	14,270
2008	3,060	1,620	4,680	8,320	8,310	16,630
2009	3,060	1,620	4,680	8,320	8,310	16,630
2010	3,250	1,450	4,700	7,720	7,720	15,440
2011	3,140	1,510	4,650	7,250	7,240	14,490
2012	3,130	1,620	4,750	7,860	7,850	15,710
2013	3,330	1,460	4,790	7,710	7,710	15,420
2014	3,510	1,650	5,160	7,520	7,530	15,050

Data source: Bureau of Transport Statistics, http://www.bts.nsw.gov.au/ArticleDocuments/223/Train%20Station%20Barrier%20Counts%202004-2014.zip.aspx, accessed 11 August 2015

The data indicates that rail patronage at Penrith Station has decreased between 2004 and 2014 by about 19 per cent (from 2004).

2.4.3 Bus Services

The interchange comprises a key bus facility serving the Penrith region and beyond. Bus entry is via the signalised intersection of Jane Street–Belmore Street and Riley Street, and exit via an egress driveway onto Belmore Street to the east of Station Street.

Penrith Station and the interchange is serviced by the bus routes shown in Table 2.3.

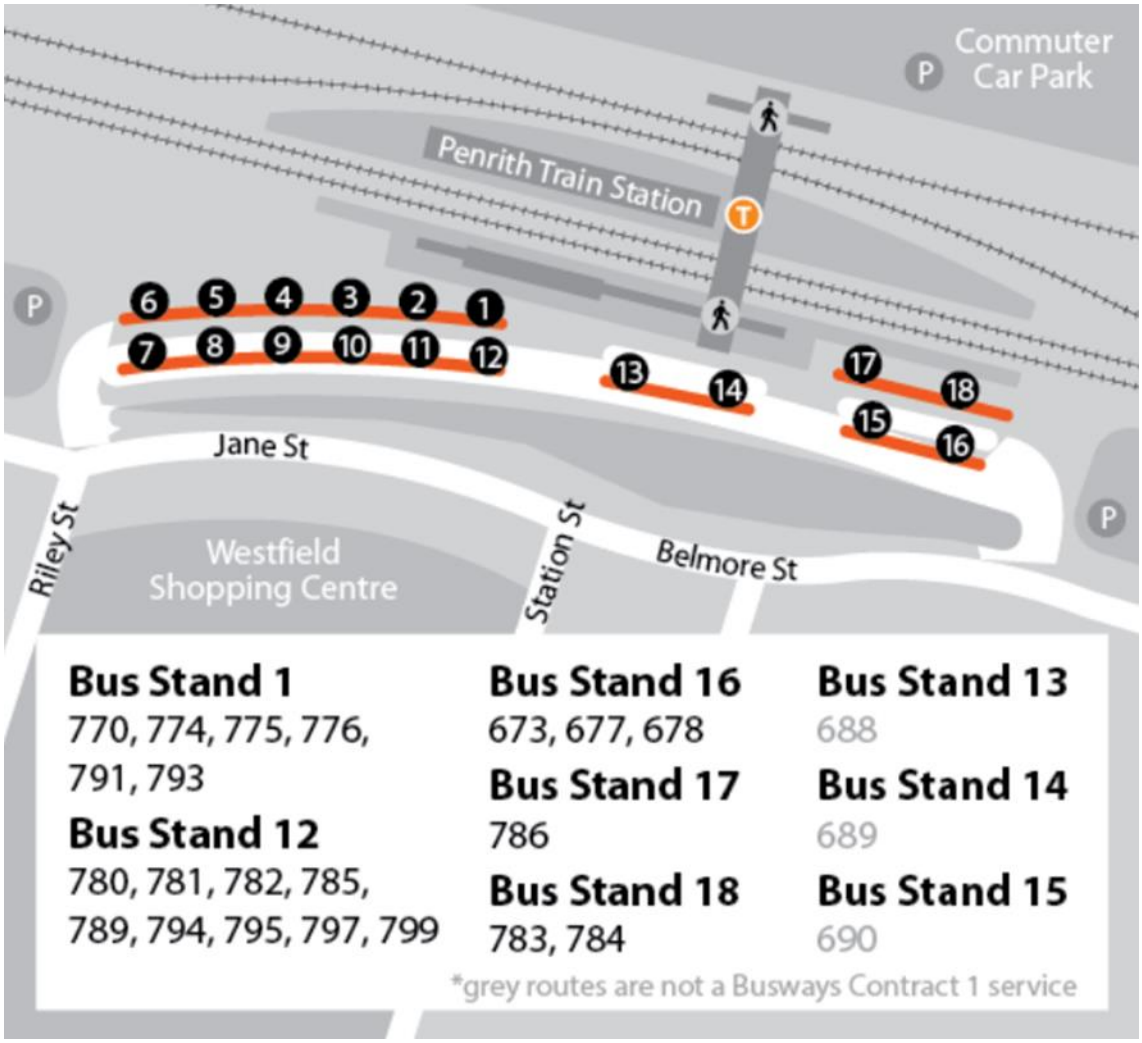
Table 2.3: Bus Routes Servicing Penrith Bus Interchange

Route Number	Route	Peak Arrival/ Departure Frequency
Blue Mountains Bus Co. services		
688	Emu Heights via Emu Plains	30 min
689	Leonay via Emu Plains	30-60 min
690P	Emu Plains/Springwood/Katoomba	60 min
691	Penrith to Mount Riverview	off peak only
Busways services		
673	Windsor to Penrith	30-60 min
677	Richmond to Penrith via Londonderry	60 min
678	Richmond to Penrith via Castlereagh	30-60 min
770	Penrith to Mt Druitt via St Marys	30 min
774	Mt Druitt to Penrith via Oxley Park	30 min
775	Mt Druitt to Penrith via St Clair & Erskine Park	30 min
776	Mt Druitt to Penrith via West St Clair	30 min
780	Mt Druitt to Penrith via Tregear	15 min
781/S13	St Marys to Penrith via Claremont Meadows	60 min
782	Penrith to St Marys via Werrington Downs	30 min
783	Penrith to Jordan Springs	30 min
784	Penrith to Cranebrook return	30 min
785/789	Penrith to Werrington via Cambridge Park	30 min
786	Penrith to Cranebrook return	30 min
791	Penrith to Jamisontown	15 min
793	South Penrith	30 min
795	Warragamba to Penrith	30-60 min
797	Penrith to Glenmore Park return	30 min
799	Penrith to Glenmore Park via Jamisontown	30 min
Nightride services		
N70	Town Hall to Penrith	5 services between 12–4am
	Penrith to Town Hall	6 services between 11pm and 4:30am

Source: Penrith Station Precinct – Station Capacity and Interchange Upgrade Concept Plan Project (AECOM, December 2013).

A diagrammatic layout of the bus interchange, showing route numbers operating from the respective bus stands, is presented in Figure 2.14.

Figure 2.14: Penrith Bus Interchange Layout



Source: www.busways.com.au/blacktown/travelling-with-us/interchange-maps, accessed 24 August 2015.

Bus shelters, lighting and security surveillance are provided at the bus interchange, although seating, both in terms of capacity and design is inadequate. A key issue with the layout of the current bus interchange is that the dispersion of bus stands can potentially confuse customers not familiar with the allocation of bus routes within the interchange. Wayfinding for unfamiliar customers looking for a particular bus route or bus stand is not immediately obvious. Although bus information at the stands is provided, there is a lack of legibility and ease of use in relation to the information being disseminated. There is the likelihood that some customers would need to travel back to the appropriate bus stand after confirming information from other stands.

2.4.4 Bus Interchange Activity

Site observations identified bus congestion at the interchange between 7:30–8am, and between 8:30–9am as it relates to the school peak activities. However, no overflow of buses into Belmore Street–Jane Street was observed at any time during the site visit.

The right turn bay from Belmore Street westbound into the bus interchange at the Riley Street intersection was found to reach its capacity (3 buses) in one instance between 8:30–9am, causing a bus to block westbound through traffic along Belmore Street–Jane Street. Other than

this incident, the signalised bus access to the interchange appeared to be operating within acceptable limits.

It is noted that the interchange is also used by buses for layover activity.

Site observations noted that as the bus interchange is also used by taxis to access the taxi ranks, during busy periods, an overflow of the highly utilised taxis creates a blockage within the interchange. This one-way interchange is shared by buses and taxis, with a common exit point onto Belmore Street. Bus and taxi blockages were observed during both the morning and afternoon peak periods at 7:30am and 4:50pm.

Figure 2.15 shows taxi/ bus interaction at the interchange during a typical busy activity period.

Figure 2.15: Bus/Taxi Interaction during Busy Periods

2.5 Pedestrian Access and Facilities

2.5.1 Pedestrian Facilities

Access to station platforms is provided by a combination of at-grade access and overhead bridges. Penrith Station has three operational platforms. Platforms 1 and 2 are accessible only by the overhead pedestrian bridge, while Platform 3 can also be accessed from ground level on the southern side. The southern access to the station is through Belmore Street adjacent to Station Street and the northern access is adjacent to Lord Sheffield Circuit in the northern plaza (Thornton). The overhead concourse is separated into ticketed and public access sections, separated by a barrier. The overhead bridge access has publicly accessible lift access to the local streets. Separate lifts are provided to access the platforms from within the paid area of the station.

Figure 2.16 shows a view of the existing overhead concourse, with the publicly accessible path to the left (east), and the ticket barriers linking to the paid area, the stairs and lifts to Platforms 1, 2 and 3.

The publicly accessible path is also provided with lifts, allowing easy access for the community across the railway corridor.

Figure 2.16: View of Existing Penrith Station Overhead Concourse

Although the bus interchange experiences lower traffic volumes and speeds compared with the adjacent Belmore Street, specific pedestrian crossing points across bus travel paths are not clearly marked. Site observations noted that there were a number of instances where pedestrians walking between the station entry and Belmore Street were not fully aware of the risks associated with bus movement and activity. This was particularly the case when a large number of school children were loitering around the bus interchange and sitting on the footpath.

Figure 2.17 shows the pedestrian crossing linking the station entry with the western bus interchange, which does not provide adequate legibility to indicate priority.

Figure 2.17: Pedestrian Crossing at Bus Interchange

2.5.2 Pedestrian Activity

GTA Consultants completed sample pedestrian count surveys at the station on 19 August 2015 during the weekday AM and PM peak periods. The survey results indicate that more than 12,800 people access Penrith Station during the AM peak period (6:30-9:30am) and almost 7,000 people during the PM peak period (3–6:30pm).

Surges in school student movements in the interchange were observed at 8:05am, 8:10am, 8:30am and 8:45am in the morning, and at 3pm and 3:30pm in the afternoon (slowly decreasing after that), with no school students observed at Penrith Station precinct after about 4:15pm.

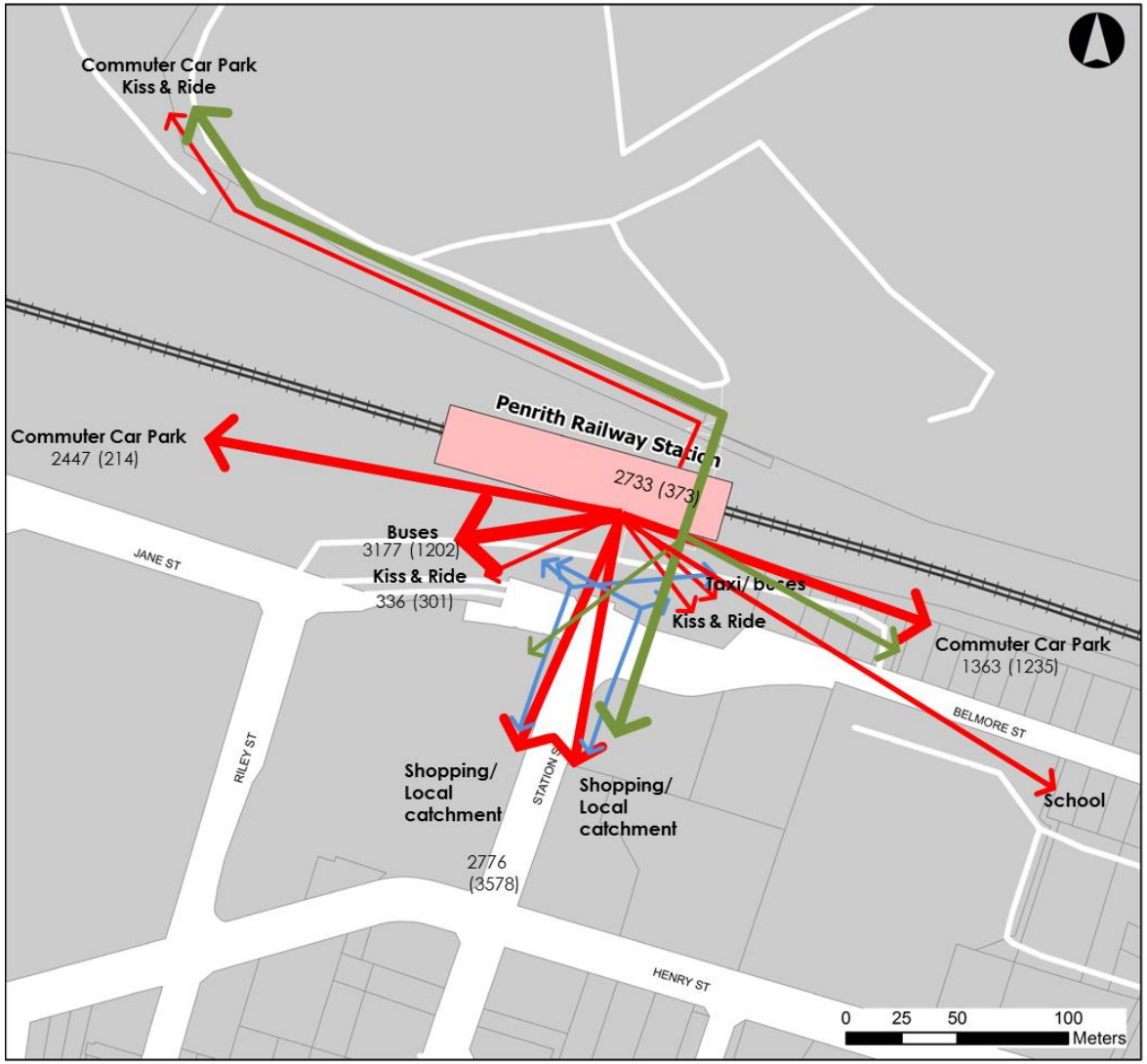
The key desire line for school students walking from/to Penrith Station was between the eastern areas on Belmore Street (towards the eastern commuter car park). For the general community, pedestrian desire lines link the station entry with commuter car parks to the north, east and west, the bus interchange, the taxi rank, kiss and ride and the local catchment of retail, commercial and school uses.

Pedestrian counts undertaken at the interchange indicate the following approximate volumes over the 3.5-hour AM peak period (6–9:30am):

- to/from Jane Street (west): 2,500 pedestrians
- between kiss and ride and station entry: 300 pedestrians
- between buses and the station entry: 3,000 pedestrians
- to/from Station Street: 3,000 pedestrians
- to/from Belmore Street (east): 1,500 pedestrians
- across overhead concourse: 2,700 pedestrians.

Figure 2.18 shows the key pedestrian desire lines at Penrith Station and interchange, indicating the potential conflicts with bus movements through the interchange. Figure 2.19 shows the typical flows during peak school student movements at the interchange.

Figure 2.18: Pedestrian Desire Lines



During the AM peak, pedestrian movements to the interchange generally came from the commuter car parks, Station Street and the bus interchange. PM peak movements were generally lower and more dispersed, with peak flows occurring around the arrival times of the Blue Mountains trains.

Figure 2.19: School Student Peak Flows from Station towards East

2.6 Cyclist Facilities

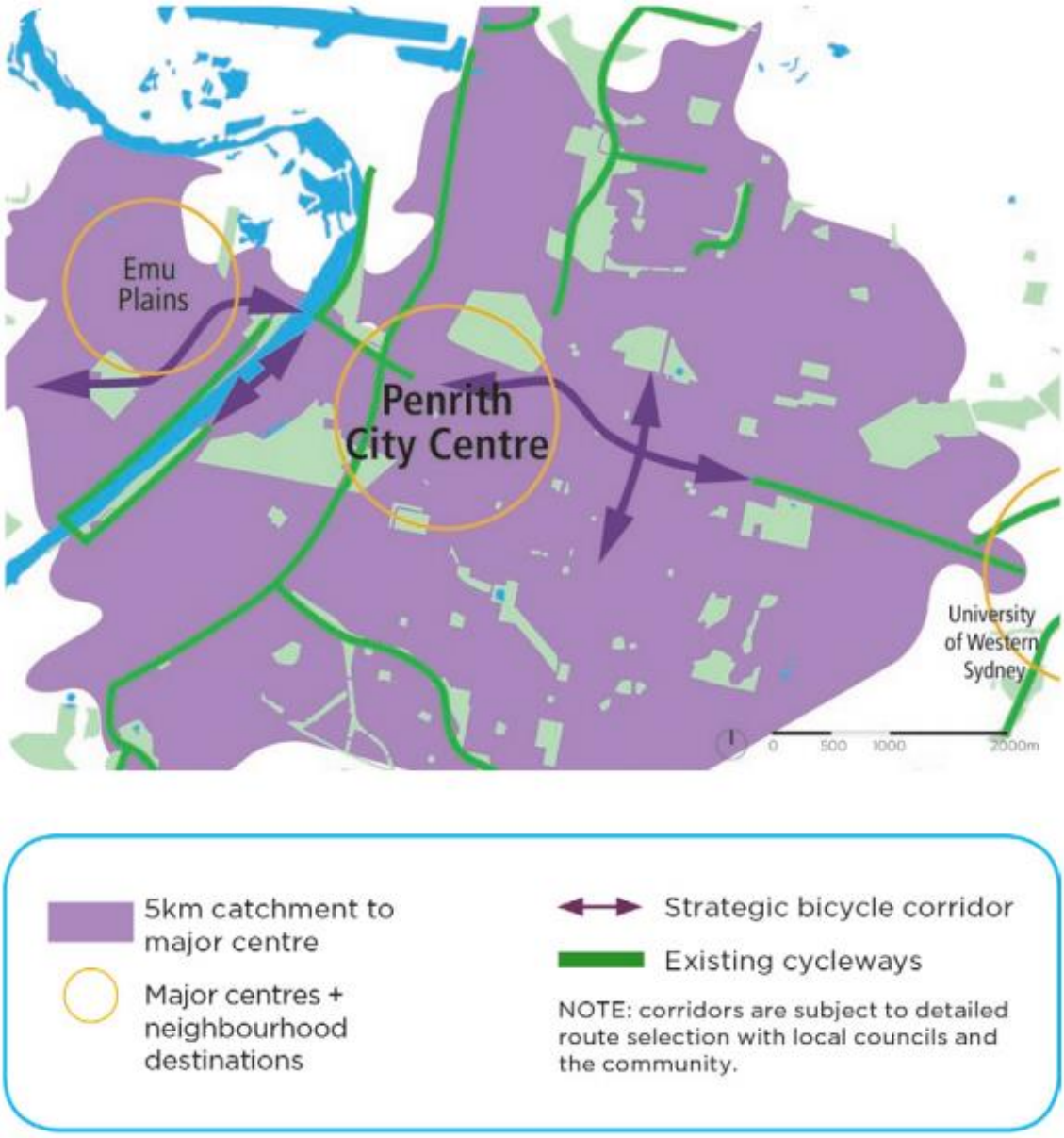
2.6.1 Cycle Routes

There are no designated cycle routes in the immediate vicinity of Penrith Station. The nearest designated cycle route is the on road/shared lane facility along Henry Street, one block to the south of Penrith Station.

However, *Sydney's Cycling Future* (TfNSW, 2013) identifies the need to complete the cycle network within Penrith City Centre, to link with regional cycle routes that would serve the wider Penrith region, including the Nepean River Green Bridge and the Penrith to St Marys corridor along the Great Western Highway (partially completed).

Figure 2.20 shows the priority cycleways proposed for Penrith, as part of *Sydney's Cycling Future* (Transport for NSW, 2013), indicating regional cycling links to Penrith City Centre.

Figure 2.20: Priority Cycleways in Penrith



Source: *Sydney's Cycling Future* (Transport for NSW, 2013).

Notwithstanding the lack of formal cycle route connectivity to interchange precinct, site observations indicate a demand for cycle access for the interchange, as seen in Figure 2.21.

Figure 2.21: Cyclists Exiting Penrith Station

2.6.2 Bicycle Parking

Bicycle parking facilities in the Penrith Station precinct are provided in the form of secure lockers as well racks in the form of public art installations (refer to Figure 2.22). In total, there are currently 63 bicycle parking spaces at Penrith Station.

Bicycle parking racks are located near the stairway landing on the south side of the overhead concourse, as shown in Figure 2.23. Together, these racks on the south side of the station provide capacity for 13 bicycles.

There is also 32 secure bicycle parking lockers located to the south of the interchange (Belmore Street)

On the north side of the station, additional bicycle parking is provided in the form of 8 lockers (on Lord Sheffield Circuit) and 10 inverted U-rails at the multi-storey commuter car park, providing capacity for 20 bicycles.

The TfNSW website for locating bicycle parking lockers[3] indicates that as of 27 August 2015, 12 of the 32 bicycle lockers to the south are still available, while only one of the 8 lockers to the north was still available.

Site observations reveal that bicycle parking facilities are heavily used at Penrith Station. Informal bicycle parking has also been observed at the pedestrian railing adjacent to the kiss and ride zone on Belmore Street.

In May 2015, the Government announced the provision of a bike shed with storage space for 30 bicycles for Penrith Station, as part of the Bike and Ride Initiative, which is identified in *Sydney's Cycling Future* (TfNSW, 2013).

[3] https://appln.transport.nsw.gov.au/bikelockers/faces/jsp/public/findALocker.xhtml#P

Figure 2.22: Bicycle Parking and Public Art

Figure 2.23: Bicycle Parking on the South Side of the Overhead Concourse

2.7 Kiss and Ride

Kiss and ride facilities at the Penrith Station are provided at the following locations:

- a kerbside facility on the northern side of Belmore Street–Jane Street, to the south of the interchange, between Station Street and Riley Street
- an off-street facility to the south of the interchange, operating as a short-stay parking facility during peak periods (6:30–9:30am and 3:30–7:30pm Monday to Saturday). Outside these periods, it functions as an unrestricted carpark.
- kerbside kiss and ride spaces on the interchange side of Lord Sheffield Circuit (two zones separated by a No Stopping zone along the bend in the road).

Informal kiss and ride activity has also been observed within the eastern commuter car park on the southern side of the railway line.

Belmore Street–Jane Street Kerbside Facility

A formal kiss and ride facility about 100 m in length is provided on the southern side of Penrith Station, on the northern side of Belmore Street–Jane Street. This designated kiss and ride zone is located between the traffic signals at Riley Street and Station Street, and provides up to 15 spaces signposted as 1/4 hour (15-minute) time-restricted parking. The site observations reveal that the kiss and ride zone to the south was well utilised during both the weekday AM and PM peak periods. However, while it was able to accommodate most kiss and ride demand, there were a few instances when vehicle demand exceeded available capacity, notably around 7am, 7:40am and 8am, as well as at 3:30pm and 3:45pm. During these instances, vehicle overflow from the kiss and ride facilities tended to obstruct eastbound through traffic flow along Jane Street.

Belmore Street Off-Street Facility

An off-street facility with about 25 spaces and a 15-minute parking restriction between 6:30–9:30am and between 3:30–7:30pm, Monday to Saturday, is provided to the south of the interchange. It can be accessed via a separate driveway from Belmore Street. Egress is via a link joining with the bus interchange/ taxi rank egress to Belmore Street, located about 50 m to the east of the access driveway.

Although not formally designated as a kiss and ride area, the peak period time restriction promotes its use as a kiss and ride facility. Moderate usage was observed during the site visit.

Lord Sheffield Circuit Kerbside Zones

To the north of the interchange, formal kerbside kiss and ride spaces are provided in two locations on Lord Sheffield Circuit, outside the multi-storey car park, with up to 9 spaces on the southern side and up to four spaces on the eastern side. The two zones are separated by a 'No Stopping' zone along the road bend. However, a considerable amount of informal kiss and ride activity was observed during peak periods along this road bend, as it is the preferred location for drop-off and pick-up, being closer to the footpath linking with the northern station plaza.

It is understood that UrbanGrowth NSW intends to provide additional kiss and ride facilities on the northern side of the station to cater for future demand.

Eastern Commuter Car Park

During the site visits for both the AM and PM peak periods, informal kiss and ride activity was observed at the designated accessible parking bays east of the station entrance. Spot counts undertaken identified 15 to 20 vehicles per hour during the 7–10am period. This is due to the close proximity of these accessible parking spaces to the station entry, and the ease of vehicle

manoeuvres at this location compared with the formal kiss and ride zone along Belmore Street. The informal kiss and ride activity in this area provides more convenient access to the station for customers with origins from the east, as the formal kiss and ride facility on the north side of Belmore Street near Riley Street is difficult to access for these customers, requiring them to loop around the city centre to access the kiss and ride zone.

Demand for the use of the accessible spaces and the circulation driveways in the eastern commuter car park as a kiss and ride area was higher when the off-street short-stay parking area adjacent to the taxi rank reached capacity.

In summary, there are a total of 28 formal kiss and ride spaces provided at Penrith Station; 15 to the south and 13 to the north. In addition, a portion of commuter parking areas are also used as informal kiss and ride areas, as well as illegal use of a section of Lord Sheffield Circuit designated as a 'No Stopping' zone.

2.8 Taxi Facilities

There are provisions for taxi set-down/ pick-up activities via three designated taxi zones at the southern end of the interchange, as illustrated in Figure 2.11. The ranks have a combined capacity of about 13 taxis. The head of the rank is located adjacent to the station entry, opposite the convenience/ retail kiosks. A second rank accommodates taxis queuing to access the head rank. A third rank accommodates overflow and is located to the west of the station entry, south of the bus bays, adjacent to Jane Street.

Taxi access and egress is shared with buses, i.e. entry on Jane Street opposite Riley Street, and exit via Belmore Street east of Station Street.

The demand for taxi spaces in the ranks within the interchange were observed to exceed capacity during a few instances between 8–9am, as well as in the evening, during which up to 14 taxis queuing for customers were observed in the interchange.[4]

The taxi zones were also observed to accommodate truck loading activities for the retail tenancies within the station building adjacent to the taxi rank. There is no designated loading zone within the interchange, and the designated car parking is generally occupied during peak loading times.

The loading activity conflicted with taxi activity at times, resulting in the taxi ranks exceeding capacity. In addition to this, a number of NSW Police vehicles were parked in one of the taxi zones (the eastern one adjacent to Belmore Street) during the site visit.

Taxi overflow was noted during the peak periods around 7:30am, 4:30pm and 4:50pm and 7pm (Thursday). With the taxis sharing the bus interchange circulation driveway, the overflow tended to cause congestion in the interchange and delay the movement of some buses, as shown in Figure 2.15.

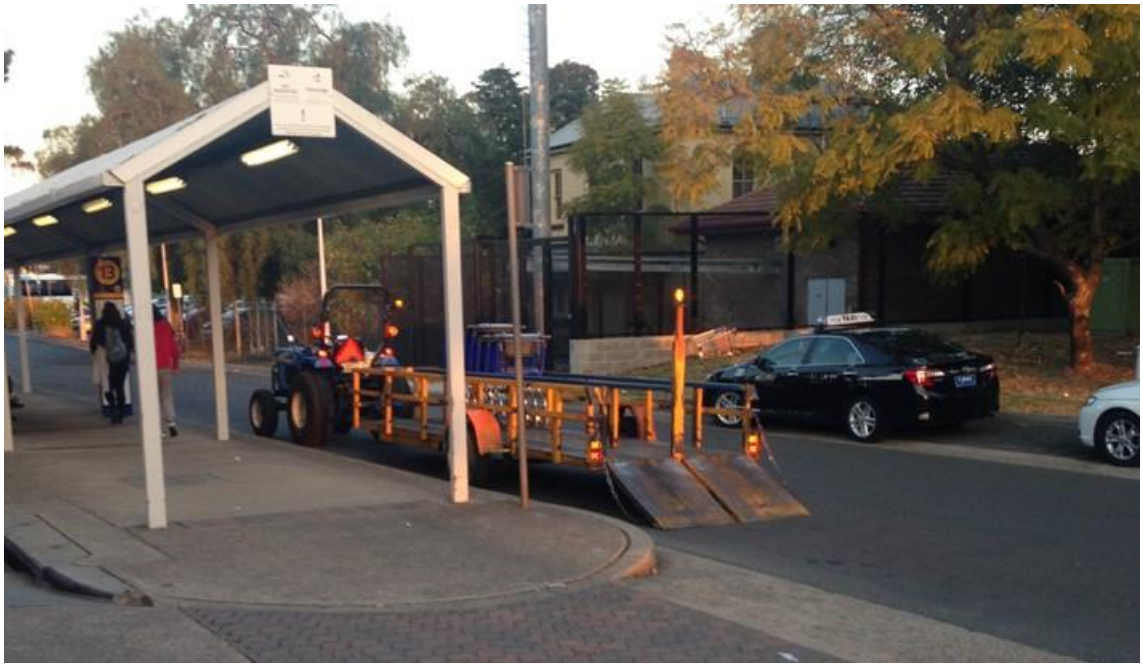
One other observation relating to the taxi areas within the interchange is the proliferation of shopping trolleys, particularly in the afternoons/ evenings, as a number of retail customers presumably take these from Westfield Penrith all the way to the interchange to transfer to taxis. Depending on where they were left, this impeded pedestrian access, especially on the bus

[4] The first two ranks were at capacity, and the overflow was accommodated at the third rank, with taxis progressively moving up the queue as taxis at the head of the rank leave the interchange.

islands. A trolley collection contractor was occasionally observed, with the vehicle and trailer parked in the bus interchange, obstructing bus movements in some instances (see Figure 2.24).

It is noted that there are limited taxi facilities within the retail precinct to the south of the interchange.

Figure 2.24: Trolley Collection Contractor Parked at Bus Bay



2.9 Traffic Volumes

To better understand existing traffic flows and movement patterns, GTA Consultants conducted sample vehicle turning movement counts during the morning and afternoon peak periods at the Belmore Street/ Station Street and the Jane Street/ Riley Street intersections, to the south of the interchange.

The counts indicate that two-way flows along Belmore Street–Jane Street is about 800 vehicles in the AM peak hour and about 1,200 vehicles in the PM peak hour. The turning movement volumes were used to assess operational traffic impacts of the proposed upgrade; in particular the proposed reversal of bus access and egress arrangements. This is presented in Section 4.7 of this report.

Traffic counts undertaken in October 2013 for a previous traffic study as part of the Power Supply Upgrade Program for TfNSW indicate that Jane Street carries approximately 12,100 vehicles per day, west of Riley Street[5].

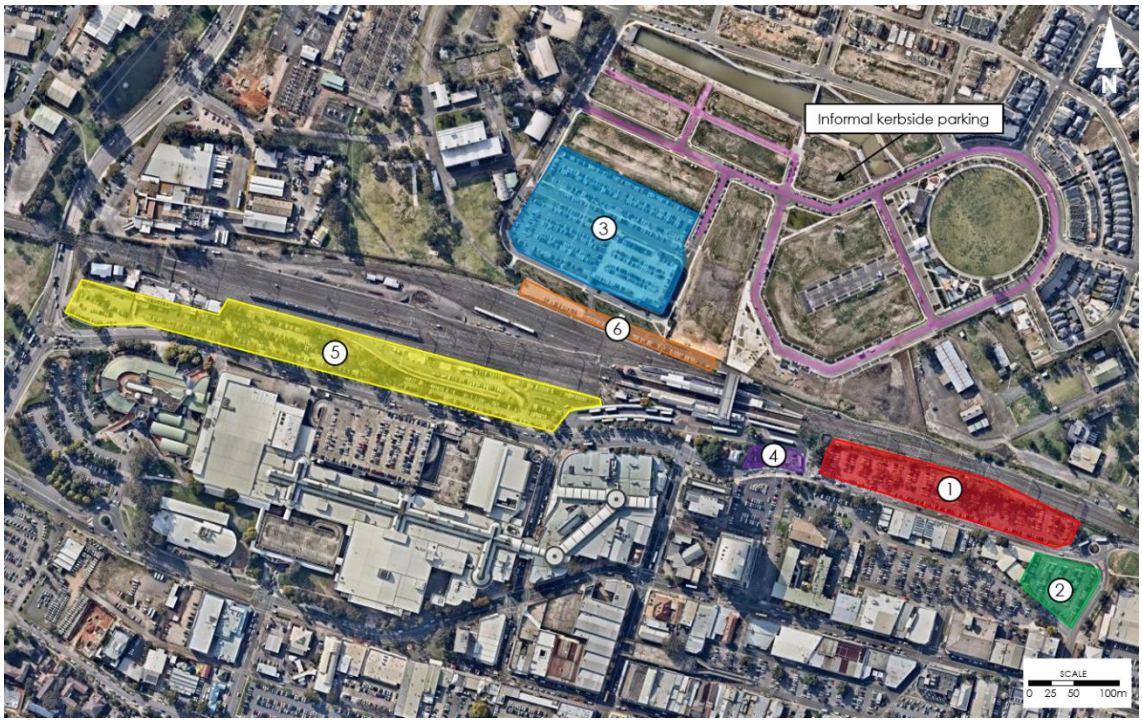
2.10 Commuter Parking Demand

There are a number of major commuter parking areas surrounding Penrith Station. Figure 2.25 shows the areas of designated car parking at the Penrith Station precinct. Existing car parking

[5] http://www.transport.nsw.gov.au/sites/default/files/b2b/projects/PSU_Penrith_REF_Appendix_i-j.pdf

conditions, behaviour and demand were observed during site visits conducted on 19 August 2015 for both the AM and PM peak periods.

Figure 2.25: Penrith Station Precinct – Commuter Car Parks



Basemap source: Nearmap (accessed 25 August 2015).

The following describes each of the car parking areas and the typical usage characteristics observed.

Car Park 1

Car Park 1 is the south east commuter car park, accessed via Belmore Street, with about 347 spaces. This car park requires walking distances to the station ranging from 100–400 m. Pedestrian movements are generally within the car park circulation driveways, as the footpath on the south side of Belmore Street requires two crossings to access the station (with no crossing facilities). The kerb on the north side does not accommodate the minimum footpath widths (further restricted by overhang from parked vehicles).

Car Park 1 was observed to have a high demand. The car park occupancy was at 75 per cent capacity by 6am and fully occupied by 8am. The designated accessible parking bays adjacent to the station entrance were informally used for set-down/ pick-up activities.

Car Park 2

Car Park 2 is the Soper Place car park, accessed via Lawson Street, with about 125 spaces. It entails a 400 m walk to the station. It is operated by Penrith City Council, but with no time restrictions, is predominantly used as a commuter car park.

Car Park 2 had a low demand around 6am but started to increase in demand when Car Park 1 reached capacity. Full capacity was reached by 8:30am.

Car Park 3

Car Park 3 is a combination of both unrestricted at-grade car parking and a multi-storey car park (3 levels) at the northern side of the station, with a total of about 1,000 spaces. It can be

accessed via Coreen Avenue and Lord Sheffield Circuit. Walking from this car park to the station ranges from 100–300 m in distance. All three car parks have footpaths, with varying levels of pedestrian crossings within the car park to access the public footpaths which are oriented towards the station.

The multi-storey car park was observed to be approaching full capacity by 7:30am. The at-grade section of Car Park 3 was at about 50 per cent capacity, although it was noted that commuters preferred to park on-street next to the car park entrance as it is closer to the station facilities. Both the at-grade and multi-storey options were at full capacity by 8am, which resulted in commuters parking within surrounding streets, particularly Lord Sheffield Circuit. A high level of parking occupancy was also observed in surrounding streets by 10:30am.

There are also spaces for 9 motorcycles located beside the 10 bicycle parking racks on the southern footpath of the multi-storey car park.

Observations of motorcycle parking demand on Lord Sheffield Circuit indicate that there is adequate capacity provided, with only up to half of the spaces occupied at the time of the site visits. During one site visit, there were no motorcycles parked at 9am.

Car Park 4

Car Park 4 is the Belmore Street car park previously discussed in the content of kiss and ride activity, with short-stay restrictions (15-minutes) between 6:30–9:30am and 3:30–7:30pm Mondays to Saturdays. Unrestricted parking is available outside of these times. A total of 25 spaces is provided, plus spaces for 7 motorcycles.

Car Park 4 had a low parking demand before 9:30am, predominantly accommodating kiss and ride activity during the restricted parking time period. Full capacity was reached by about 10am.

The demand for motorcycle parking spaces at this car park is sufficiently met by the existing capacity, with no observed overflow demand into the other car parking spaces.

Car Park 5

Car Park 5 is the unrestricted at-grade car park[6] directly west of the interchange, accessed via Jane Street, with about 445 spaces[7], as well as 11 motorcycle parking spaces adjacent to the bus interchange on the eastern end. This car park requires walking distances to the station ranging from 150–700 m. A footpath is provided on the northern side of Jane Street, assisting customers accessing the station.

Car Park 5 was observed to be reaching full capacity by about 7:30am and at capacity by 8:30am. The observations also indicate that demand for the motorcycle parking spaces was low, with only about 2–3 occupied.

Car Park 6

Car Park 6 is the unrestricted at-grade car park directly north of the station, adjacent to the railway corridor. It has capacity for about 47 cars. The capacity was estimated at 80 per cent full by about 6:30am, and at capacity by about 7am.

Other Car Parking

[7] Combined commuter and staff parking

In addition to the designated car parking areas, the kerbside spaces along Lord Sheffield Circuit in the Thornton development to the north were also observed to be used for all-day commuter parking. The capacity varies, as ongoing construction activities within Thornton require closure of some sections of the local road network.

There are several other unrestricted car parks within Penrith City Centre. However, those listed above were the primary locations where commuter parking demand was accommodated.

2.11 Road Safety

Recorded crash data (sourced from RMS) in the vicinity of Penrith Station is presented in Table 2.4. The data includes the most recent 5-year period from July 2009 to July 2014 and indicates that a total of 79 crashes have occurred in the immediate surrounds of Penrith Station. The breakdown of these crashes is as follows:

- 53 crashes occurred on Great Western Highway/ Jane Street/ Belmore Street
- 20 crashes occurred on Henry Street
- 1 crash occurred on Riley Street
- 1 crash occurred on Soper Place
- 3 crashes occurred on Station Street
- 1 crash occurred on Woodriff Street.

The crash statistics are summarised in Table 2.4.

Table 2.4: Crash Statistics Summary

Location	Type of Crash	Number of Crashes
The Great Western Highway/ Jane Street/ Belmore Street	Pedestrian	5
	Head-on	28
	Rear-end/Side-swipe	11
	Entering roadway	5
	Off-path	4
Other Streets	Pedestrian	6
	Intersection	2
	Head on	7
	Rear-end	4
	Entering roadway	2
	Vehicle door	1
	Off-path	4

Further to the above and as discussed within this report, the following safety concerns in the immediate vicinity of the station were identified:

- pedestrian/ vehicle conflicts along Jane Street and Belmore Street, focusing on the Riley Street and Station Street intersections
- pedestrian/ vehicle conflicts at the intersection of Henry Street/ Station Street
- vehicle head-on collisions on Henry Street and along Belmore Street and Jane Street
- rear-end crashes mainly along Belmore Street and Jane Street
- off-path crashes mainly occurring on Station Street and near the Station Street/ Belmore Street intersection outside the Penrith Station main entrance, highlighting a potential pedestrian safety issue.

Figure 2.26 shows the location of recorded crashes in the vicinity of Penrith Station.

Figure 2.26: Crash Locations in the Vicinity of Penrith Station (July 2009- June 2014)

Data source: Roads and Maritime Services.

3. Proposed Station Upgrade

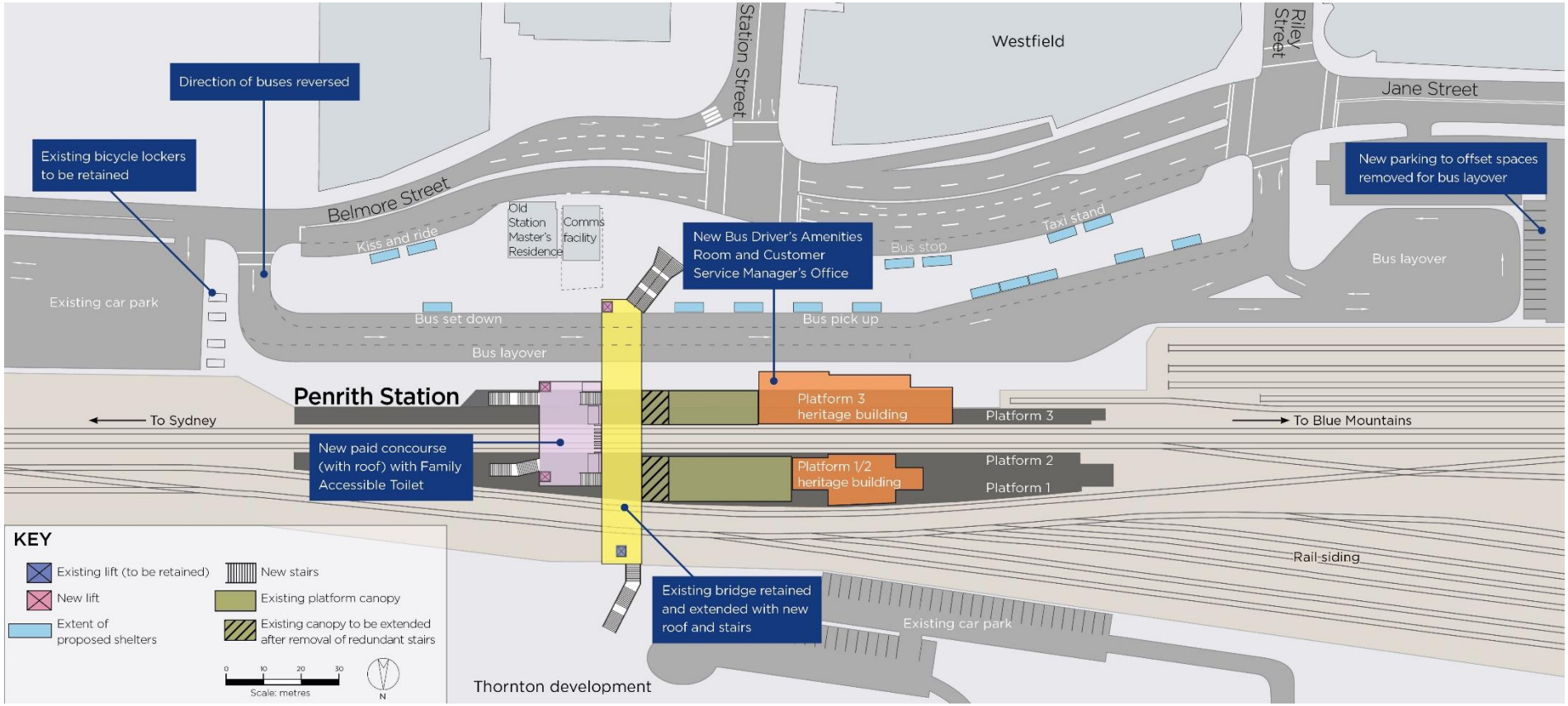
3.1 Overview

The upgrade works at Penrith Station and Interchange includes the following indicative key scope items:

- existing pedestrian footbridge retained for unpaid access across the railway and extended further south
- new stairs on both the northern and southern entrances of the pedestrian footbridge
- new paid concourse accessible from the pedestrian footbridge with relocated ticket gates, new Customer Information Window, Family Accessible Toilet, store room and stairs to platforms
- three replacement lifts to provide access to the platforms/interchange
- new canopies for the existing footbridge and new stairs, lift landings, paid concourse, in addition to replacing platform canopies affected by the works
- reconfiguration of the southern transport interchange which would involve:
    - upgraded bus interchange with reversed traffic flow to include set-down, pick-up and layover spaces for buses, and shelters for weather protection for customers
    - relocated kiss and ride and taxi rank (with shelters) on Belmore Street
    - landscaping, paving and lighting for the interchange and forecourt area
- extension of the south-western commuter car park with approximately 25 spaces (to offset some of the commuter parking removed for the long-term bus layover)
- establishment of a new Bus Driver's Amenities Room and Customer Service Manager's Office in the existing Platform 3 heritage building
- ancillary works including services diversion and/or relocation, alterations to traffic signals, station power supply upgrade, minor drainage works, adjustments to fencing, lighting and seating, improvements to station communication systems with new infrastructure (including lighting, CCTV cameras, Passenger Information Display boards and Opal card readers) and wayfinding signage.

A preliminary layout for the proposed upgrade is shown in Figure 3.1.

Figure 3.1: Penrith Station Upgrade – Indicative Layout



Source: Transport for NSW

3.2 Station Access

The Proposal incorporates access improvements for pedestrians, with customers accessing the station and the platforms via the existing footbridge, which will be upgraded as follows:

- The length of the existing footbridge/ overhead concourse will be extended to the south over the existing bus interchange circulation roadway, with new stairs and lifts provided in an upgraded forecourt area (southern plaza). The existing southern stairs linking with the taxi rank will be removed, as there will no longer be a requirement for them. New stairs will be provided from the extended footbridge to the upgraded southern plaza opposite Station Street.
- The northern end of the footbridge will also be upgraded with the provision of new stairs to the northern plaza in Thornton. The existing lifts will be retained.
- The paid area barrier on the footbridge will be removed, with the entire width being made publicly accessible.
- The extended footbridge will link with a new expanded area to the east to create a new paid concourse. The new ticket barriers will be located within this expanded concourse area, maximising the available concourse capacity for the general public, including Thornton residents accessing Penrith City Centre.
- The new paid concourse will be provided with new lifts and stairs to the east and west, to link with the station platforms.

The existing at-grade access to Platform 3 from the south will no longer be available under normal operating conditions, and will be used only for emergency egress.

3.3 Bus Interchange

The Proposal incorporates upgrading the existing bus interchange to provide a consolidated area for bus facilities and operations (refer Figure 3.1), including:

- Provision for three lanes for buses: a bus stop lane, a bus through movement lane and a bus layover lane.
- The facility will include provision for five (5) pick-up ranks; four (4) within the interchange and one (1) for the Blue Mountains Bus Company on the north side of Belmore Street–Jane Street, west of Station Street (at the head of the existing kiss and ride rank).
- The upgraded bus interchange will also include a set-down zone, breakdown space, four (4) layover spaces, and an area to the west for long term bus layover.

Bus access and flows will be reversed compared with existing, to enable buses to pick up and set down customers next to the new forecourt (southern plaza, currently part of the taxi rank).

3.4 Taxi Rank

A relocated taxi rank with capacity for approximately 8 taxis will be provided at the western end of Belmore Street (refer Figure 3.1).

3.5 Kiss and Ride

The existing kiss and ride facility on the western side of Belmore Street will be converted to a bus set-down/ pick-up area and a taxi rank, and a new kiss and ride zone with approximately seven spaces will be provided on Belmore Street to the east of the old Station Master's Residence,

opposite the existing car park adjacent to the NSW Government office building (refer Figure 3.1 3.1). The existing short-stay parking area will be removed and converted into a landscaped area. The Proposal will reduce available formal kiss and ride capacity to the south of the station by approximately eight spaces.

No changes are proposed to kiss and ride facilities to the north (Lord Sheffield Circuit). However, it is understood that UrbanGrowth NSW, as part of the Thornton development, proposes to provide additional kiss and ride spaces in the northern plaza to cater for future demand.

3.6 Bicycle Parking

The new landscaped areas will provide opportunities for additional bicycle parking facilities on the southern side of the interchange. As discussed in Section 2.6.2, the Bike and Ride Initiative of the NSW Government aims to provide a bicycle shed with capacity for 30 bicycles at Penrith Station.

The design and location of this will be further considered as part of the Bike and Ride Initiative, and would be subject to a separate approval process. However, the design of the Penrith Station Upgrade has considered the potential location for the bike shed and would not preclude this from being installed.

The location and number of the existing bicycle lockers will be retained.

3.7 Commuter Parking

To allow for the upgraded bus interchange, the Proposal would require the removal of the existing short-stay peak period car park to the east of the southern station access (Car Park 4), with 25 car and 7 motorcycle spaces.

The bus interchange upgrade will also require a section of the western commuter car park (Car Park 5) to be reconfigured, resulting in a net loss of about 20 car parking spaces and 11 motorbike parking spaces.

4. Operational Impacts

4.1 Future Station Patronage

Forecast station patronage data provided by TfNSW is presented in Table 4.1. This data indicates that rail patronage at Penrith Station is expected to increase to 26,880 persons per day and 8,096 in an average weekday AM peak period by 2036. This equates to an 80 percent overall increase in passengers per day.

Typically, 15% additional patronage is factored in for design purposes. In this regard, the design patronage for 2036 would be 30,915 for a 24-hour period. This would equate to approximately doubling 2014 patronage levels.

Table 4.1: Forecast Patronage – Penrith Station

	Period in Years				
	2011-2016	2016-2021	2021-2026	2026-2031	2031-2036
Growth	17%	12%	18%	10%	9%
Daily Patronage (at the end of period)	16,965	19,000	22,420	24,665	26,880
AM peak (6–9:30am)	5,553	5,830	6,856	7,490	8,096
24-hour design patronage including additional 15%					30,915
3.5-hour AM peak design patronage including additional 15%					9,310

Source: Transport for NSW, Contract No. TPD-14-4003 – Easy Access / Station Upgrade Projects 2014 (Project 2), Portion 2 (Penrith) – Deed Exhibit B – Works Brief – Appendix A.

The expansion of the station facilities, including an upgraded footbridge/ overhead concourse to service customers and the general public will contribute positively to meeting the growth requirements of Penrith Station.

4.2 Buses

The *Penrith Station Precinct - Station Capacity and Interchange Upgrade* (AECOM, 2013) assessed the future requirements for bus interchange capacity at Penrith Station, based on an analysis of existing timetables, and incorporated the school bus requirements from consultation with bus operators.

The assessment indicated that the maximum number of buses per hour at the bus interchange is about 45, with the proposed appropriation of bus stands as shown in Table 4.2.

Table 4.2: Proposed Bus Stand Allocation

Bus Routes	Proposed Number of Loading Areas
774, 770, 793, 775, 799, 776, 791, 789, S13	2-3
786, 678, 784, 673, 677, 783, 4097, 4021, 4042	2
780, 782, 797, 795, 785, 781, 4075	2
688, 689, 690P, 4094, 4001, 4017, 4019	2

Source: *Penrith Station Precinct - Station Capacity and Interchange* Upgrade Concept Plan Project (AECOM, December 2013)

The following requirements for the bus interchange were recommended in the assessment:

- 5 pick-up ranks with up to 9 loading areas
- potential timetable readjustment (to improve efficiency of bus interchange)

- 2 bus stops to the north (Lord Sheffield Circuit).

The Proposal adequately addresses these forecast bus interchange requirements on the southern side of Penrith Station.

The removal of bus and taxi conflicts with pedestrian flows also positively contributes in providing better opportunities for more efficient bus operations at the interchange.

The change in bus access arrangements and the bus directional flow through the interchange, could potentially have minor impacts on bus travel times as a result of delays at access intersections, arising from the revised turning manoeuvres required. There are also potential difficulties with tighter turning manoeuvres required for bus access and egress.

These potential impacts are expected to balance out, with opportunities for overall travel time savings with the proposal to provide bus priority at the signalised access intersections.

The requirement for two bus stops to the northern plaza, accessed via Lord Sheffield Circuit, will need to be reviewed in-line with future bus plans for the region, and integrated with planning for Thornton. The Proposal does not preclude these bus facilities, should the review indicate that they would be required.

4.3 Pedestrians

The proposed pedestrian facilities, including the extended footbridge/ overhead concourse (with new entrance stairs) that would be used for unpaid public access, along with a new paid concourse area, lifts and stairs to the platforms and new canopies would present pedestrian benefits, particularly in improving accessibility, as well as customer experience and amenity by providing new and upgraded facilities, not only for transport customers, but for the general public. This positively contributes towards making walking a more attractive travel mode choice for Penrith.

Figure 2.18 outlines the existing pedestrian desire lines between the main transport interchange trip generators. The upgrade of the overhead concourse will eliminate several potential conflicts between these pedestrian desire lines and bus and taxi movements through the interchange, resulting in lower road safety risk levels for pedestrians.

The integration of the existing separate paid and unpaid areas within the concourse provides a facility with significantly greater capacity to accommodate future pedestrian flows; also positively contributing to pedestrian circulation and amenity.

It is noted that customers who are currently using Platform 3 will need to traverse two flights of stairs and a corresponding longer walking distance to access the southern station forecourt. However, this negative impact is offset by the improved road safety and reduced potential conflicts with bus and taxi movements through the interchange.

Capacity Assessment

To understand whether there is adequate capacity in the station surrounds to cater for future pedestrian demands with suitable safety and convenience for pedestrians, GTA Consultants followed guidance from RailCorp's *Engineering Standard: Stations and Buildings – Station Design Standard Requirements: ESB 003 – Station Functional Spaces*[8], which requires pedestrian access, queuing and circulation to satisfy "Fruin Level of Service C".

[8] As amended under Asset Standards Authority Technical Note – TN 044: 2015 dated 28 July 2015.

In addressing this, GTA Consultants used Fruin Theory[9] as reproduced in the *'Transit Capacity and Quality of Service Manual – 3nd Edition – Part 10'*[10] which involves evaluating the pedestrian capacity and level of service (LOS) of an area.

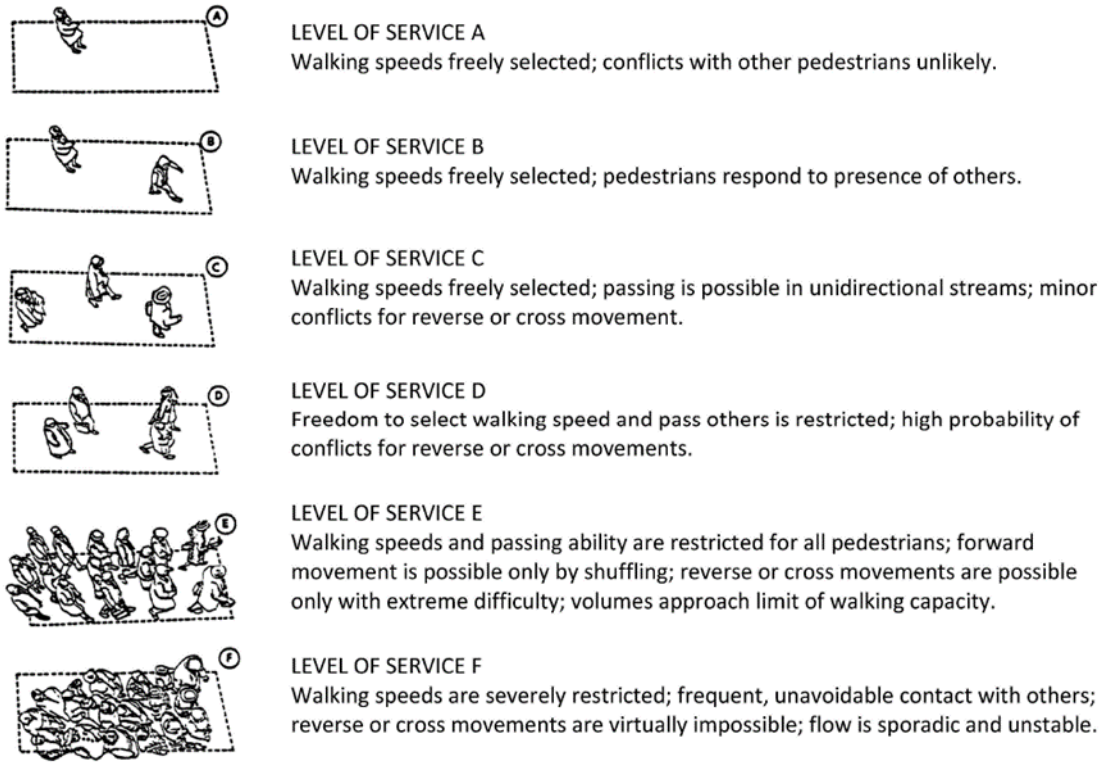
To assess pedestrian Level of Service (LOS), GTA Consultants chose to use the criteria of 'Pedestrian Flow Rate'. Pedestrian flow rate, measured in pedestrians per metre per minute (pmm), is the number of pedestrians that pass a point during a specific period of time for a given level of service, which is a qualitative measure of pedestrian comfort and crowding tolerance level.

Table 4.3 presents the LOS criteria based on 'Pedestrian Flow Rate', while Figure 4.1 presents a graphical representation of the walkway and stairway LOS.

Table 4.3: Pedestrian Level of Service on Walkways and Stairways

Level of Service (LOS)	Walkway Flow per Unit Width (pmm)	Stairway Flow per Unit Width (pmm)
A	0–23	0–16
B	23–33	16–23
C	33–49	23–33
D	49–66	33–43
E	66–82	43–56
F	Variable	56 and greater

Figure 4.1: Illustration of Fruin Theory Walkway Levels of Service



[9] Fruin, John J. 1987 *Pedestrian Planning and Design – Revised Edition*

[10] Transportation Research Board 2013 *Transit Capacity and Quality of Service Manual – 3nd Edition – Part 10*

Source: Transportation Research Board 2013 Transit Capacity and Quality of Service Manual – 3nd Edition – Part 10.

Table 4.4 presents the results of the pedestrian LOS assessment for the proposed expanded overhead concourse at Penrith Station. The assessment was undertaken for the peak 15 minute interval during the study hour. The walkway width used is based on the estimated path width along the extended overhead concourse at the station access points.

Table 4.4: Pedestrian LOS Assessment Overview

Period	Peak Pedestrian Volume (p)		Estimated Nominal Walkway Width (m)	Pedestrian Flow Rate (pmm)	LOS
	(p/ 15min)	(p/ min)			
Existing overhead concourse	75	5	2.0	2.5	A
Existing main access	745	50	-	-	-
Design patronage 2036+15% [1]	820	55	4.0 [2]	14	A

[1] Based on the assumption that all station access and egress will be via the overhead concourse, and a forecast doubling in design station patronage for 2036 including 15%, as detailed Table 4.1.

[2] The upgraded footbridge will have an overall width of 9.165 m. Due to constrictions at the southern end where retail space will be provided, the effective remaining width has been estimated as 4.0 m.

Table 4.4 indicates that, based on existing pedestrian volumes, the pedestrian LOS for the existing overhead concourse is LOS A and operates well over a 15 or 1 minute peak. With the Proposal, the upgrade will provide a wider space to cater to increased movements, and still maintain LOS A operation.

The Proposal also caters for future growth in pedestrian movement to/from the north.

Therefore the proposed 4m pedestrian travel width on the overhead concourse would be adequate to accommodate the expected growth in passenger demand, with no anticipated queuing or delay at this location at any time during a typical week. This would considerably improve pedestrian flows and interaction in and around the station.

Further assessment of potential pinch points undertaken by GHD WestonWilliamson in October 2015 indicates that all pedestrian passageways (stairways, ticket barriers and walkways) will operate at LOS C or better with 2036+15% demand levels during both AM and PM peaks.

4.4 Cyclists

Regional cycle access to the interchange is not expected to be impacted by the Proposal.

It is understood that, as part of the Proposal, the existing 32 bicycle lockers adjacent to the eastern car park will be retained. The existing 13 bicycle racks in the southern plaza would be removed and provided to Penrith City Council.

There would be opportunities for more consolidated and conspicuous bicycle parking facilities in the southern plaza. However, there could be impacts associated with crowding and congestion where facilities are overly concentrated. Pedestrian and cyclist movement and interaction would need to be investigated further during detailed design.

In the interim, the remaining bicycle parking facilities would be sufficient. In the future, the provision of a bike shed as part of a separate program (and a separate approval process) is anticipated to improve the availability and quality of bicycle parking at Penrith Station. It is anticipated that the bike shed will have a capacity for 30 bicycles.

4.5 Taxis

The Proposal requires the relocation of the taxi rank to the north side of Belmore Street–Jane Street, which is currently used as a kiss and ride zone. The current zone can typically accommodate up to 14 vehicle spaces, which corresponds to the current peak period maximum observed queue of taxis at the interchange. However, the Proposal also requires a bus set-down and pick up space to be accommodated within this zone, thereby reducing the available taxi rank capacity to 8 taxis.

A positive impact of this relocation is that the taxi rank will be consolidated into a single rank, compared with the current three zones. This would allow for more efficient taxi operations.

However, the following potential issues have been identified:

- The Proposal reduces the taxi rank capacity at the interchange from 13 (existing) to 8 (proposed).
- The Proposal does not provide capacity for taxi layover, nor identifies any additional space for potential taxi overflow.
- Compared with the existing access arrangement for taxis, the Proposal will constrain taxi access to the rank from the east (e.g. Belmore Street and Station Street). These taxis will need to loop via the Henry Street/ Riley Street intersection to access the rank.
- Potential minor to moderate traffic impacts will result from taxi queues if these exceed the 8-space capacity. The additional taxis queuing would extend to the Jane Street/ Riley Street intersection and potentially impact intersection operation, as well as bus egress from the interchange. The existing configuration allows for additional taxi queuing (more than 13) without significantly impacting on the traffic operation of the Jane Street/ Riley Street intersection (limited to bus operations in the existing interchange).
- The existing retail tenancies that service both taxi drivers and passengers will no longer be located adjacent to the taxi rank. Appropriate signage, weather protection and line-of-sight should mitigate this issue.

It is recommended that further consultation with the NSW Taxi Council and Penrith City Council be undertaken during the next phases of design in order to ascertain the adequacy of the proposed taxi rank capacity and identify any management measures that could be considered to accommodate potential taxi overflow. Investigation into other measures to mitigate the potential taxi overflow issues (e.g. location/s for an alternate/ overflow rank and/or options to increase capacity of the proposed rank) would also need to be undertaken during the next phases of design.

4.6 Kiss and Ride

The Proposal incorporates the relocation of the existing kiss and ride facility from the western end of Belmore Street–Jane Street to a location east of the old Station Master's Residence on Belmore Street. This will reduce the kiss and ride zone capacity from the existing 15 spaces to 7 spaces.

Further, the removal of the existing peak period short-stay car park to the east of the interchange, which is currently also used as a kiss and ride area, will reduce the informal kiss and ride capacity at the interchange.

Site observations indicate that current levels of kiss and ride demand at the existing facility on Belmore Street-Jane Street can reach as high as 20 or more at any given time, particularly around the time of train arrivals in the PM peak. The proposal to reduce the kiss and ride zone capacity

will result in negative impacts, particularly during the PM peak, when typically cars stay longer to pick up passengers (vehicles tend to stay shorter during the AM peak, as these are typically just drop-offs).

To mitigate this reduction in kiss and ride capacity, it is recommended that consideration be made during the next phases of design for a portion of the existing eastern commuter car park to be converted to peak period short stay (15 min) parking (in a similar manner to the existing peak period short-stay parking facility being used as a kiss and ride area). This could potentially be within the area adjacent to the existing accessible car parking spaces and the location of the bicycle lockers.

Informal kiss and ride activity is already currently occurring at this location, as indicated in Figure 2.11. This would reduce commuter parking availability in close proximity to the station. However, the resultant impact would be negligible in the context of the significant overall commuter parking supply.

With regard to kiss and ride capacity to the north, it is understood that UrbanGrowth NSW, as part of the Thornton development, proposes to provide additional kiss and ride spaces in the northern plaza to cater for future demand.

4.7 Traffic Impacts

4.7.1 South Side

Given that the Proposal provides a higher level of station accessibility and usability within the Penrith Station precinct, the improved commuter experience and upgraded facilities are likely to attract greater commuter use. As a result, traffic activity is anticipated to marginally increase, but unlikely to have any significant impact on the surrounding road network.

One key impact the Proposal would have on traffic flows is the revised bus access arrangements.

Currently, the access/egress arrangements of all buses servicing the interchange can be summarised into four main routes:

- access via northbound Riley Street and egress via southbound Station Street
- access via northbound Riley Street and egress via westbound Jane Street
- access via eastbound Jane Street and egress via westbound Jane Street
- access and egress via Station Street.

The revised bus interchange circulation will alter access arrangements and have potential implications on the Belmore Street–Jane Street/ Riley Street intersection and the Belmore Street/Station Street intersection, as shown in Table 4.5, which also presents a summary of the potential impacts of the bus interchange access/ egress changes on the Riley Street and Station Street intersections.

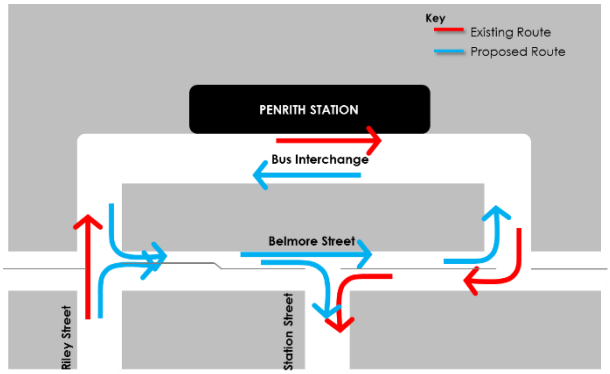
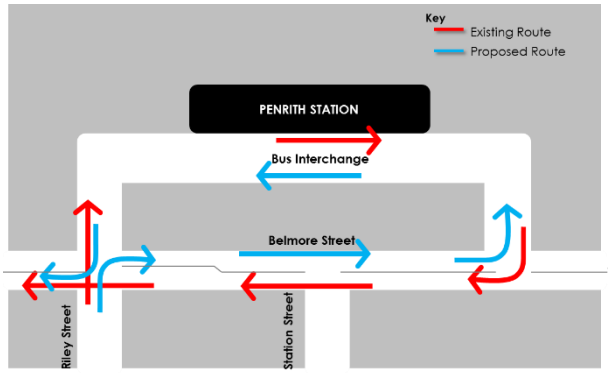
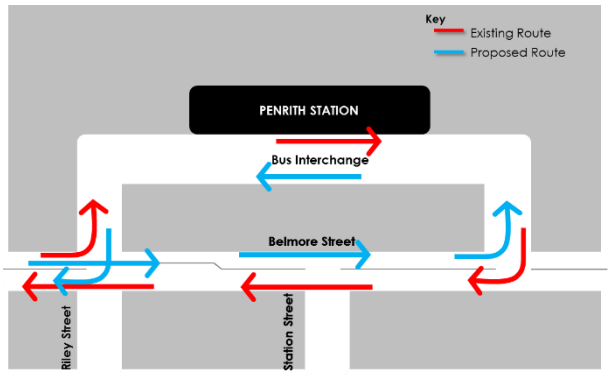
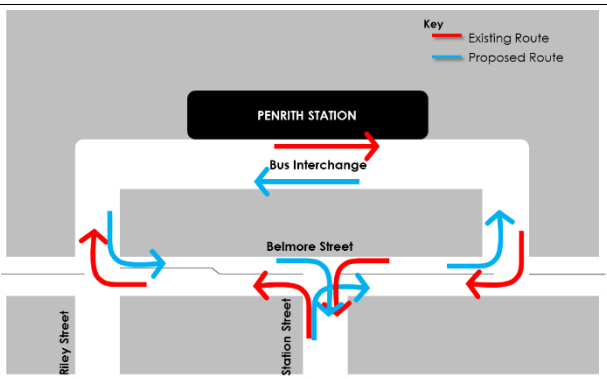
There are several external factors that could further impact traffic flows at these two key intersections. These include potential implications for taxi and kiss and ride activity, other Council proposals in relation to Penrith City Centre, as well as potential regional traffic flow changes resulting from the upgrade of the Jane Street/ Mulgoa Road intersection to the west of the interchange.

However, for purposes of providing a comparative analysis of the potential bus route change impacts, a high-level assessment was undertaken for the Belmore Street/ Station Street and the Jane Street/ Riley Street intersections.

The assessment considered current turning movement volumes through the two intersections, as determined from sample traffic counts undertaken during the AM and PM peak hours in August 2015, as well as estimated peak hour movements for each bus route servicing the interchange, from a review of bus timetables.

Table 4.5 illustrates the changes resulting from the reversal of bus movements through the interchange and summarises the potential traffic impacts that could arise for each group of bus routes.

Table 4.5: Bus Access and Egress Arrangements – Existing vs Proposed

Existing Access/ Egress	Diagram of Existing vs Proposed Access/ Egress	Potential Traffic Impacts
○ Access via northbound Riley Street ○ Egress via southbound Station Street		○ Negligible impacts on Riley Street, as signal phasing would likely be comparable. ○ Potential impacts on Station Street, with increased right turn demand from the interchange.
○ Access via northbound Riley Street ○ Egress via westbound Jane Street		○ Potential impacts on Riley Street, with additional right turn egress phase required. ○ Negligible impacts on Station Street, phasing not impacted.
○ Access via eastbound Jane Street ○ Egress via westbound Jane Street		○ Potential minor impacts on Riley Street, with additional right turn egress phase required. ○ Negligible impacts on Station Street, phasing not impacted.
○ Access and egress via Station Street		○ Potential improvements for Riley Street, with right turn phase from Jane Street potentially removed. The right turn bay could also potentially be removed. ○ Potential impacts on Station Street, with additional right turn demand for both inbound and outbound directions.

Comparative Assessment of Traffic Operations

The operations of the signalised intersections of Belmore Street–Jane Street with Station Street and with Riley Street have been assessed using SIDRA INTERSECTION[11], a computer based modelling package which calculates intersection performance.

The commonly used measure of intersection performance, as defined by the RMS, is vehicle delay. SIDRA INTERSECTION determines the average delay that vehicles encounter and provides a measure of the level of service.

Table 4.6 shows the criteria that SIDRA INTERSECTION adopts in assessing the level of service.

Table 4.6: SIDRA INTERSECTION Level of Service Criteria

Level of Service (LOS)	Average Delay per vehicle (secs/veh)	Traffic Signals, Roundabout	Give Way & Stop Sign
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 required
D	43 to 56	Near capacity	Near capacity, accident study required
E	57 to 70	At capacity, at signals incidents will cause excessive delays	At capacity, requires other control mode
F	Greater than 70	Extra capacity required	Extreme delay, major treatment required

Table 4.7 and Table 4.8 compare the existing operation of the Belmore Street/ Station Street and the Jane Street/ Riley Street intersections with the likely operating conditions under the Proposal. Detailed SIDRA INTERSECTION results are presented in Appendix A of this report.

[11] Program used under license from Akcelik & Associates Pty Ltd.

Table 4.7: Comparison of Belmore Street/ Station Street Intersection Operating Conditions

Leg	Degree of Saturation (DOS)		Average Delay (sec)		95th Percentile Queue (m)		Level of Service (LOS)	
	Existing	Proposed	Existing	Proposed	Existing	Proposed	Existing	Proposed
AM Peak								
Station Street (South)	0.154	0.239	16.4	20.3	12.9	20.5	B	B
Belmore Street (East)	0.268	0.261	18.4	19.8	24.3	23.6	B	B
Jane Street (west)	0.309	0.318	9.0	9.3	42.8	44.2	A	A
Overall	**0.309**	**0.318**	**12.9**	**13.7**	**42.8**	**44.2**	**A**	**A**
PM Peak								
Station Street (South)	0.252	0.224	21.3	22.2	35.7	27.4	B	B
Belmore Street (East)	0.311	0.312	15.6	17.5	46.6	45.5	B	B
Jane Street (west)	0.311	0.319	8.1	8.5	47.7	49.2	A	A
Overall	**0.311**	**0.319**	**13.4**	**14.1**	**47.7**	**49.2**	**A**	**A**

Table 4.8: Comparison of Jane Street/ Riley Street Intersection Operating Conditions

Leg	Degree of Saturation (DOS)		Average Delay (sec)		95th Percentile Queue (m)		Level of Service (LOS)	
	Existing	Proposed	Existing	Proposed	Existing	Proposed	Existing	Proposed
AM Peak								
Riley Street (South)	0.527	0.476	36.1	35.8	32.9	31.8	C	C
Jane Street (East)	0.222	0.307	16.7	24.0	23.1	29.7	B	B
Bus Interchange (North)	-	0.437	-	40.7	-	21.6	-	C
Jane Street (West)	0.550	0.503	26.7	25.4	54.1	51.4	B	B
Overall	**0.550**	**0.503**	**24.7**	**27.5**	**54.1**	**51.4**	**B**	**B**
PM Peak								
Riley Street (South)	0.504	0.490	35.1	34.5	49.1	50.3	C	C
Jane Street (East)	0.262	0.420	18.9	27.6	38.0	48.4	B	B
Bus Interchange (North)	-	0.465	-	45.3	-	26.0	-	D
Jane Street (West)	0.527	0.515	28.7	28.4	62.5	60.9	C	B
Overall	**0.527**	**0.515**	**27.4**	**30.9**	**62.5**	**60.9**	**B**	**C**

On the basis of the above assessment, it can be strategically demonstrated that:

- While the reversal of the bus movements through the interchange as identified in the Proposal would result in marginally longer overall average vehicle delays at the Belmore Street/ Station Street and Jane Street/ Riley Street intersections, both intersections would continue to operate with acceptable levels of service during both the AM and PM peak hours.
- Although the degree of saturation for the Belmore Street/ Station Street intersection would slightly be higher as a result of the new arrangements, it would continue to operate with spare capacity during both peak periods.
- The degree of saturation for the Jane Street/ Riley Street intersection would be lower as a result of the new arrangements, with current bus and taxi queues on the westbound right turn from Jane Street eliminated and any queuing confined within the bus interchange.
- The overall Level of Service for the intersections will generally remain within existing levels, except for the Jane Street/ Riley Street intersection in the PM peak, which will operate from LOS B to LOS C as a result of reversal in bus direction (buses now

approaching intersection and incurring a delay). However, all other intersection approaches remain consistent with existing levels of service.

Based on the above, the reversal of bus interchange movements associated with the Proposal would have minor impacts on traffic flows during the peak periods assessed. Notwithstanding this, it is envisaged that further detailed analysis of intersection operation would be conducted as design development for the Proposal progresses. The analysis would likely address potential reconfiguration options for the Belmore Street/ Station Street and Jane Street/ Riley Street intersections, including changes to the existing Jane Street/ Riley Street right turn bay into the interchange (which would no longer be required), as well as potential signal phasing changes to incorporate bus priority.

Notwithstanding this, the proposed changes will need consent from RMS in accordance with Section 138 of the Roads Act.

4.7.2 North Side

Traffic impacts of the Proposal on the north side of the interchange would primarily be focused on Lord Sheffield Circuit, Sydney Smith Drive, Combewood Avenue, Thornton Drive and Coreen Avenue.

It is not known at this stage how much additional traffic the Proposal will generate on the north side of Penrith Station as a result of the upgrade. However, only minor additional traffic volumes accessing the interchange are anticipated as a result of improvements to the station forecourt. Increased activity on the northern side of Penrith Station will largely be a function of an increasing residential population, with associated park and ride and/or kiss and ride commuter demands. In this regard, the Proposal will have negligible traffic impacts on the north side of the station.

4.8 Parking Demand

The Proposal is not expected to significantly increase commuter car parking demand. However, it is noted that that the proposed improvements would reduce the amount of available car parking and motorcycle parking in Car Park 4.

Further, changes to parking layouts (see Section 3.7) in the western car park (Car Park 5) would result in a net reduction in the number of unrestricted car parking spaces available of about 20 car parking spaces and 11 motorbike parking spaces.

The generally accepted interchange priority principles for access modes, as outlined in *Interchange Places: Design Handbook* (TfNSW, 2012) state:

> *To facilitate convenient transfers onto and between public transport trips, interchanges are strategically designed to promote and support the most efficient and sustainable access modes. This is achieved through general transport interchange access mode priorities. These modes are, in order of priority:*
>
> - *Pedestrian/bicycle*
> - *Train*
> - *Tram*
> - *Bus/ferry*
> - *Kiss and ride (passenger drop-off and pick-up)*
> - *Park and ride (commuter parking for cars and motorcycles).*

While the modal priority principles are based on modes of access to transport interchanges (often vehicles), the priority order for planning interchanges is to address the needs of people – the users of the modes – first.

In this regard, commuter car (and motorcycle) parking (park and ride) could be considered as having the lowest planning priority among the interchange access modes.

While it would be beneficial if an alternate area for displaced commuter parking (including motorcycle parking) could be investigated during the next phases of design, the negative impacts relating to the reduction of commuter parking supply at the interchange of about 20 car parking spaces in the western car park, reduction of short stay parking (25 spaces) and removal of 18 motorcycle parking spaces could be considered acceptable given that it results in increasing capacity and accessibility for other higher priority transport interchange access modes.

4.9 Property Access

The Proposal is not expected to have any impact on existing access to properties in the vicinity of Penrith Station.

Customer access to retail facilities will be improved. While the two existing convenience/ retail spaces at the station will be demolished as part of the Proposal, two new retail tenancies are proposed to be installed in the pedestrian footbridge area, ensuring appropriate facilities continue to be available and accessible for customers.

4.10 Road Safety

The Proposal includes upgrades and improvements to the existing Penrith Station and interchange pedestrian access, in particular reducing the potential conflicts between pedestrian desire lines and bus and taxi movements through the interchange, resulting in lower road safety risk levels for pedestrians.

5. Impacts during Construction

5.1 Construction Activities

5.1.1 Construction Works

As previously identified, the proposed upgrade works at Penrith Station includes the following indicative key scope items:

- existing pedestrian footbridge retained for unpaid access across the railway and extended further south
- new stairs on both the northern and southern entrances of the pedestrian footbridge
- new paid concourse accessible from the pedestrian footbridge with relocated ticket gates, new Customer Information Window, Family Accessible Toilet, store room and stairs to platforms
- three replacement lifts to provide access to the platforms/interchange
- new canopies for the existing footbridge and new stairs, lift landings, paid concourse, in addition to replacing platform canopies affected by the works
- reconfiguration of the southern transport interchange which would involve:
  - upgraded bus interchange with reversed traffic flow to include set-down, pick-up and layover spaces for buses, and shelters for weather protection for customers
  - relocated kiss and ride and taxi rank (with shelters) on Belmore Street
  - landscaping, paving and lighting for the interchange and forecourt area
- extension of the south-western commuter car park with approximately 25 spaces (to offset some of the commuter parking removed for the long-term bus layover)
- establishment of a new Bus Driver's Amenities Room and Customer Service Manager's Office in the existing Platform 3 heritage building
- ancillary works including services diversion and/or relocation, alterations to traffic signals, station power supply upgrade, minor drainage works, adjustments to fencing, lighting and seating, improvements to station communication systems with new infrastructure (including lighting, CCTV cameras, Passenger Information Display boards and Opal card readers) and wayfinding signage.

5.1.2 General Staging Plan

The general approach for the staging of construction activities is that all construction work should not affect levels of service for interchange operations, and must ensure that access for station staff and interchange customers is available throughout station operating hours.

Other construction sequencing requirements include the construction of a fully operational new concourse or temporary concourse prior to decommission of the existing GAC booth, gate array at-grade (on Platform 3) and closure of station entrance from Belmore Street.

The main construction staging area would likely include an area to the north of the station, in the vicinity of the northern plaza. This would be accessed via a temporary road linking with Lord Sheffield Circuit.

5.1.3 Construction Hours

Construction works at Penrith Station are likely to be restricted to the standard hours of construction as follows:

- Mondays–Fridays: 7am–6pm
- Saturdays: 8am–1pm.

No work would generally be undertaken on Sundays and/ or public holidays without prior approval from TfNSW. Should construction activities need to be undertaken outside these hours, advanced notification would typically need to be given to surrounding residents and businesses using standard TfNSW communications procedures. It is anticipated that weekend track possessions would typically occur on three occasions per year, with construction to commence in 2016 for approximately two years.

On this basis, there are expected to be negligible project-specific impacts associated with works undertaken outside these standard hours, including weekend works.

5.2 Construction Vehicle Routes

The surrounding road network is well established and would provide direct access to/ from the site. Figure 5.1 illustrates the likely access routes to be used by construction vehicles to access the Penrith Station construction site, making use of the existing bus interchange facilities. These routes are RMS approved B-double routes and link to the wider State Road network. These routes include:

- Great Western Highway (Jane Street/ Belmore Street)
- M4 Western Motorway
- Mulgoa Road
- Castlereagh Road
- The Northern Road (Route A9).

Locally, the main construction access route to/ from the northern end of the site is proposed via Combewood Avenue, linking with Coreen Avenue and Castlereagh Road. The main construction vehicle access to/ from the southern end of the station is proposed via Belmore Street and Jane Street to link with Mulgoa Road in the west and The Northern Road in the east, as shown in Figure 5.2.

Figure 5.1: Potential Construction Vehicle Routes

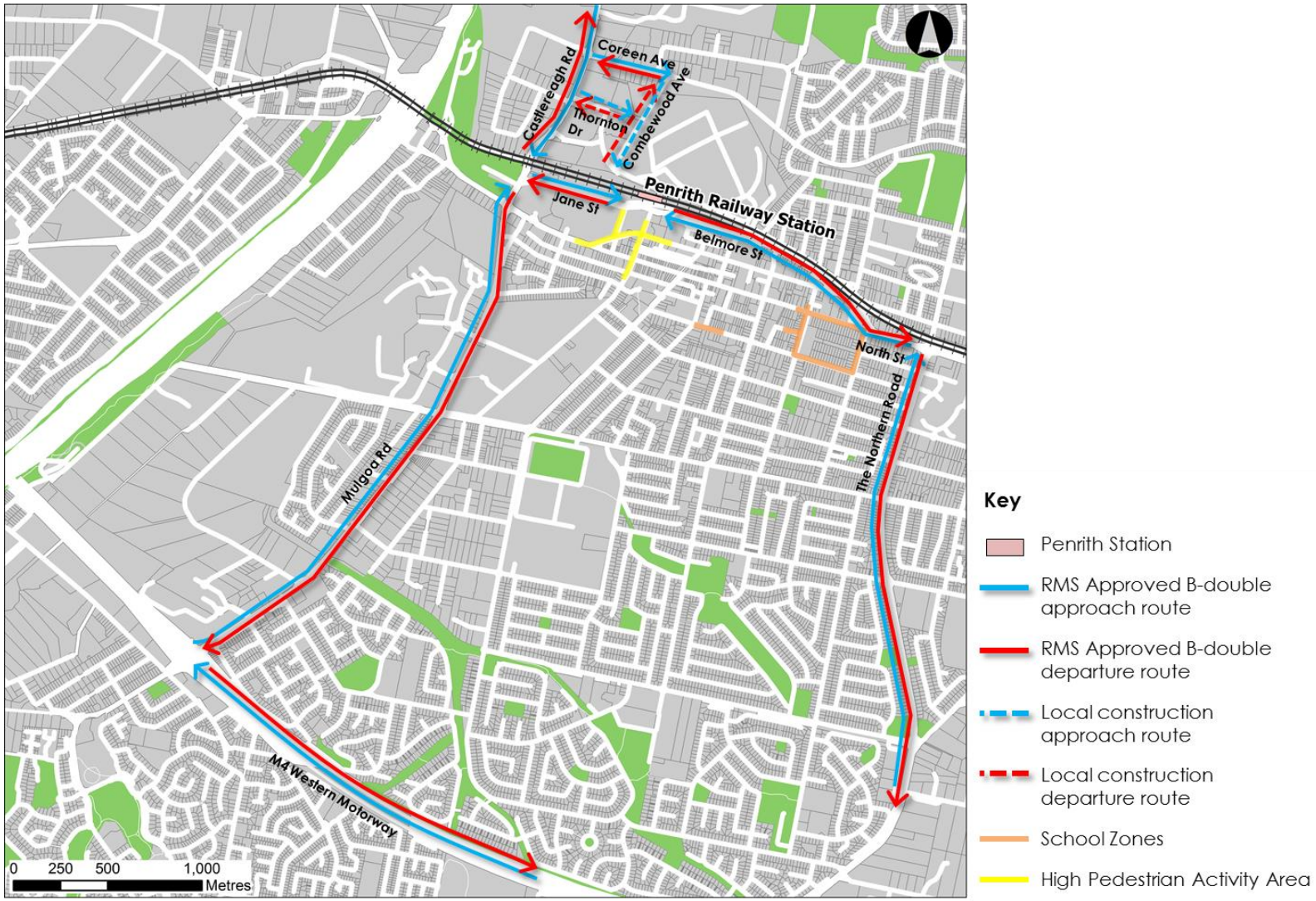
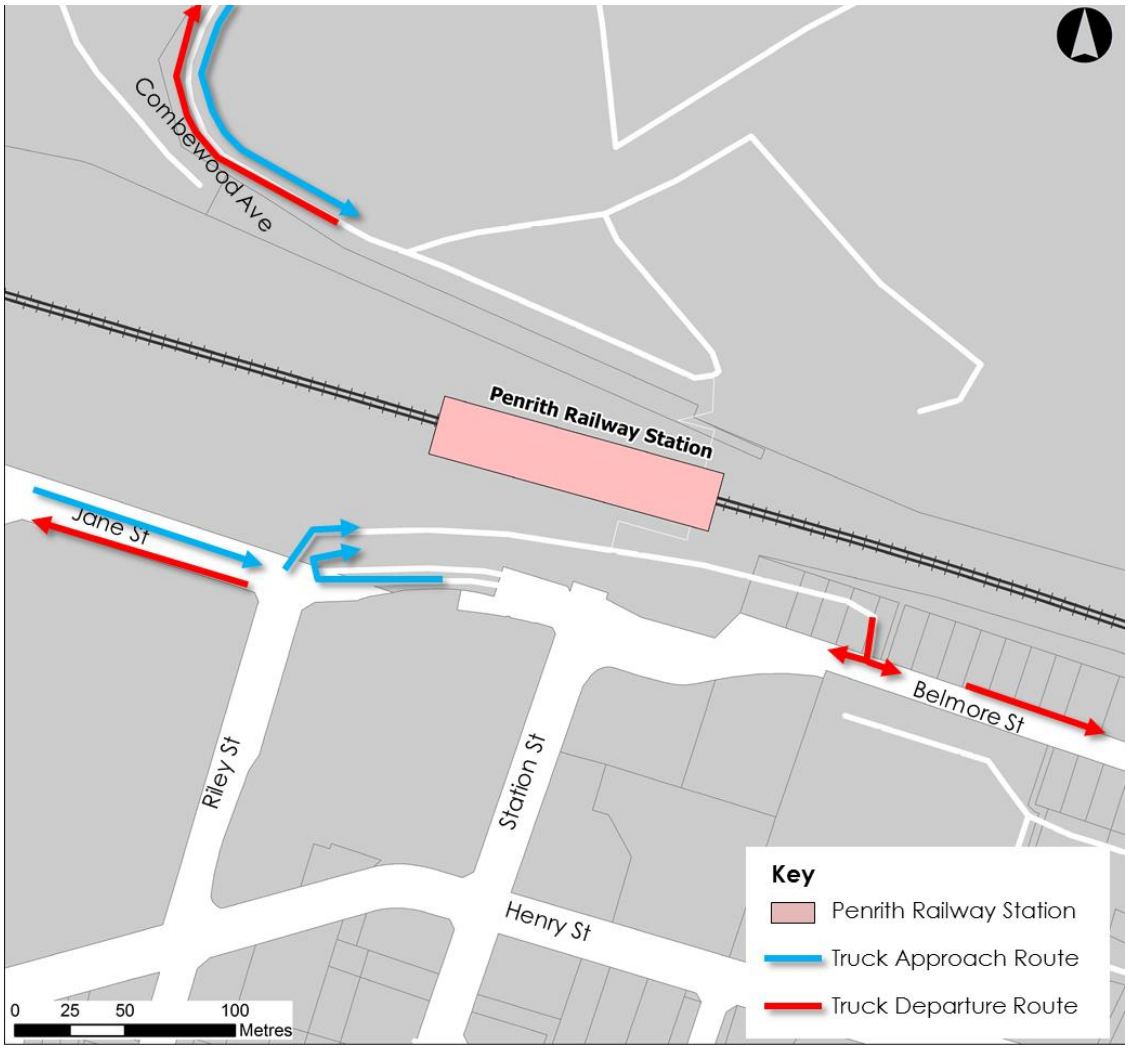


Figure 5.2: Local Construction Vehicle Access/ Egress



5.3 Pedestrian Impacts

The following impacts to pedestrians and customers are anticipated to arise from construction activities:

- potential for increased congestion during peak periods resulting from constrictions on the existing overhead concourse and along walkways in the station forecourt
- the likelihood of longer walking distances resulting from diversions in the bus interchange area associated with interchange works
- potential higher levels of platform congestion, arising from narrower movement areas
- higher road safety risk levels associated with construction vehicle and pedestrian interaction.

These impacts are considered to be manageable, with the Construction Environmental Management Plan to be prepared by the Contractor outlining how these impacts would be specifically managed.

5.4 Traffic Impacts

Traffic generated by construction activities includes construction worker light vehicles (including utility vans), as well as heavy vehicles for periodic delivery and removal of materials. Vehicle types and sizes would vary depending on the required use, but typically include medium and large rigid vehicles and articulated vehicles for import of bulk materials or spoil removal, as well as concrete trucks. The amount of fill material or spoil would be minor as the site is (for the most part) level and paved.

Specific oversize vehicles may be required for precast elements such as spans for the overhead concourse and pre-fabricated sections/structures. Specific permits would be required for such vehicles and therefore addressed separately.

The traffic generated by construction activities would typically involve 4 to 6 movements per day accessing the northern side of the station (for plant and equipment), 6 to 8 movements accessing the southern side of the station, and approximately 18 to 22 movements per day for works in the interchange. There would also be some light vehicle movements for staff/ contractors (about 10 to 12 movements per day). During rail possessions, this is likely to increase to approximately 80 to 92 movements over a weekend possession.

These levels of traffic during construction are expected to be manageable and have limited impacts on existing traffic conditions. Construction site access via the north to the nominated staging area would be via Combewood Avenue from Coreen Avenue or Castlereagh Road–Thornton Drive, to Lord Sheffield Circuit. Access via Sydney Smith Drive through residential land uses in Thornton should be avoided. Interfaces with local traffic movements would also need to be managed in this regard.

Works on classified roads such as Belmore Street–Jane Street will need to be approved by RMS in accordance with Section 138 of the Roads Act. Construction Traffic Management Plans (CTMPs) would need to be prepared for consultation with Penrith City Council and RMS. The CTMPs would need to detail how the interaction between the work sites and street frontages (including traffic and pedestrians) would be managed. Typically, accredited personnel would need to be deployed, particularly during construction activities that require materials and component delivery using oversized vehicles, to ensure safety for all users.

While no known specific restrictions would limit access and/ or the work hours as specified, the CTMPs also need to outline how construction traffic, including traffic associated with works on weekends, would be managed. In particular, potential weekend road closures relating to track possessions need to be identified in the CTMPs and suitable alternative access routes provided, in consultation with RMS and Council.

5.5 Bus Operations

As indicated, details of the proposed construction staging for the project, in particular the construction of the bus and taxi interchange area, are still currently being developed. However, key impacts of construction activities on bus operations may include:

- potential congestion at the bus interchange due to reduced operational and circulation areas for bus access and for passenger set-down and pick-up, as well as the requirement for temporary bus shelters and other customer facilities
- potential access and egress difficulties (turning manoeuvres) for buses, depending on configuration of any temporary bus interchange facilities

- potential for confusion among bus customers as a result of bus interchange operational areas and access arrangements changing from one construction stage to the next
- difficulties during the transition period when the upgraded bus interchange is used with current bus flow arrangements, prior to construction completion.

Depending on construction staging, it is possible that temporary stairs will need to be provided linking the new overhead concourse with temporary bus bays adjacent to the station.

Potential strategies to manage these impacts may include:

- expansion of temporary bus interchange operational areas into proposed landscaped areas
- consideration for direct temporary bus access from Station Street
- provision of traffic marshals to direct and control pedestrian movements across/ through bus interchange construction zones.

5.6 Taxi Operations

The construction of the upgraded bus interchange will require the relocation of the taxi ranks to their end-state location at the western end of Belmore Street. The key impacts would be similar to the impacts during operation, including:

- Potential traffic impacts of taxi queues longer than the allowed capacity of 8 vehicles. Should taxi queues exceed the taxi rank capacity, additional taxis queuing could extend to the Riley Street/Jane Street intersection and potentially impact intersection operation. The existing configuration allows for additional taxi queuing without significantly impacting on intersection operation. Appropriate management measures could address this and would need to be developed in consultation with the NSW Taxi Council and Penrith City Council during the next stages of design.
- Taxi access to the rank from Station Street will be constrained. Taxis accessing the rank from the south will need to do so via Riley Street.

Overall, the impacts of construction activities on taxi operations are considered manageable with the relocation of the taxi rank to the existing kiss and ride rank on Belmore Street–Jane Street, subject to appropriate taxi rank queue management systems being put in place.

5.7 Kiss and Ride Activity

The construction activities and staging will displace existing kiss and ride activity from the current locations on Belmore Street-Jane Street and the time-restricted short-stay car park to the east of the Station Master's Residence.

Potential mitigation measures to manage impacts on kiss and ride activity may include:

- designation of a portion of the existing eastern commuter car park as time-restricted short-stay car parking (noting impacts on commuter parking)
- temporarily designating a portion of Station Street (either northbound or southbound) as a peak period kiss and ride zone
- temporarily designating the Belmore Street car park adjacent to the NSW State Government Building as a time-restricted short-stay car park (particularly during peak periods).

Safe and convenient pedestrian paths will need to be provided between any temporary kiss and ride zones and the main station entry (south) during the construction period. There may be

instances during peak periods where traffic marshals are required to assist customers, particularly pedestrians crossing the Belmore Street/ Station Street intersection.

5.8 Commuter Parking

The details for the interchange and station construction staging are not defined at this stage. Current information indicates that the key parking areas likely to be impacted are limited to:

- the existing time-restricted short-stay car parking area adjacent to the existing taxi rank (Car Park 4), with 25 car spaces and 7 motorcycle spaces
- the unrestricted at-grade car park directly north of the interchange adjacent to the railway corridor (Car Park 6), with 47 spaces
- the western car park (Car Park 5), which would result in a net loss of 20 parking spaces required for the establishment of the long term bus layover. Approximately 45 spaces would be impacted, but the replacement spaces for approximately 25 vehicles would be established prior to the removal of the existing parking spaces to reduce parking impacts.

During various stages of construction, a portion of these affected car parks will be used as construction compounds, and would not be available.

The anticipated parking impacts associated with construction will be a minor overspill of commuter parking and staff parking demand to other areas, while sections of existing commuter car parking areas are closed for construction activities (e.g. short-stay and motorcycle parking), and construction staff in light vehicles increasing long-stay parking demand. This would impact on existing parking spaces within the town centre and potentially within residential streets in Thornton as well.

The objectives for maintaining appropriate levels of customer service, in particular relating to bus and taxi operations, may require the temporary conversion of other commuter car parking areas for bus and/or taxi operations, which would further decrease available commuter parking.

Strategies that could assist in mitigating parking impacts include:

- car pooling for construction staff
- providing for safe pedestrian access between car parking areas and the station entry at all times
- potential conversion of a portion of time-restricted parking areas in the Penrith CBD to unrestricted parking (in discussion with Penrith City Council)
- operation of an off-site commuter car parking area with a shuttle bus link to the station
- temporary conversion of additional areas in Thornton for commuter car parking
- customer car pooling
- advanced prior notice if any temporary public car parking loss is required during the construction activity.

5.9 Property Access

The construction of the Proposal is anticipated to have access impacts on the railway corridor, potentially affecting Sydney Trains maintenance and operations activities.

No other impacts to property access are expected during the construction of the Proposal.

5.10 Other Recommended Mitigation Measures

Notwithstanding the impacts of construction on traffic, transport and access of the surrounding network, a Traffic Control Plan (TCP) would likely need to be prepared and submitted to the RMS and/ or Council to appropriately manage the use of the designated construction routes and site interfaces.

As part of implementation of the TCP, standard signage warning approaching vehicles of the construction activity and heavy vehicle movements should be installed. This should include static signage to be in-place in advance of the works. Other possible mitigation measures to minimise traffic impacts during construction of the station upgrade generally include:

- Appropriate traffic management, including static signs, manual traffic control and provision of temporary barriers to control the proposed work areas and minimise delays.
- Establishment of safe access points to work areas from the adjacent road network including safety measures such as barriers and warnings to pedestrians, maintaining sight distance requirements and signage and the provision of traffic management measures such as those identified above.
- Use of traffic controllers to negotiate pedestrian and construction vehicle priority and access, if required.

The TCP should also outline how potential construction vehicle manoeuvres could be accommodated in and out of the construction sites. In addition, swept path analysis should be conducted to ensure that the largest required vehicle can turn in and out of the work sites.

A standard work zone speed limit of 40 km/h will need to be implemented in the vicinity of the interchange, including along Belmore Street-Jane Street between Lawson Street and the Westfield Car Park entry intersection, along Station Street between Belmore Street and Henry Street, and along Lord Sheffield Circuit.

5.10.1 Worker Induction

All workers and subcontractors engaged on-site would be required to undergo a site induction. The induction should include permitted access routes to and from the construction site for all vehicles, as well as standard environmental, WHS, driver protocols and emergency procedures.

Any workers required to undertake works or traffic control within the public domain would be suitably trained and covered by adequate and appropriate insurances. All traffic control personnel would be required to hold RMS accreditation in accordance with Section 8 of Traffic Control at Work Sites.

5.10.2 Construction Traffic Management

A Construction Traffic Management Plan would be required to be prepared and submitted to Council's Local Traffic Committee and/or Roads and Maritime / Transport Management Centre (TMC). The plan should include a description of:

- Final construction traffic approach and departure routes.
- Locations of access to and from the local road network.
- Details of construction signage and traffic controllers.

Appendix A

SIDRA INTERSECTION Outputs

Appendix available on request to TfNSW.

Melbourne

A Level 25, 55 Collins Street
PO Box 24055
MELBOURNE VIC 3000
P +613 9851 9600
E melbourne@gta.com.au

Brisbane

A Level 4, 283 Elizabeth Street
BRISBANE QLD 4000
GPO Box 115
BRISBANE QLD 4001
P +617 3113 5000
E brisbane@gta.com.au

Adelaide

A Suite 4, Level 1, 136 The Parade
PO Box 3421
NORWOOD SA 5067
P +618 8334 3600
E adelaide@gta.com.au

Townsville

A Level 1, 25 Sturt Street
PO Box 1064
TOWNSVILLE QLD 4810
P +617 4722 2765
E townsville@gta.com.au

Sydney

A Level 6, 15 Help Street
CHATSWOOD NSW 2067
PO Box 5254
WEST CHATSWOOD NSW 1515
P +612 8448 1800
E sydney@gta.com.au

Canberra

A Tower A, Level 5,
7 London Circuit
Canberra ACT 2600
P +612 6243 4826
E canberra@gta.com.au

Gold Coast

A Level 9, Corporate Centre 2
Box 37, 1 Corporate Court
BUNDALL QLD 4217
P +617 5510 4800
F +617 5510 4814
E goldcoast@gta.com.au

Perth

A Level 27, 44 St Georges Terrace
PERTH WA 6000
P +618 6361 4634
E perth@gta.com.au