

Blacktown City Council
**Riverstone Town Centre
Masterplan**
Transport Assessment

Rev C | 13 October 2020

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1 Introduction

1.1 Study Appreciation

The Riverstone town centre is situated within the Riverstone Precinct – one of the first release precincts of the North West Growth Area (NWGA). The town centre is supported by Riverstone railway station which functions as the primary public transport hub serving the area. Road connectivity to the centre is focused along the Garfield Road East corridor, however high traffic volumes (including large proportion of heavy vehicle movements) along this route act as a major barrier to pedestrian and cycle movements. Noise and exhaust fumes generated by heavy vehicles along Garfield Road East significantly detracts from the town centre environment.

Arup has been engaged to provide transport planning services to support the development of a Masterplan for the Riverstone town centre. It is envisaged that the Masterplan will create a thriving, economically viable, well designed and safe town centre.

1.2 Study Objectives

Given that the Riverstone precinct could accommodate up to an additional 30,000 residents in the coming years, it will be important that the traffic impacts arising from this growth are properly considered. A transport network must be developed which supports the overall objectives of the town centre Masterplan. Specific objectives of the study will be to:

- Identify existing transport infrastructure and traffic and transport trends;
- Consider the current function of the transport network including local and arterial roads, public transport services, car parking, pedestrian networks and cycling routes;
- Identify any improvements to the transport network that are necessary to implement the recommendations of the town centre Masterplan; and
- Identify future transport needs to manage growth within the area

1.3 Study Area

The Riverstone Town Centre is located approximately 15 km north of Blacktown and 50 km northwest of the Sydney CBD, wholly within the Blacktown Local Government Area (LGA). The study area is located adjacent to the Richmond railway line – generally within a 400m radius east of Riverstone train station. The study areas is illustrated in Figure 1 and is bounded by King Street, Piccadilly Street, Elizabeth Street and the Richmond Railway Line.

The Town Centre comprises of business zoned land fronting Garfield Road East, the Council owned Marketown Shopping Centre, a range of community services and recreation uses, as well as low density residential housing. There are a number of heritage listed buildings within the Town Centre.

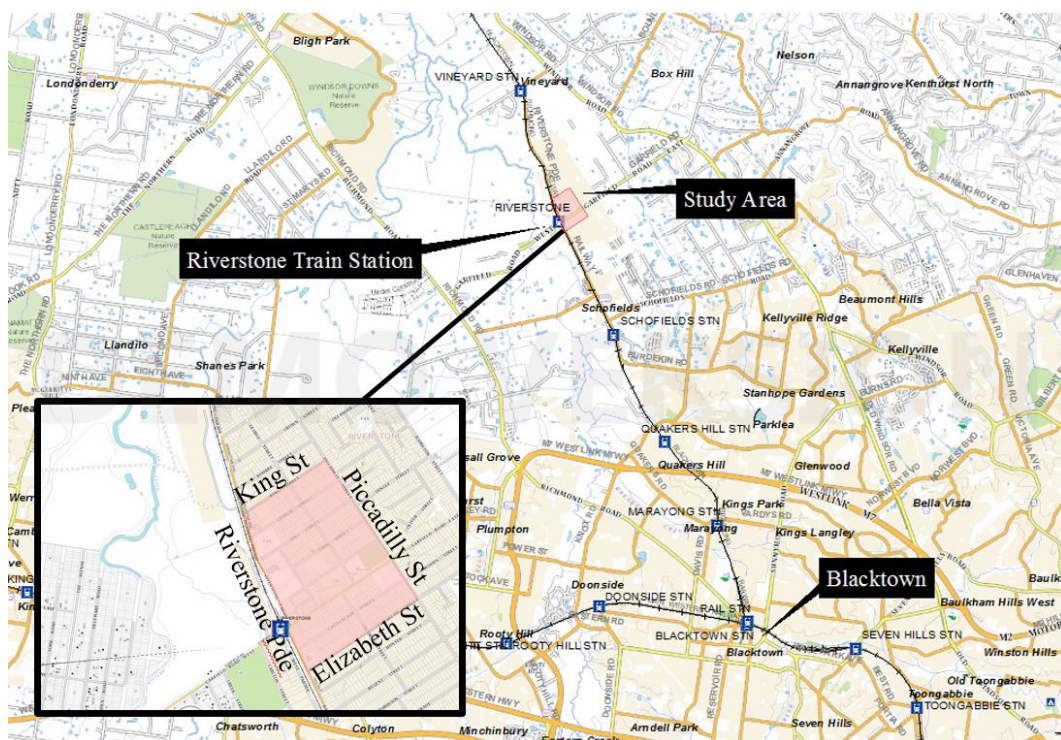


Figure 1 Study area

2 Planning Context

2.1 North West Growth Area

The NWGA comprises of 16 precincts. It is approximately 10,000 hectares and is expected to contain around 90,000 new dwellings for 250,000 people over the next 25-30 years. 11 of the 16 precincts have been rezoned for development, those being:

- North Kellyville
- Alex Avenue
- Riverstone
- Riverstone West
- Colebee
- Area 20
- Marsden Park Industrial
- Schofields
- Box Hill
- Box Hill Industrial
- Marsden Park

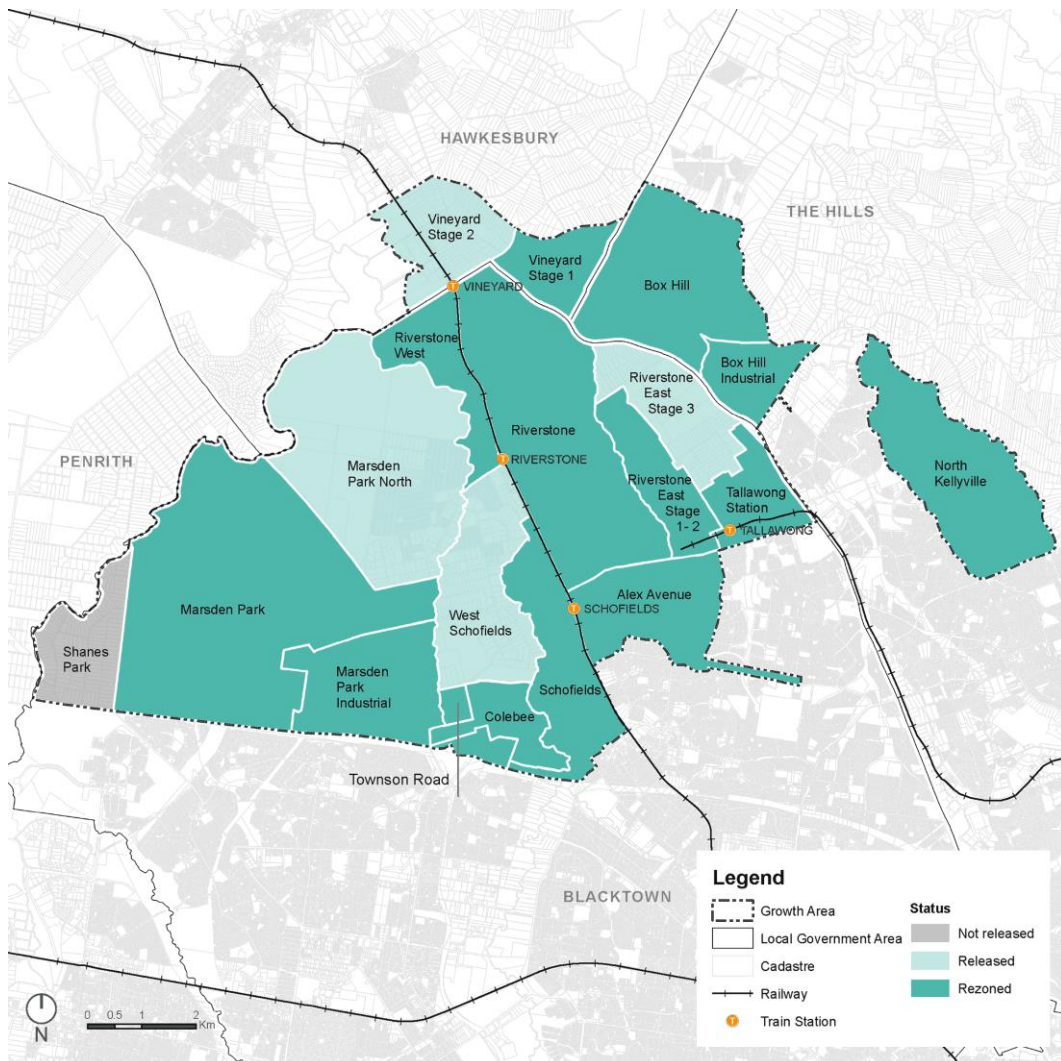


Figure 2 North West Growth Area

The NWGA spans three local government areas (LGA) – Blacktown, Hawkesbury and The Hills Shire. The NWGA is undergoing a streamlined planning process to enable land to be rezoned in a shorter period. Figure 3 illustrates the current North West Land Use and Infrastructure Plan.

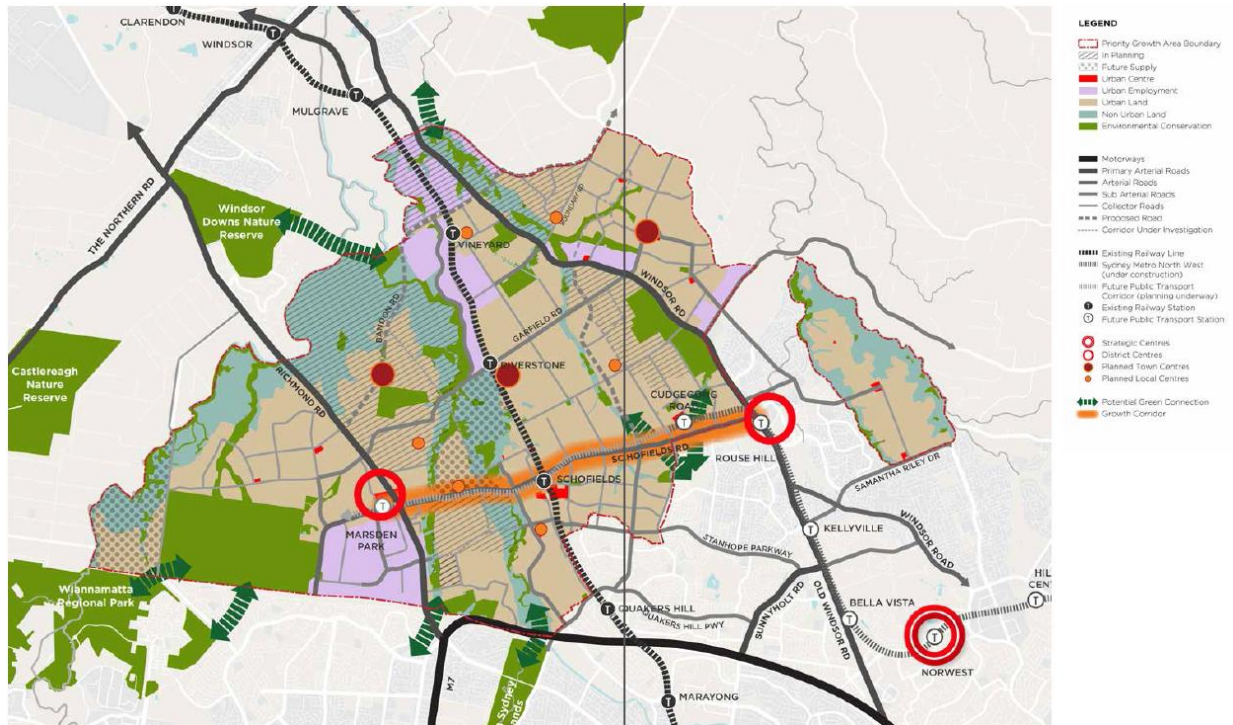


Figure 3 North West Growth Area Structure Plan

2.2 Planning Objectives

A range of existing planning documents have been reviewed to understand the key planning objectives already identified for the study area. These documents are listed below highlighting the relevant objectives that have provided direction for the outcomes of this study.

1. Greater Sydney Region Plan – Directions

- D1: A city supported by Infrastructure – Infrastructure supporting new developments
- D5: A city of great places – Designing places for people
- D6: A well connected city – Developing a more accessible and walkable city
- D7: Jobs and skills for the city – Creating the conditions for a stronger economy

2. Central City District Plan – Planning Priorities

- C1 Planning for a city supported by infrastructure
- C3 Providing services and social infrastructure to meet people's changing needs

- C4 Fostering healthy, creative, culturally rich and socially connected communities
- C5 Providing housing supply, choice and affordability with access to jobs, services and public transport
- C9 Delivering integrated land use and transport planning and a 30-minute city

3. Blacktown LSPS – Local Planning Priorities

- LPP1: Planning for a city supported by infrastructure
- LPP5: Providing housing supply, choice and affordability with access to jobs, services and public transport
- LPP6: Creating and renewing great places and centres.
- LPP7: Delivering integrated land use and transport planning and a 30-minute city

4. Our Blacktown 2036 – Strategic Directions

- SD2: A clean, sustainable and healthy environment
- SD3: A smart and prosperous economy
- SD4: A growing city supported by accessible infrastructure
- SD5: A sporting and active city

2.3 Riverstone Release Precinct

The Riverstone Precinct was one of the first release precincts of the North West Growth Centre, rezoned for development in May 2010. It is bounded by Bandon Road to the north, Schofields Road to the south, the Richmond Rail Line to the west and First Ponds Creek and Windsor Road to the east.

The precinct plan allows for up to an additional 9,000 dwellings accommodating an additional 27,000 people. The final indicative layout plan for the rezoning of Riverstone is shown in Figure 4.

Importantly no changes to the zoning of the Riverstone Town Centre were made as part of the release of the wider precinct.

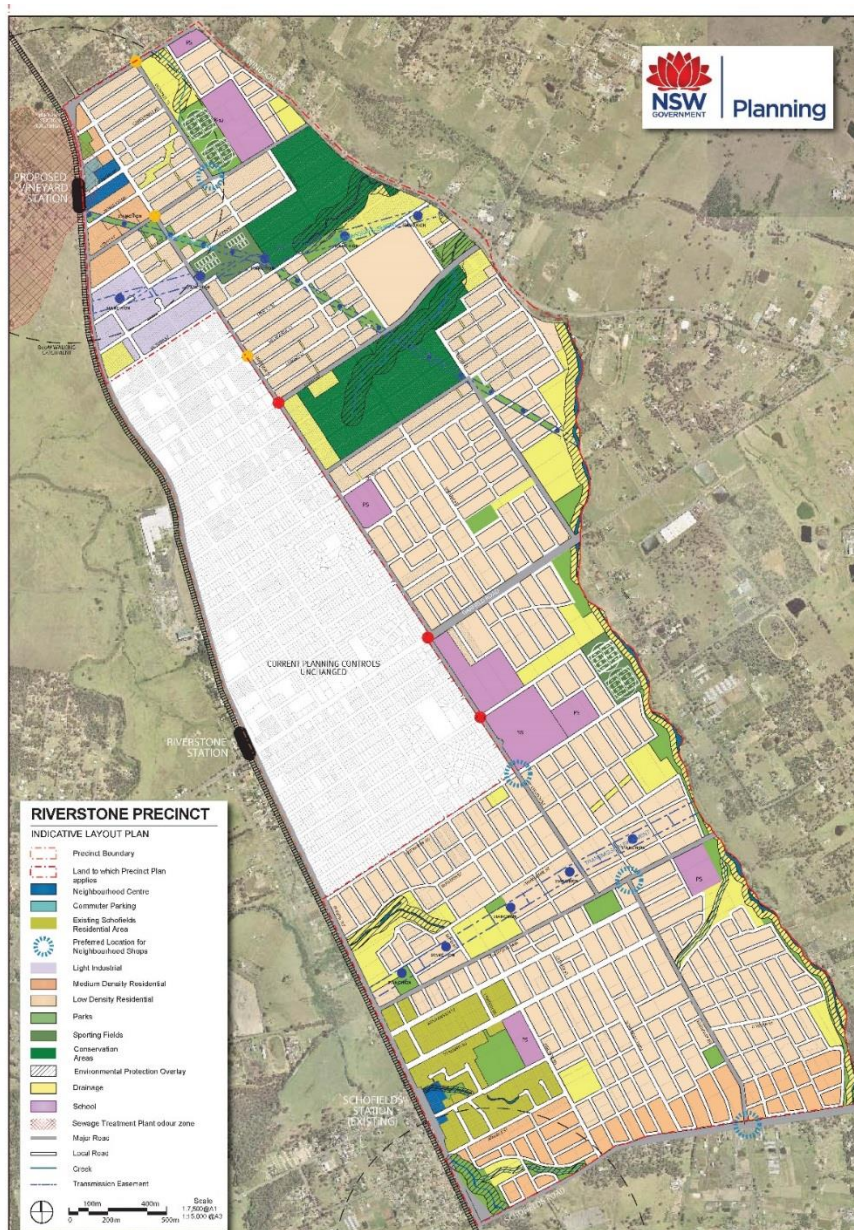


Figure 4 Final indicative plan

Source: <http://growthcentres.planning.nsw.gov.au>

3 Existing Transport Conditions

3.1 Travel Patterns

Existing travel characteristics in the Riverstone Town Centre and suburbs under the Blacktown City Council jurisdiction have been identified based on 2016 Australian Bureau of Statistics Census Journey to Work data.

3.1.1 Place of Residence

The journey to work method of people living in these areas are shown in Figure 5.

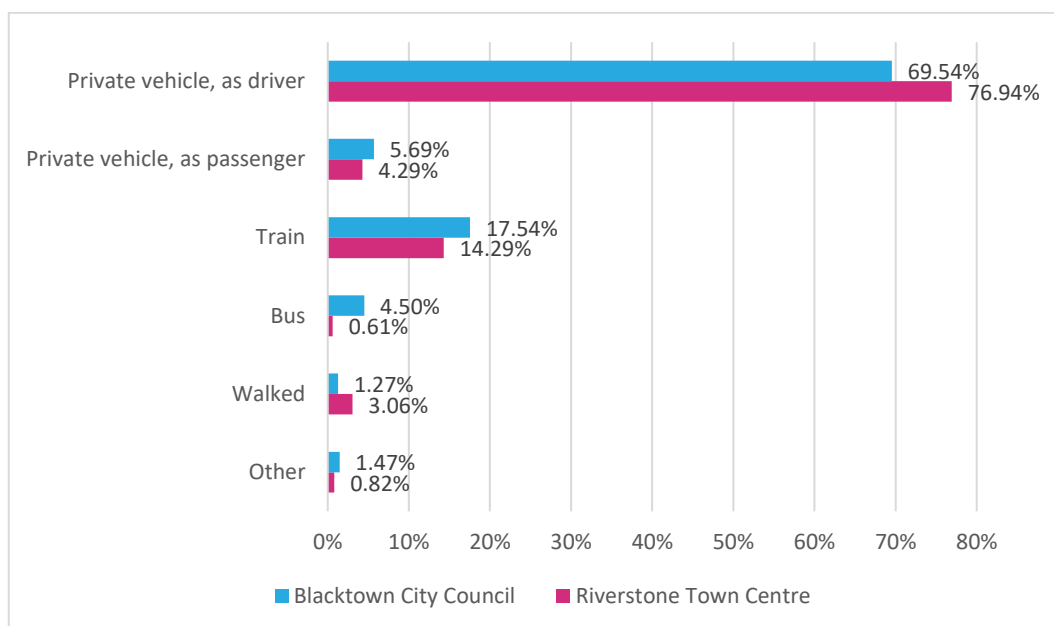


Figure 5 Existing travel patterns of residents

Source: ABS 2016 Census Data

The results indicate the majority of work trips for residents of these areas are made by private vehicles. A higher user rate of private vehicles is observed in the Riverstone Town Centre area when compared to other areas in the Blacktown City Council jurisdiction – reflecting the greater accessibility of public transport in many areas of the Blacktown Council area compared to the Riverstone Town Centre.

Trips by train account for 14.29% of total work trips in the study area, however this would be expected to increase following the recent completion of the North West Rail Link.

3.2 Road Network

The existing road network supporting the Riverstone Town Centre, as well as potential future road infrastructure upgrades, is outlined in this section.

3.2.1 Windsor Road

Windsor Road forms the primary access route into the precinct, providing north and south traffic access. It is located east of the study area and is classified as a sub-arterial road, with two traffic lanes in each direction with provision of a third lane for right turn vehicles at certain intersections. East of Commercial Road (at Rouse Hill town centre) Windsor Road widens to three lanes in each direction, reflecting the increasing traffic demands at this location.



Figure 6 Windsor Road

3.2.2 Garfield Road

Garfield Road currently provides the primary east-west road connection through Riverstone. It provides a link between Windsor Road and Riverstone Parade (to Riverstone Railway Station), extending west to Richmond Road. It is currently an undivided two-lane sealed road, with a 50km/hr speed limit within the study area. It currently forms an at grade intersection with the Richmond railway line.

Roads and Maritime have identified Garfield Road as a future east-west road corridor providing connectivity between Windsor Road and Garfield Road. This infrastructure would be delivered by the time the North West Growth Area reaches approximately 75% of its population and employment development.



Figure 7 Garfield Road East

3.2.3 Schofields Road

Schofields Road, located south of the site and is illustrated in Figure 8. Stage 1 upgrades between Windsor Road and Tallawong Road were completed in June 2014 and now provide two traffic lanes in both directions.

Stage 2 involved constructing an underpass crossing of the Richmond Rail Line, while Stage 3 involved widening of Schofields Road west of the underpass to create a four lane divided road corridor along the full length of the road between Windsor Road and Richmond Road. A wide central median has been provided to allow for a six lane corridor in the future should demand necessitate. This will meet the future transport needs of the NWGA. Additionally, the Schofields Road upgrade places more emphasis on active and public transport (i.e. creating a ‘transit boulevard’) with connections provided for pedestrians, cyclists and buses to surrounding land uses.

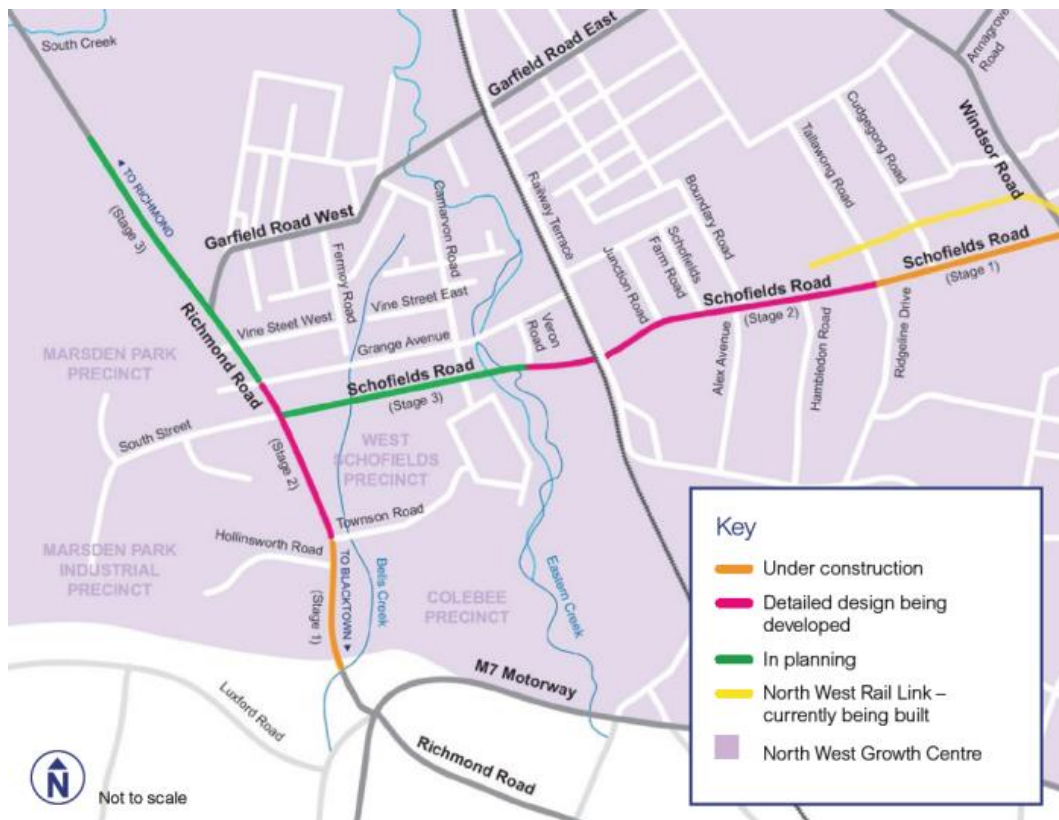


Figure 8 Schofields Road upgrade

(Source: RMS, Schofields Road upgrade location map)

3.2.4 Richmond Road

Richmond Road currently lies to the west of the Precinct and is being upgraded in three separate stages. Richmond Road serves as a principle arterial road for the NWGA and is being upgraded in accordance with this function.

Stage 1 was completed mid-2014 and involved upgrading Richmond Road to a four-lane divided road with traffic signals at Townson Road and two new intersections at Colebee and the Sydney Business Park.

Stage 2 was completed at the end of 2016 and involved extending the four-lane section of Richmond Road up to Garfield Road, as shown in Figure 9. Stage 3 was completed in mid-2018 and involved upgrading Richmond Road between Bells Creek and the South Creek floodplain at Marsden Park, as also shown.

The upgrade of Richmond Road provides continued service as a “principal arterial” providing access to pedestrians, cyclists and buses within the NWGA and to surrounding areas. A wide central median has been provided to allow for a six-lane corridor in the future should demand necessitate. This will meet the future transport needs of the NWGA.

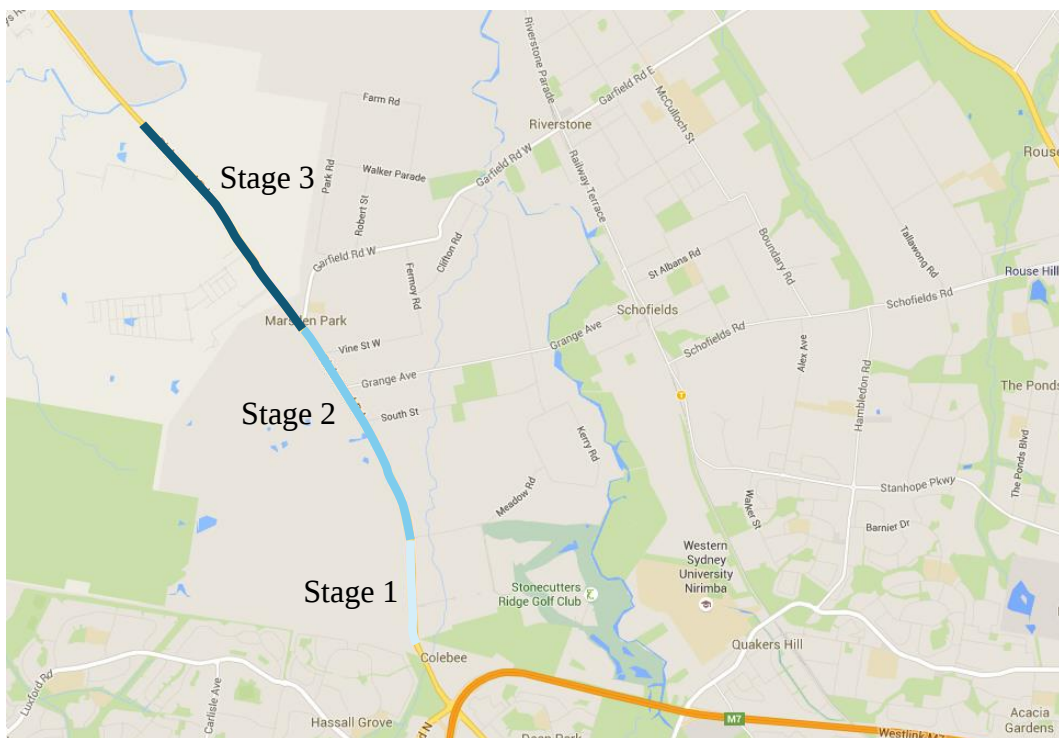


Figure 9 Richmond Road Upgrade

3.2.5 Local Roads

Piccadilly Street and King Street which bound the north and east of the study area are local roads. They provide access to residential dwellings and are both undivided and unmarked two-way roads.

3.3 Parking

There are a number of public off-street car parking areas within the study area as illustrated in Figure 10.

A commuter car parking area is located directly adjacent to Riverstone railway station which provides 67 all day parking spaces. Overflow commuter parking is also available on the eastern side of Railway Parade with capacity for an additional 100 vehicles. A 50 space car park is located at the eastern edge of the study area adjacent to George Street, serving the nearby swimming pool and park.

193 parking spaces are provided for the Market Town centre along with other uses in the town centre. These parking spaces are time limited to four hours and therefore not available for commuters.



Figure 10 Off-street car parking

Unrestricted, all day on street parking is generally provided within the study area. One hour time limits are in place along Garfield Road and Riverstone Parade in the town centre to encourage higher turnover of vehicles.

3.4 Traffic Volumes

Based on the existing land uses within the town centre, it is estimated that in the order of 800 vehicle trips are generated in the commuter peak hours.

Traffic surveys were carried out in March 2014 to understand the existing level of traffic in the vicinity of the Riverstone precinct. Intersection counts and seven day automated counts were undertaken at a total of 19 locations in the area.

The results of the surveys are shown in Figure 11, and indicate Windsor Road carries the majority of traffic in the precinct. Traffic volumes on Windsor Road progressively increase from north to south, attributable to the more densely developed areas around Rouse Hill and The Ponds.

In the vicinity of the study area, Garfield Road east of the railway line currently carries approximately 530 vehicles per hour in each direction. West of the railway line, this increase to approximately 900 vehicles per hour.

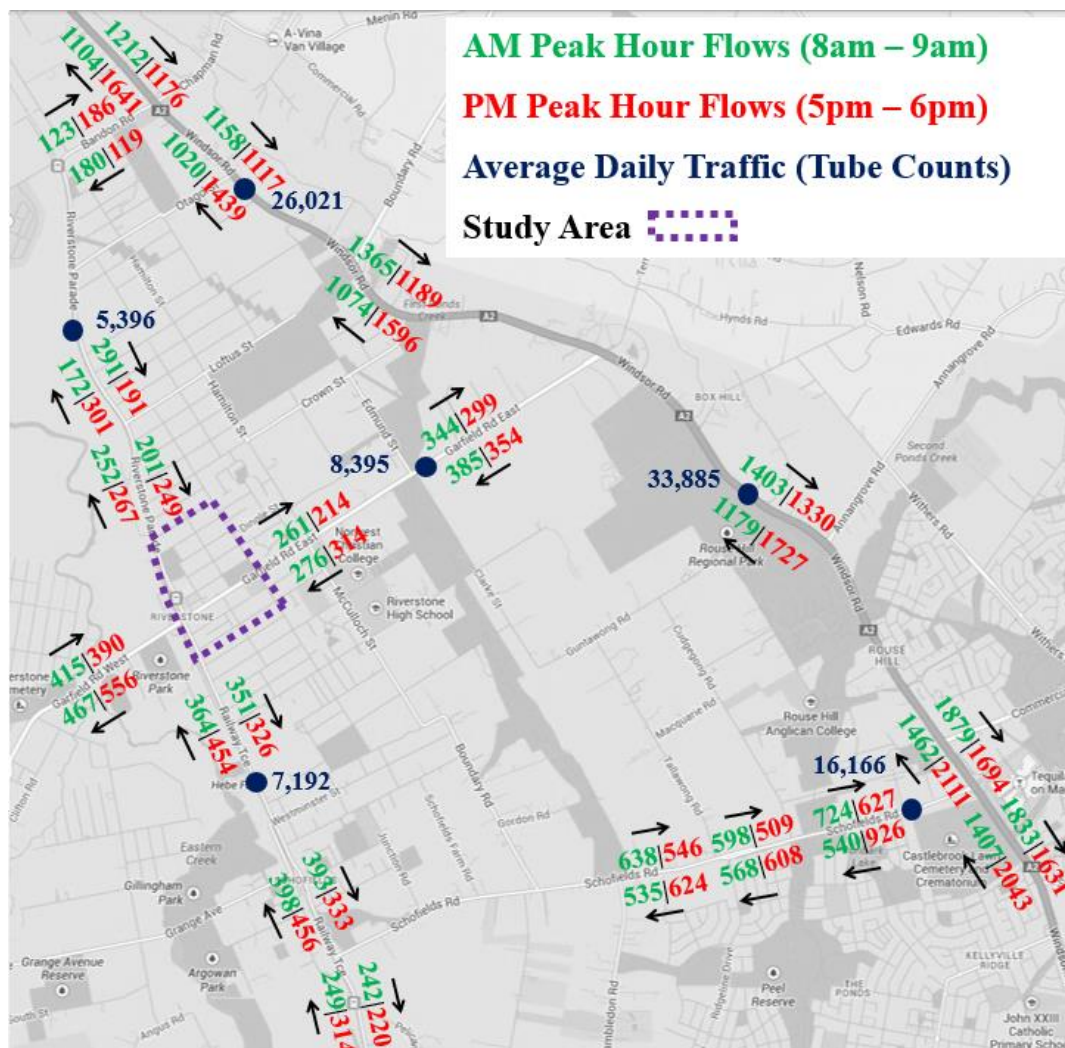


Figure 11 2014 Traffic Volumes

3.5 Traffic Conditions

Traffic congestion in the Riverstone town centre is common during commuter peak hours in and around the level crossing of the Richmond railway line at the Garfield Road / Riverstone Parade intersection (Figure 12). This location is currently controlled by traffic signals. During train arrivals and departures, boom gates on both sides of Garfield Road are lowered to prevent traffic from crossing the railway line. This typically results in significant queues of traffic through the town centre and along Riverstone Parade.



Figure 12 Riverstone Parade level crossing

3.6 Heavy Vehicles

Traffic surveys conducted in March 2014 identified the existing level of heavy vehicles utilising key roads in the vicinity of the study area. Key findings from the surveys, with respect to heavy vehicle traffic, were as follows:

- 12% of traffic (approximately 1,100 vehicles per day) were identified as heavy vehicles along Garfield Road. This is a significant number and reflects the current function of Garfield Road as the predominant east-west link between Windsor Road and Richmond Road. The presence of these heavy vehicles detracts from the function of the Riverstone town centre as a pedestrian friendly environment.
- On Riverstone Parade to the north of the study area, 16% of all vehicles surveyed were identified as heavy vehicles. This reflects the number of light industrial uses in this area and relatively low number of local residents.

The outcomes of the surveys with respect to heavy vehicles are illustrated in Figure 13.

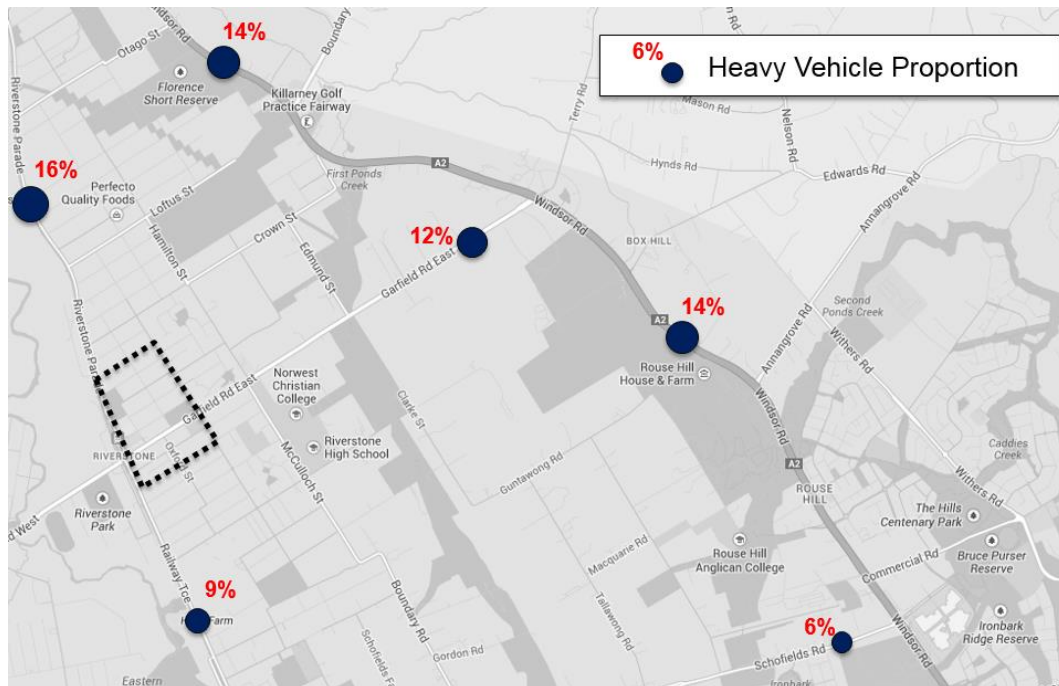


Figure 13 Heavy vehicle proportions

3.7 Rail Services

The Riverstone town centre is currently served by the Richmond railway line, a branch of the main western line. The Richmond Line currently provides access to key centres located throughout Sydney via both direct links and onward connections. A summary of the existing services along the Richmond Line is shown in Table 1.

Table 1 Existing services along the Richmond rail line

Departing Station	Direction	Average Frequency of Services (Weekday)		
		AM Peak (7am – 9am)	PM Peak (4pm – 6pm)	Off Peak (10am – 3pm)
Riverstone	Northbound	30 minutes	30 minutes	30 minutes
	Southbound	30 minutes	30 minutes	30 minutes
Schofields	Northbound	20 minutes	15 minutes	15 minutes
	Southbound	12 minutes	15 minutes	15 minutes

In 2011 a duplication of the rail line was completed between Quakers Hill and Schofields, including the opening of the new Schofields Station. This duplication has allowed for more frequent train services travelling to and from Schofields. The new station at Schofields includes 230 park and ride spaces and a new bus interchange servicing residents of the North West Growth Centre.

A second stage of the project includes a new and relocated Vineyard station and an upgrade of the existing Riverstone Station. This second stage of the project is not presently proceeding, however the planning of the Riverstone Precinct considered a new station location at Vineyard.

3.8 Sydney Metro Northwest

Sydney Metro Northwest (previously known as the North West Rail Link), is the first stage of Sydney Metro. The project was completed in 2019 and delivers eight new railway stations to Sydney's North West, providing a connection into Chatswood and the Sydney CBD. Rail services are provided every 5 minutes during peak periods and every 10 minutes across the day.

The new rail line will ultimately connect with Metro City & Southwest - the second stage of the Sydney Metro network. This will provide residents of the Riverstone Town Centre with direct rail services between Bankstown, the Sydney CBD, North Sydney, Macquarie Park and the North West Growth Centre.

The Sydney Metro Northwest map is illustrated in Figure 14.

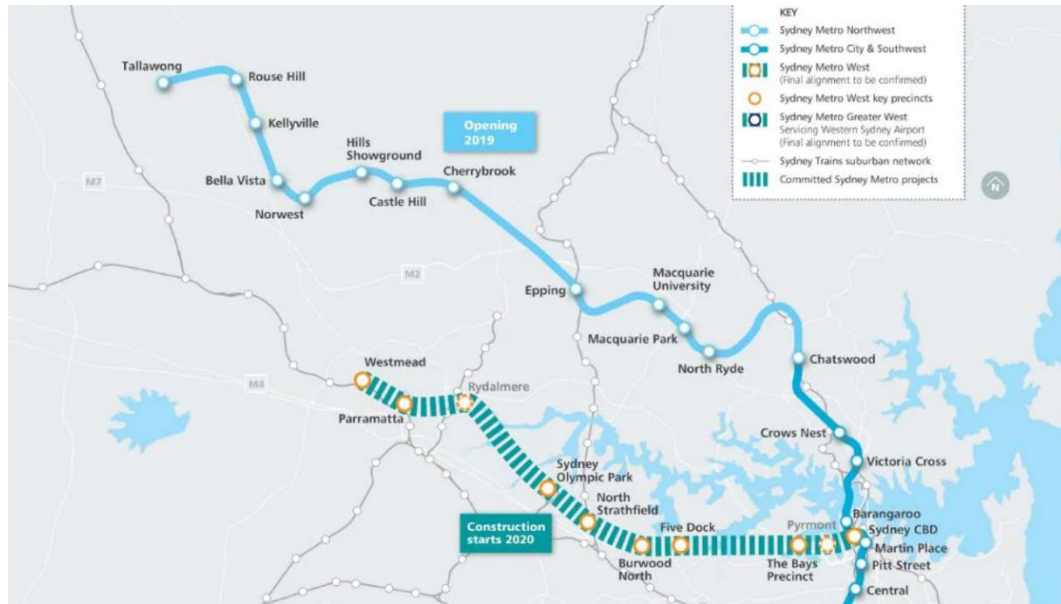


Figure 14 Sydney Metro Northwest map

Source: Transport for NSW, 2019

Residents of the Riverstone town centre can access the Northwest Metro via the rail interchange at Tallawong Station. Located between Tallawong Road and Cudgegong Road, the new station provides for 1,000 commuter car parking spaces and space for 6 buses. Pedestrian linkages are also included as well as secure parking and storage for up to 45 bicycles. The Tallawong train station is located some 3km from the study area.

3.9 Bus Services

Within the study area, bus stops are located along Riverstone Parade, next to the train station, and along Piccadilly Street. There are currently limited bus services within the vicinity of the Riverstone town centre. These typically run at low frequencies throughout the day which limit the uptake of travel by bus. The following bus routes currently service the Riverstone town centre precinct.

- **Route 661:** Windsor to Riverstone via McGraths Hill (via Commercial Road and Crown Street)
- **Route 662:** Riverstone to Maraylya and Oakville (via Boundary Road)
- **Route 757:** Mt Druitt to Riverstone via Rooty Hill Rd North & Marsden Park (via Richmond Road to Riverstone Station)
- **Route T75:** Blacktown to Rouse Hill and Riverstone (via Schofields Road, Tallawong Road and Cudgegong Road)
- **Route T74:** Blacktown to Riverstone via The Ponds (via Burdekin Road and Railway Terrace)

This is illustrated in Figure 15.

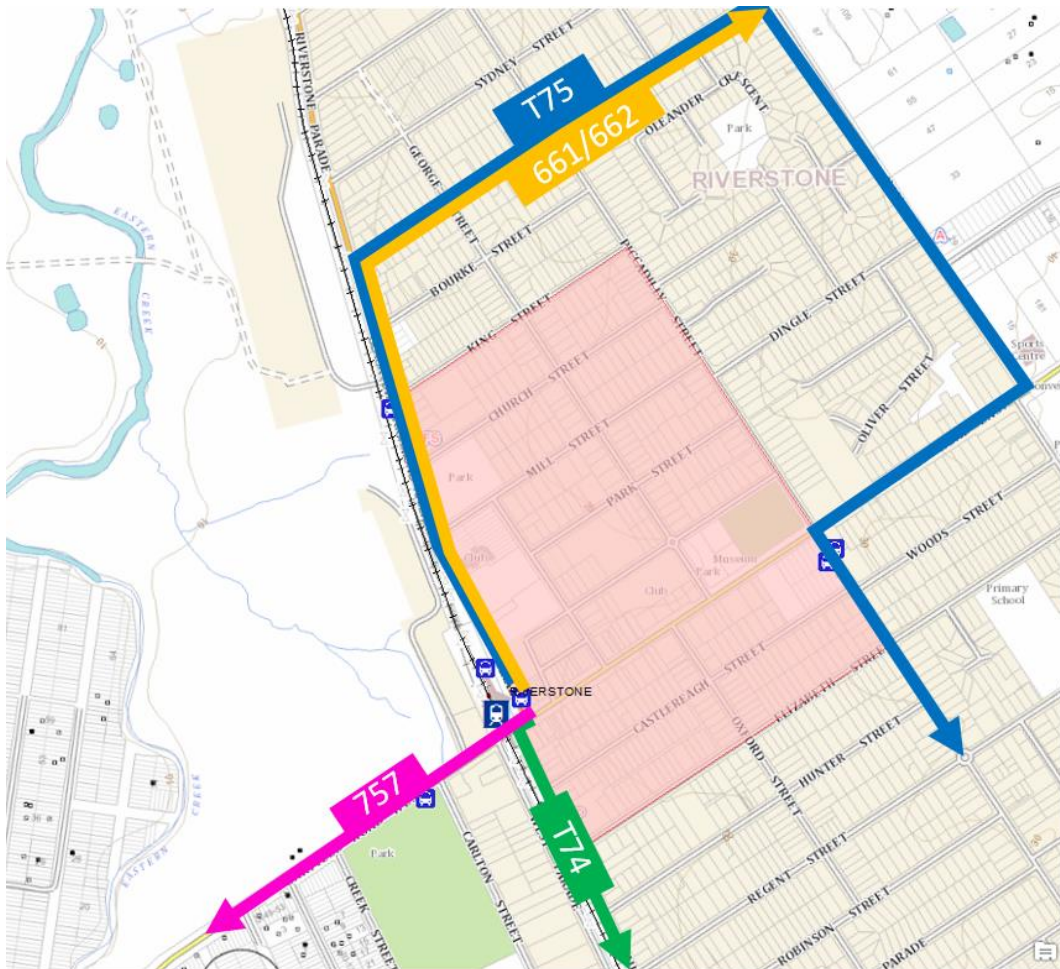


Figure 15 Bus services

3.10 Walking

Pedestrian crossing facilities are limited within the Riverstone town centre and only provided at signalised intersections located at:

- Garfield Road East and Riverstone Parade
- Garfield Road East and Piccadilly Street

No formal crossing facilities are provided along Garfield Road in between these locations. Other pedestrian facilities in the study area include:

- A zebra crossing on Piccadilly Street (north of Castlereagh Street)
- Pedestrian refuges at the intersection of George Street and Market Street

Several of the local roads within the study area such as Mill Street, Church Street and King Street have no footpaths along either sides of the road. Most of the other local roads have footpaths on one side of the road only.

The existing pedestrian facilities are shown in Figure 16.



Figure 16 Existing pedestrian facilities

3.11 Cycling

Existing cycling routes and facilities within and surrounding the study area are currently limited.

Windsor Road provides on-road cycleways, however include no dedicated bicycle facility (e.g. on-road markings). These designated cycle routes often carry large volumes of traffic and are generally only appropriate for confident riders.

According to the Blacktown Bike Plan 2016, several developer funded bicycle lanes are proposed to be constructed near the study area. They will run along McCulloch Street and Riverstone Parade. Council has also recommended a state link bicycle route through Garfield Road.



Figure 17 Blacktown Bike Plan 2016 map

4 Future Transport Upgrades

4.1 Crossings of the Richmond Rail Line

The RMS has developed a strategy for the provision of grade-separated road crossings across the Richmond rail line. The strategy has recommended an upgrade of Bandon Road (including an underpass of the Richmond railway line) which would provide a high quality road connection between Windsor Road and Richmond Road. This upgrade would be completed by the time the NWGA reaches approximately 25% of its population and employment development. This will provide connectivity for Vineyard residents and visitors travelling west of the railway line.

In addition, the strategy has recommended the construction of a grade separated crossing at Garfield Road, replacing the existing level crossing. This infrastructure would be delivered by the time the NWGA reaches approximately 75% of its population and employment development.

An overview of the Bandon Road and Garfield Road crossing alignments are illustrated in Figure 18.

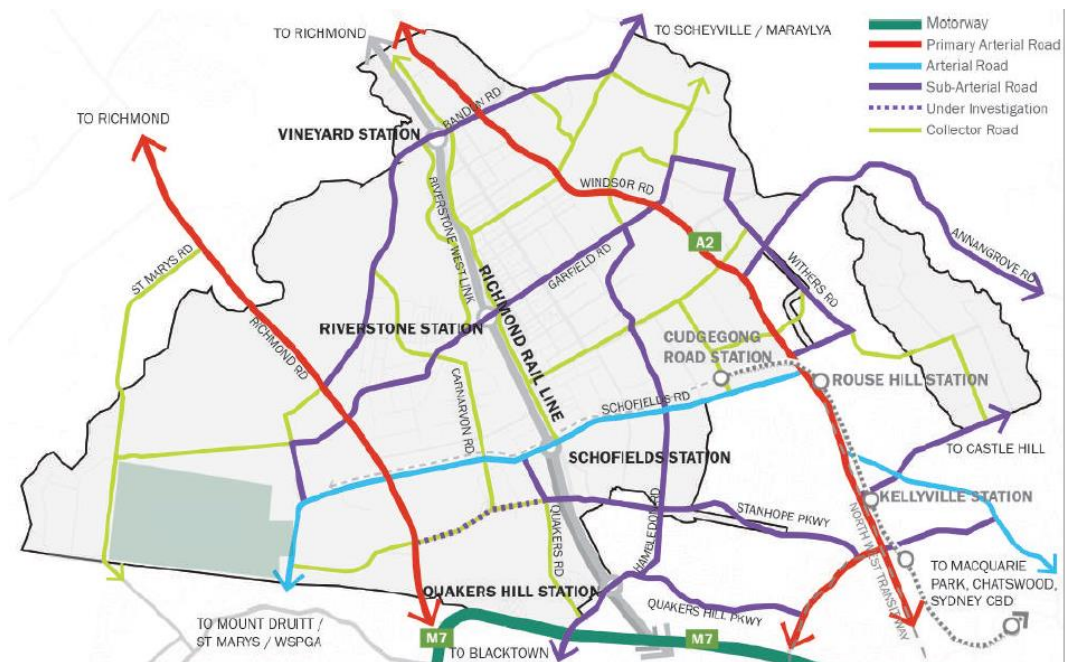


Figure 18 Road hierarchy and rail crossing alignments

Source: North West Growth Area structure plan review (Jacobs, 2017)

The road network strategy has been divided into short, medium and long terms works as described in detail in the sections below.

4.1.1 Short Term Works

The planned short term works (to be completed within the next four years) will directly influence traffic conditions within the Riverstone town centre. These works include:

- Work with Blacktown City Council to develop local strategies to improve traffic flow within Riverstone town centre to boost capacity and minimise delays, with the existing level crossing retained. The specific location and extent of these works are currently being developed.
- Link Westminster Street with Garfield Road West to provide an alternative route for local traffic away from the Garfield Road level crossing.
- Work with the Department of Planning and Environment and Blacktown City Council to reserve a road corridor along Garfield Road between Richmond Road and Windsor Road for future widening

4.1.2 Medium Term Works

The strategy has recommended an upgrade of Bandon Road to function as a transit boulevard (including an underpass of the Richmond railway line) which would provide a high quality road connection between Windsor Road and Richmond Road. This upgrade would be completed by the time the NWGA reaches approximately 25% of its population and employment development. Based on current projections, this could occur by 2021. Works include the construction of an underpass and creation a new road connection between Richmond Road and Windsor Road. The existing level crossings at Bandon Road and Level Crossing Road would be closed at this time.

4.1.3 Long Term Works

The road network strategy has recommended the construction of a grade separated crossing at Garfield Road, replacing the existing level crossing. This infrastructure would be delivered by the time the NWGA reaches approximately 75% of its population and employment development. Based on current projections, this could occur between 2031 and 2036. Works would also include an upgrade Garfield Road between Richmond Road and Windsor Road.

5 Masterplan Development

5.1 Options Development

Prior to the development of the preferred master plan for the Riverstone Town Centre, two alternate options were developed and considered. These options (options 1, 3 and 4) are outlined in more detail in the overall planning study, however transport comments in relation to these are summarised below.

5.1.1 Option 1

- Should Market Street be the focus of activity it is recommended this remain open to vehicular traffic. Closing Market Street as indicated would place a high reliance on George Street for access and on-street parking serving the town centre – particularly following the introduction of the overpass which will restrict access into Pitt Street.
- Some form of pedestrian crossing facility (potentially zebra crossing) should be provided at the Market Street / Pitt Street intersection to emphasise the priority pedestrian route between the town centre and the train station

5.1.2 Option 3

- Pedestrian priority should be focused around the Market Street / Riverstone Parade intersection to provide good access for people travelling between the train station and town centre. This option indicates the pedestrian crossing to be located just south of this intersection which does not meet the pedestrian desire line.
- Closing Pitt Street to vehicular traffic between Market Street and Park Street reduces the overall level of permeability through the town centre – directing more traffic towards George Street which is already expected to accommodate significant increase in traffic volumes. This measure would also limit opportunities for vehicle access into an upgraded Marketown.
- A better outcome in terms of the functionality of the town centre would be to provide a north-south pedestrian link between Pitt Street and George Street adjacent to the Village Green.

5.1.3 Option 4

- Closing the western end of Market Street to support improved pedestrian connectivity to Riverstone Station is feasible and supported. This will however require all vehicular access (private vehicles and service vehicles) to Marketown to be via Pitt Street.
- The proposal for a pedestrian pathway between Garfield Road East and Market Street will improve pedestrian connectivity and permeability, providing a valuable link between the Village Green and Garfield Road East. It will however require the provision of a new pedestrian crossing facility on Garfield Road East to accommodate the new pedestrian desire line.

5.1.4 Option 2 – Preferred Masterplan

Detailed comments relating to the preferred master plan option (option 2) are described below as well as in Section 6 of this report.

The preferred Masterplan for the Riverstone town centre is illustrated in Figure 19 below. This focuses activity predominantly along the Market Street corridor, centred around the community hub and village green. High density mixed use development (up to nine storeys) is proposed close to the railway station, with medium density residential (up to six storeys) location towards the periphery of the town centre.

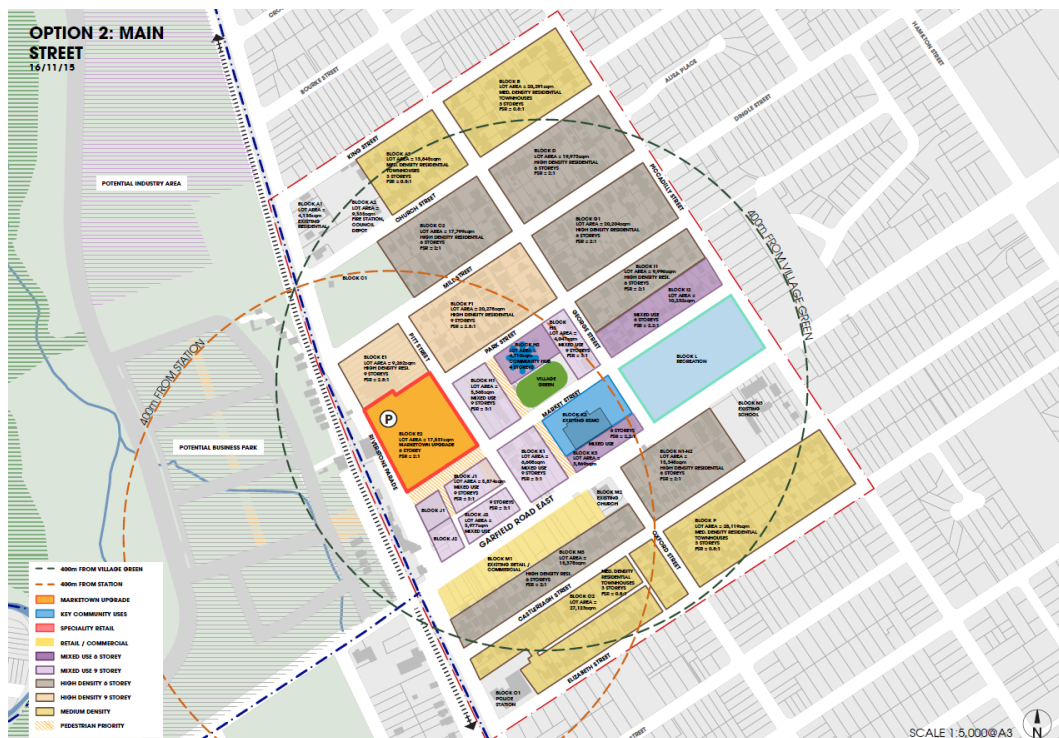


Figure 19 Preferred town centre Masterplan

Source: Group GSA

Key features of the Masterplan relating to transport connectivity include:

- Pedestrianisation of the western end of Market Street, between Pitt Street and Riverstone Parade, providing a direct connection to Riverstone train station
- A new pedestrian through link between Park Street and Garfield Road East
- A calmed traffic environment on Market Street
- New pedestrian crossing opportunities across Garfield Road East

5.2 Potential Development Yields

The preferred Masterplan envisages the following development yields:

- 475,561m² of residential floor space, equivalent to 3,804 dwellings
- 12,373m² of retail floor space (not including the supermarket)
- 4,000m² supermarket
- 9,373m² of commercial floor space
- 5,000m² community/recreational floor space

6 Transport Assessment

6.1 Transport Planning Objectives

The following transport objectives have been identified in conjunction with the Master Planners, which aim to provide a coherent transport network that supports movement both to and within the Riverstone Town Centre:

- Provide a road network allowing access to all modes of transport, particularly public transport, walking and cycling;
- Design a physical site layout which encourages walking and cycling, particularly to key land uses and public transport nodes;
- Ensure the road network for the town centre provides suitable connections to adjacent development precincts in the North West Growth Centre;
- Ensure the road network within the town centre continues to operate at satisfactory levels of service;
- Integrate transport and land use planning so that high intensity land uses have strong accessibility to public transport;
- Provide high quality access to public transport stops to reduce the dependence on private vehicles;
- Protect residential areas from through traffic intrusion, particularly heavy vehicles.

6.2 Existing Traffic Flow and Peak Hour

Traffic surveys were conducted on 20th August 2019 (Tuesday) for the five key intersections along Garfield Road to establish the existing peak hour traffic volumes. The five surveyed intersections are listed and shown on Figure 20 below:

- Garfield Road / Riverstone Parade / Railway Terrace signalised intersection (J1)
- Garfield Road / Pitt Street priority intersection (J3)
- Garfield Road / Oxford Street priority intersection (J4)
- Garfield Road / George Street priority intersection (J5)
- Garfield Road / Piccadilly Street signalised intersection (J6)

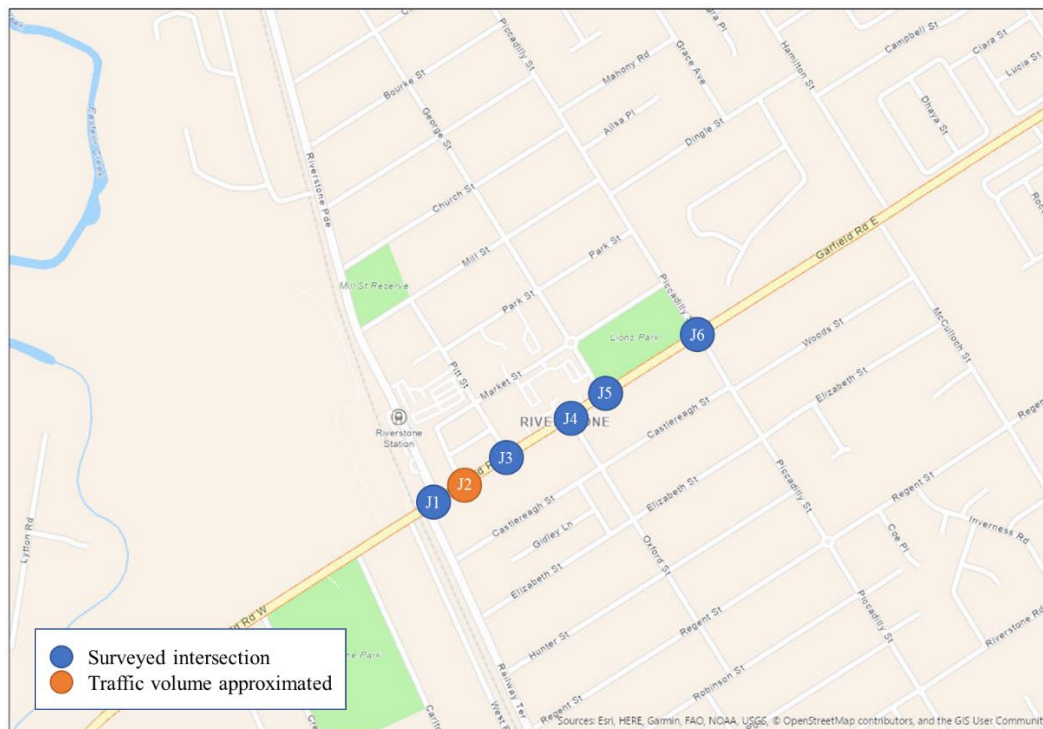


Figure 20 Intersection location

To determine the study area AM and PM peak hours, the traffic volumes were aggregated for hourly periods over fifteen-minute intervals for the survey periods. These volumes are shown in Figure 21 and Figure 22 with the following peak hours identified:

- AM Peak: 07:15 – 08:15 (1 hour)
- PM Peak: 16:45 – 17:45 (1 hour)

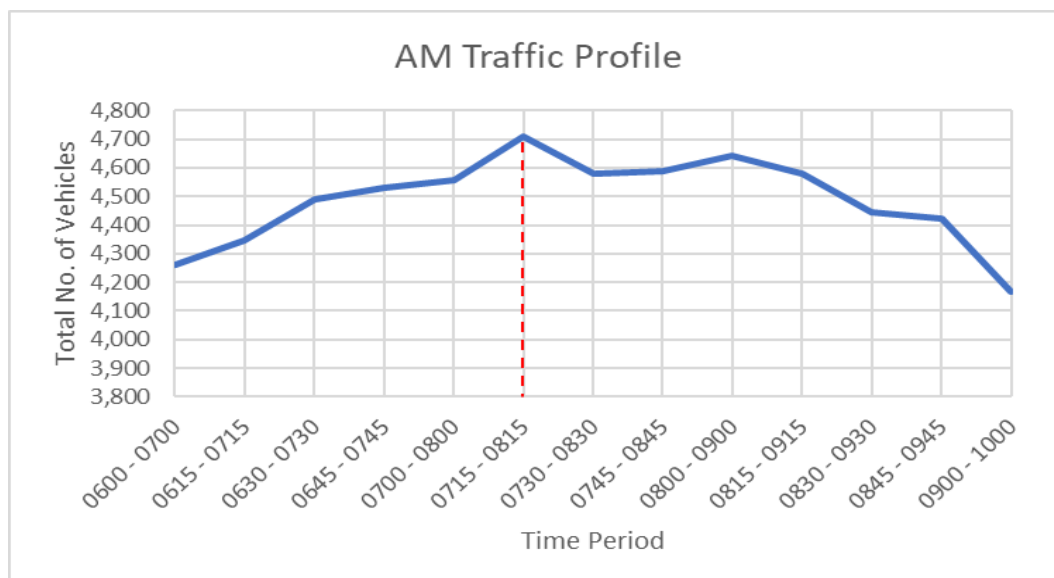


Figure 21 AM hourly traffic volume (total)

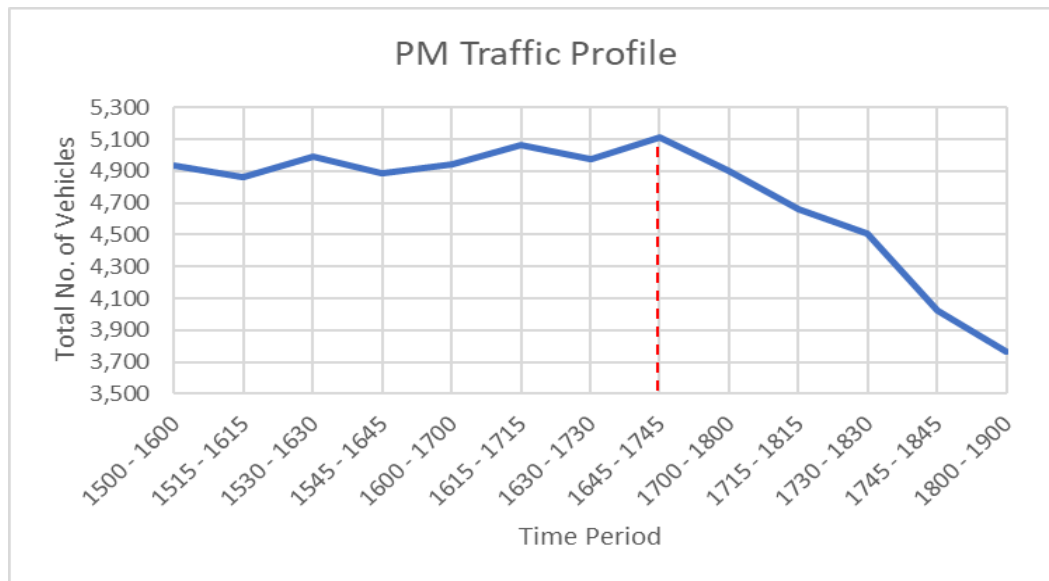


Figure 22 PM hourly traffic volume (total)

Network diagrams of the existing peak traffic flows were developed for both peak periods for both light and heavy vehicles. These diagrams are shown in Figure 23 and Figure 24 below where blue text represents the AM peak and red text represents the PM Peak. As traffic counts were not collected for the minor Garfield Road / Marketown Lane priority intersection (J2), the turning volumes were approximated by balancing the traffic volumes of adjacent intersections from the traffic survey.

Riverstone
Observed Traffic Flow
Base Year: Tue, 20th August 2019 AM Period: 0715 - 0815
Class: Lights PM Period: 1645 - 1745
Units: No. of Vehicles

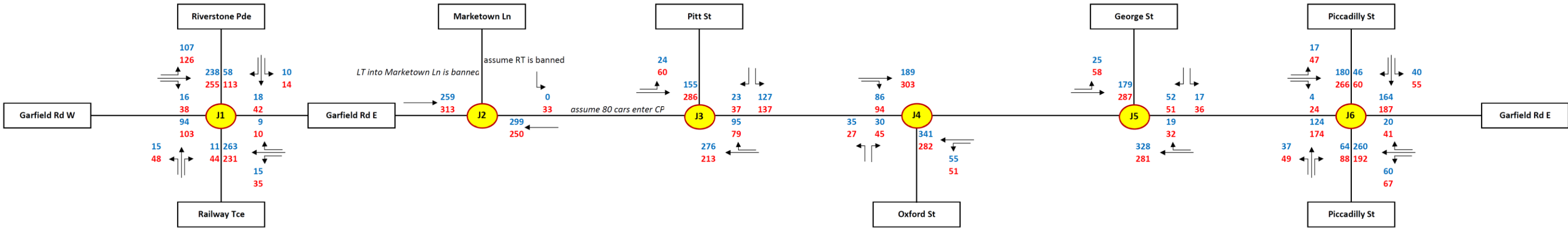


Figure 23 Existing traffic flow - light vehicles

Riverstone
Observed Traffic Flow
Base Year: Tue, 20th August 2019 AM Period: 0715 - 0815
Class: Heavies PM Period: 1645 - 1745
Units: No. of Vehicles

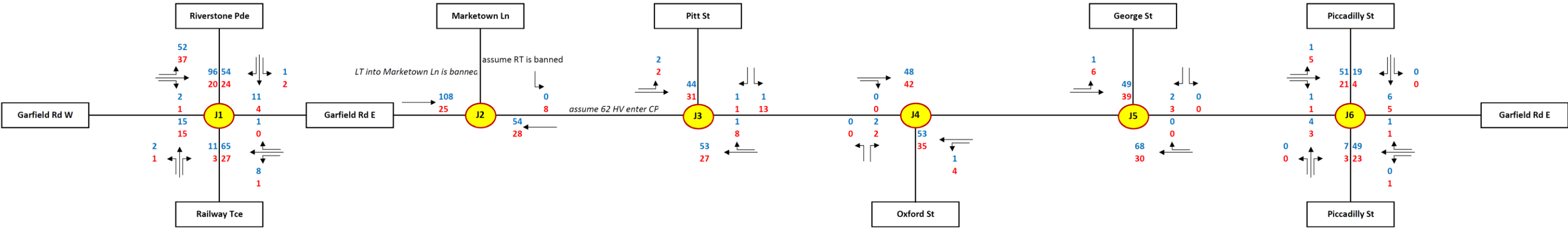


Figure 24 Existing traffic flow - heavy vehicles

6.3 Assessment Years and Scenarios

It was agreed with Blacktown City Council that the intersection modelling would include the following assessment years / scenarios for evaluation for both the AM and PM peak hours:

- 2019 – Existing
- 2024 – Without Development
- 2029 – Without Development
- 2029 – With Development (Low Development Growth Scenario)
- 2029 – With Development (High Development Growth Scenario)

6.3.1 Background Growth

A linear growth rate of 2.10% per annum has been adopted to factor the existing traffic volumes within the study area. This accounts for the background traffic growth in Riverstone and is applied to both the Without Development and With Development scenarios for the respective years. The network diagrams of 2024 and 2029 Without Development scenarios (background traffic only) and shown in Figure 25 to Figure 28 below.

Riverstone
Background Traffic
Year: 2024
Class: Lights
Units: No. of Vehicles

AM Period: 0715 - 0815
PM Period: 1645 - 1745

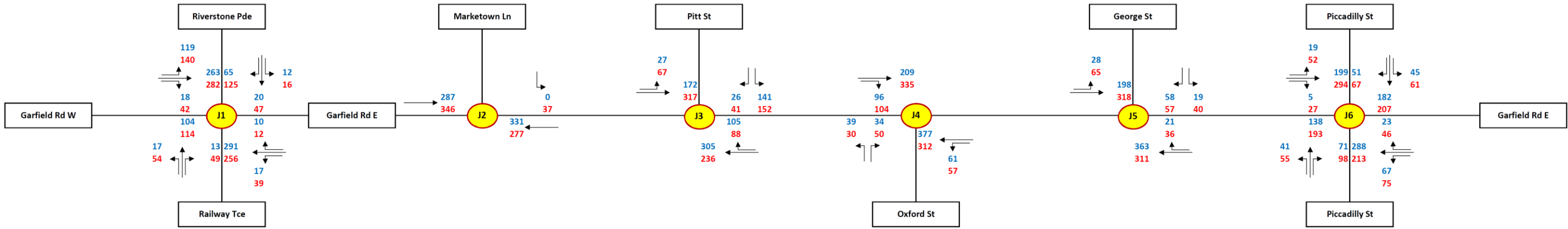


Figure 25 2024 Without Development - light vehicles

Riverstone
Background Traffic
Year: 2024
Class: Heavies
Units: No. of Vehicles

AM Period: 0715 - 0815
PM Period: 1645 - 1745

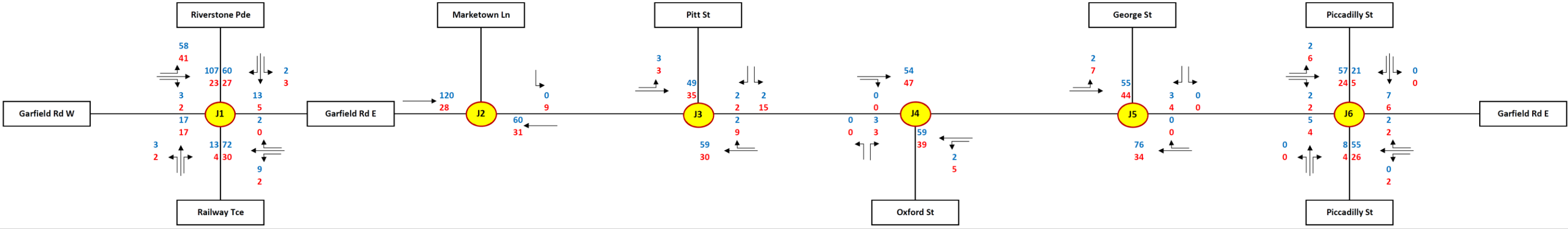


Figure 26 2024 Without Development - heavy vehicles

Riverstone
Background Traffic
Year: 2029
Class: Lights
Units: No. of Vehicles

AM Period: 0715 - 0815
PM Period: 1645 - 1745

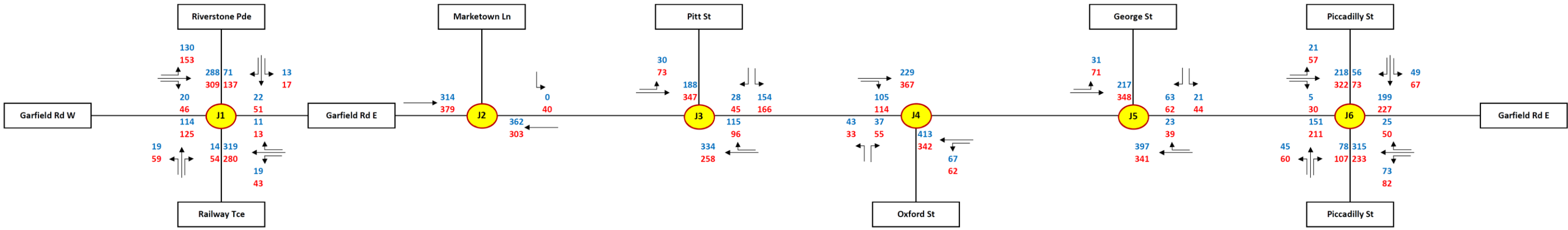


Figure 27 2029 Without Development - light vehicles

Riverstone
Background Traffic
Year: 2029
Class: Heavies
Units: No. of Vehicles

AM Period: 0715 - 0815
PM Period: 1645 - 1745

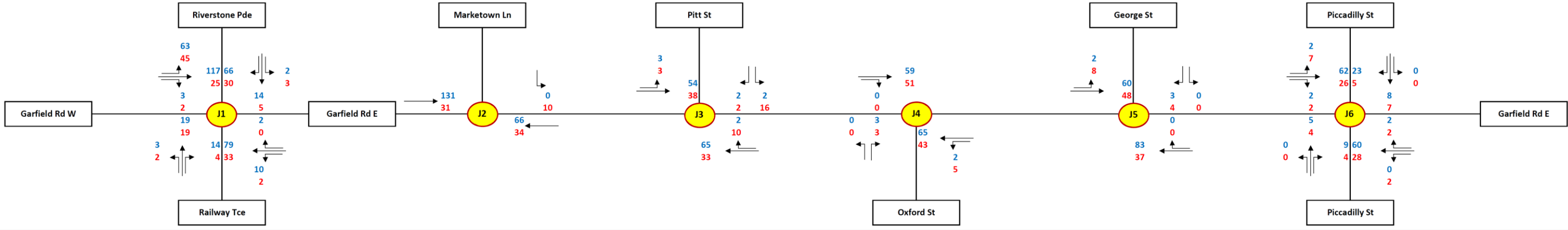


Figure 28 2029 Without Development - heavy vehicles

6.3.2 Trip Generation

The proposed development yields and respective land use classifications within the town centre have been provided by Blacktown City Council, refer Appendix A. These yields have been used to determine the likely trip generation caused by the proposed development. The low growth and high growth development yields for 2029, and the ultimate proposed yields are shown in Table 2 below.

Table 2 Additional GFA and dwelling units for 2029 With Development

Land use	Ultimate Scheme (Beyond 2029)	2029 With Development	
		Low Scenario	High Scenario
Retail	3,712 sqm	215 sqm*	859 sqm*
Commercial	2,812 sqm	163 sqm*	651 sqm*
Community/recreation floorspace	5,000 sqm	289 sqm*	1,157 sqm*
Residential (medium + high density)	3,457 units	200 units	800 units

*proportionate to residential units

The current and proposed ultimate retail and commercial land use is shown in Table 3 below highlighting the scale of the increase in development.

Table 3 Ultimate retail and commercial (Source: Blacktown City Council)

Land use	Floorspace (sqm)		
	Current	Proposed	Increase
Retail	8,661	12,373	3,712
Commercial	6,561	9,373	2,812
Total	15,222	21,726	6,524

The trip rates used for each land use is shown in Table 4 below which were provided by Transport for NSW (TfNSW) on 4th August 2020 which have been specifically adjusted for Riverstone Town Centre.

Table 4 Assumed trip rates

Land use		Trip Rate			
		AM	PM	Unit	Source
Residential	High Density	0.36	0.28	per dwelling	TfNSW
	Medium Density	0.86	0.9	per dwelling	TfNSW
Retail		3.1	6.2	per 100 sqm	TfNSW
Commercial		1.98	1.49	per 100 sqm	TfNSW
Recreation/Community hub		1.74	1.56	per 100 sqm	ITE (8 th ed.)

Within the trip rates, there is a proportion of inbound and outbound trips to the respective land uses. Table 5 below shows the assumed inbound and outbound trips for both peak periods.

Table 5 Assumed directional split for trip rates

Land Use	AM Peak		PM Peak	
	Inbound	Outbound	Inbound	Outbound
Residential	20%	80%	80%	20%
Retail	80%	20%	50%	50%
Commercial	80%	20%	20%	80%
Recreation/Community hub	61%	39%	37%	63%

The proposed development is divided into two sites, Northern Site and Southern Site, which is separated by Garfield Road East. The ultimate scheme of the preferred town centre Masterplan (beyond 2029) is shown in Figure 29 below.

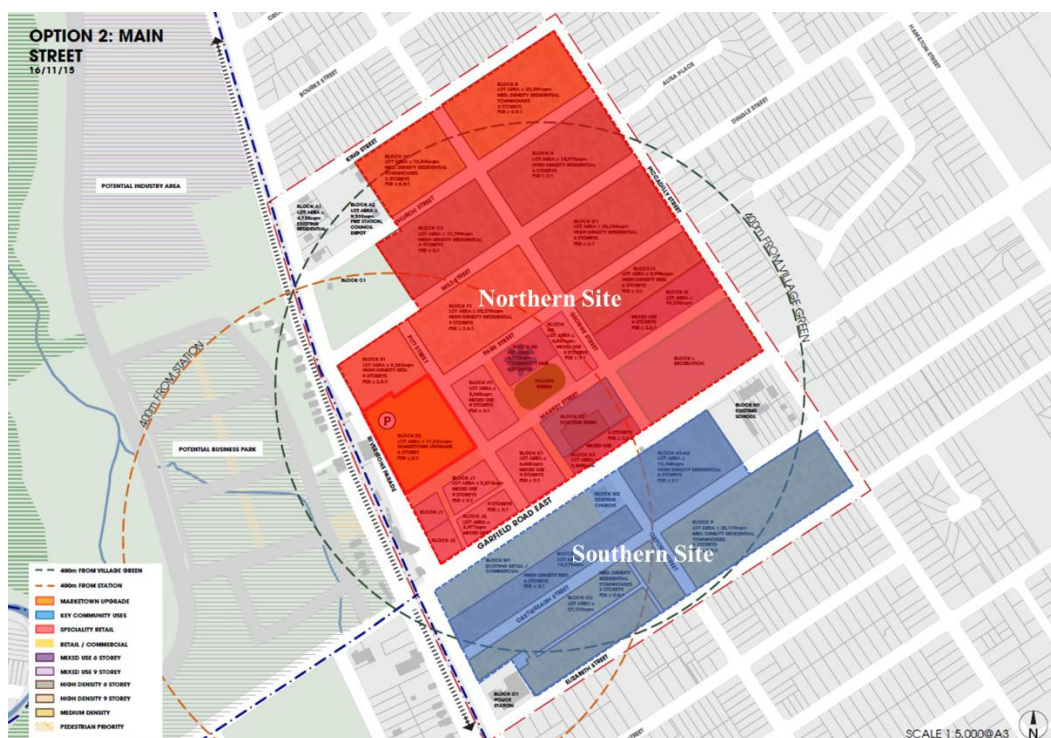


Figure 29 Northern and Southern Site (ultimate scheme)

The proposed retail, commercial and recreation/community hub space is located within the Northern Site and will be proportionate based on the residential units in the respective scenario (see Table 2, Low Scenario = 5.8% and High Scenario = 23.1%). Based on the Masterplan, Table 6 shows the proportions of residential units spread between the two sites as well as the percentages of medium density and high density dwellings within each site. It is assumed this distribution will be relatively similar for the 2029 With Development scenarios.

Table 6 Distribution of residential units

Proposed Site	Type of density (within each site)			Proportion of units between two sites
	Medium	High	Total	
Northern	12%	88%	100%	70%
Southern	41%	59%	100%	30%
TOTAL				100%

The likely trips generated from the proposed low and high growth development scenarios are summarised in Table 7 below.

Table 7 Proposed development trip generation

Proposed Site	Land use	2029 With Development (Low Scenario)				2029 With Development (High Scenario)			
		AM		PM		AM		PM	
		In	Out	In	Out	In	Out	In	Out
Northern	Residential (medium density)	3	11	12	3	11	45	46	12
	Residential (high density)	9	36	28	7	36	142	110	28
	Retail	6	1	7	7	22	5	27	27
	Commercial	3	1	1	2	10	3	2	8
	Recreation/Community hub	3	2	2	3	12	8	7	11
	Sub Total	24	51	49	22	91	203	192	86
Southern	Residential (medium density)	4	18	18	5	17	69	72	18
	Residential (high density)	3	10	9	2	10	42	33	8
	Sub Total	7	28	27	7	28	110	105	26
	TOTAL	31	79	76	29	119	313	297	112

6.3.3 Trip Distribution

The distribution of existing traffic was assessed using 2011 Journey to Work Census data and found that of the vehicles travelling to and from the Riverstone town centre:

- 40% travelling to/from the west (primarily to/from Blacktown)
- 25% travelling to/from the east (primarily to/from Rouse Hill)
- 20% travelling to/from the south (primarily to/from Baulkham Hills and Penrith)
- 15% travelling to/from the north (primarily to/from Richmond)

The external directional splits are also illustrated in Figure 30 below.

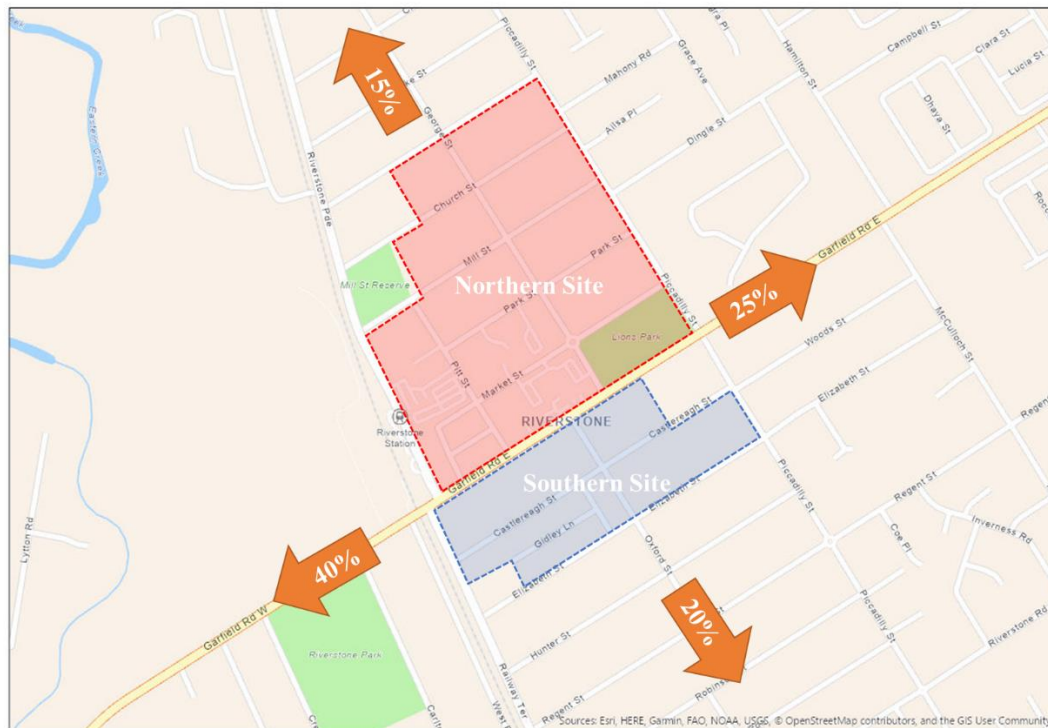


Figure 30 External trip distribution (Source: Journey to work 2011)

In addition, Google Maps data was used in conjunction to the Journey to Work data to understand the quickest route currently undertaken by private vehicle.

The local trip distribution of traffic through the town centre along Garfield Road between Piccadilly Street and Railway Parade was estimated by site observations. The existing utilisation of the key roads identified for the traffic assessment are estimated separately for the Northern and Southern site as illustrated in Figure 31 (inbound and outbound). Based on existing traffic flow, it is assumed the proportions of development traffic utilising Marketown Lane is minimal and therefore not shown in Figure 31.



Figure 31 Local trip distribution

The projected development traffic for the low and high growth scenarios are shown in Figure 32 and Figure 33 respectively, which have then been overlaid with the background traffic growth to produce the 2029 low and high growth traffic volumes to be modelled. These volumes are shown in Figure 34 and Figure 35 below.

Riverstone
Development Traffic (Outbound + Inbound) - Low Scenario
Year: 2029 AM Period: 0715 - 0815
Class: Lights PM Period: 1645 - 1745
Units: No. of Vehicles

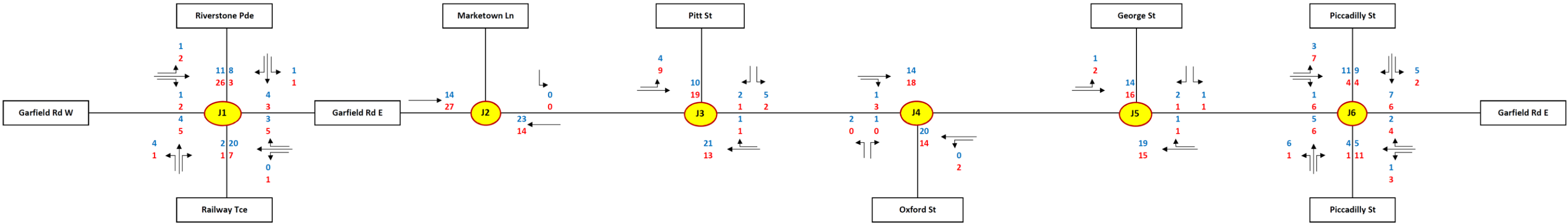


Figure 32 Development Traffic Only (Low Scenario)

Riverstone
Development Traffic (Outbound + Inbound) - High Scenario
Year: 2029 AM Period: 0715 - 0815
Class: Lights PM Period: 1645 - 1745
Units: No. of Vehicles

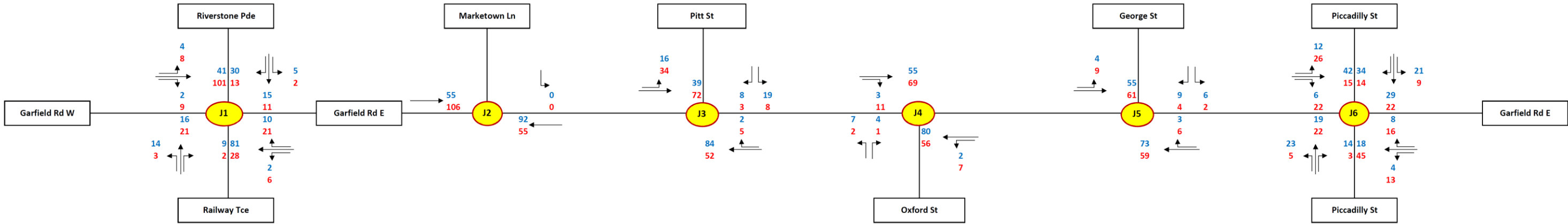


Figure 33 Development Traffic Only (High Scenario)

Riverstone
Total Traffic (Background + Development Low Scenario)
Year: 2029 AM Period: 0715 - 0815
Class: Lights PM Period: 1645 - 1745
Units: No. of Vehicles

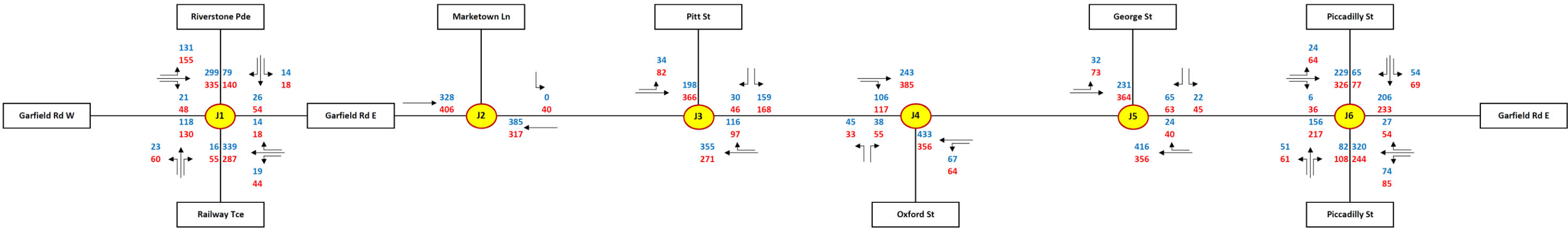


Figure 34 2029 With Development - light vehicles (Low Scenario)

Riverstone
Total Traffic (Background + Development High Scenario)
Year: 2029 AM Period: 0715 - 0815
Class: Lights PM Period: 1645 - 1745
Units: No. of Vehicles

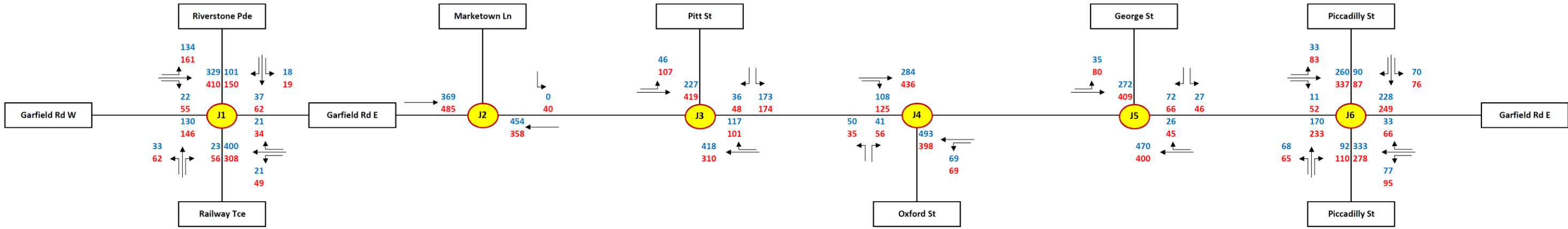


Figure 35 2029 With Development - light vehicles (High Scenario)

6.4 Intersection modelling

Intersection analysis has been undertaken using SIDRA Intersection 8.0 software, with analysis undertaken for each assessment year / scenario as outlined Section 6.3. Roads and Maritime Services (RMS) Traffic Modelling Guidelines for single intersection modelling has been used as a guide to develop the six existing intersections including the two signalised intersections:

- Garfield Road / Riverstone Parade / Railway Terrace
- Garfield Road / Piccadilly Street intersection.

The existing average signal timing of Garfield Road / Riverstone Parade / Railway Terrace intersection were calculated using SCATS data from the date the traffic surveys were completed. Average signal timing from the Garfield Road / Piccadilly Street intersection was estimated from the traffic survey video footage as the SCATS data was faulty on the survey date.

The future Without Development and With Development scenarios phase timings for both intersections were optimised using SIDRA's User-Given Cycle Time functionality while keeping the cycle time and phasing as per the existing year.

Observation from the traffic survey video footage indicated that the rail boom gates at Garfield Road / Riverstone Parade / Railway Terrace signalised intersection were lowered four times during each peak hour on the survey date. It is observed either the pedestrian phase (Phase D or F) or Phase C1 (a variation of Phase C) is most likely to be activated during the rail crossing. This delay is captured within the SCATS average signal timing data provided by RMS. To ensure some time is allocated for the pedestrian phase and rail phase in the future Without Development and With Development scenarios, Phase D is defined as a 'dummy' phase where the phase time is fixed (as per the existing year) during the signal optimisation process in SIDRA.

6.4.1 Evaluation Criteria

To assist with the interpretation of the SIDRA output, the Degree of Saturation (DoS) is defined as the ratio of demand flow to intersection capacity. This measure indicates the performance of the intersection relative to its capacity. The following DoS is typical for busy urban intersection during peak hours:

- 0.9 for a signalised intersection
- 0.8 for a priority-controlled intersection

The Level of Service (LOS) is a measure that describes the quality of traffic service based on the average delay experienced by the driver. LOS is defined from A-F with LOS A representing the best operating condition – with conditions at or close to free flow – while LOS F represents the worst, most congested, conditions.

6.4.2 Queue Validation

A queue length survey was conducted for the five key intersections within the study area. Table 8 shows a comparison between observed and modelled maximum queues in SIDRA. The results show that the observed and modelled queues are comparable and therefore are a sufficient baseline for future modelling.

Table 8 Existing queue validation

Intersection Name	Approach	Observed Max Queue (veh)		Modelled 95% Max Queue (veh)	
		AM Peak	PM Peak	AM Peak	PM Peak
J1 - Garfield Rd / Riverstone Pde / Railway Tce	Railway Terrace (South)	16	25	10	12
	Garfield Road E (East)	20	19	23	20
	Riverstone Parade (North)	12	18	11	15
	Garfield Road W (West)	15+	15+	68	60
J3 - Garfield Rd / Pitt St	Garfield Road E (East)	8	8	1	1
	Pitt Street (North)	3	5	0	1
	Garfield Road E (West)	0	0	0	0
J4 - Garfield Rd / Oxford St	Oxford Street (South)	5	5	0	0
	Garfield Road E (East)	3	0	0	0
	Garfield Road E (West)	3	3	1	1
J5 - Garfield Rd / George St	Garfield Road E (East)	0	2	0	0
	George Street (North)	2	5	0	0
	Garfield Road E (West)	0	0	0	0
J6 - Garfield Rd / Piccadilly St	Piccadilly Street (South)	5	7	3	5
	Garfield Road E (East)	8	6	5	5
	Piccadilly Street (North)	6	6	4	4
	Garfield Road E (West)	5	8	3	6

6.4.3 Intersection Analysis

SIDRA models have been developed for the six intersections outlined below:

- Garfield Road / Riverstone Parade / Railway Terrace signalised intersection (J1)
- Garfield Road / Marketown Lane Priority Intersection (J2)
- Garfield Road / Pitt Street priority intersection (J3)
- Garfield Road / Oxford Street priority intersection (J4)
- Garfield Road / George Street priority intersection (J5)
- Garfield Road / Piccadilly Street signalised intersection (J6)

A base model and future year models for each forecast year and development scenario has been created. A summary of the results of the worst performing approach of each intersection is shown in Table 9 below, with the detailed intersection results located in Appendix C.

The key findings of the SIDRA modelling are:

- Garfield Road / Riverstone Parade intersection is consistently operating above capacity with the west approach recording DoS > 1 regardless of the development traffic.
- Significant queuing is observed along Garfield Road W which is likely to obstruct upstream intersections not captured within the study area.
- The Garfield Road / Riverstone Parade intersection east approach queue is likely to impact adjacent intersections such as Marketown Lane, Pitt Street and Oxford Street especially in the 2029 With Development (High Scenario).
- From the existing traffic survey, it is noted Garfield Road experiences relatively high percentages of heavy vehicles (15 – 28% in the AM peak)
- The rail phase is triggered 4 times per peak hour; road treatments such as the grade separation of the rail crossing should help to improve the performance of this intersection.
- The other five intersections are expected to be operate within its design capacity for the assessment years, including with the projected additional traffic from the proposed development.
- The introduction of development traffic does not significantly alter the performance of the road network in these intersections.

Table 9 Comparison of SIDRA results (worst approach)

Peak	Intersection	2019 - Existing				2029 - Without Development				2029 - With Development (Low Scenario)				2029 - With Development (High Scenario)			
		Deg. of Sat. (v/c)	LOS	95% Back of Queue (m)	Associated movement	Deg. of Sat. (v/c)	LOS	95% Back of Queue (m)	Associated movement	Deg. of Sat. (v/c)	LOS	95% Back of Queue (m)	Associated movement	Deg. of Sat. (v/c)	LOS	95% Back of Queue (m)	Associated movement
AM	Garfield Road / Riverstone Parade	1.03	LOS F	599	West	1.01	LOS F	672	West	1.04	LOS F	780	West	1.13	LOS F	1080	West
	Garfield Road / Marketown Lane	0.22	LOS A	0	West	0.27	LOS A	0	West	0.28	LOS A	0	West	0.30	LOS A	0	West
	Garfield Road / Pitt Street	0.25	LOS A	6	East	0.31	LOS A	9	East	0.32	LOS A	9	East	0.36	LOS A	10	East
	Garfield Road / Oxford Street	0.25	LOS A	0	East	0.31	LOS A	0	East	0.32	LOS A	0	East	0.35	LOS A	0	East
	Garfield Road / George Street	0.23	LOS A	0	East	0.28	LOS A	0	East	0.29	LOS A	0	East	0.31	LOS A	0	East
	Garfield Road / Piccadilly Street	0.45	LOS A	38	East	0.52	LOS A	46	East	0.56	LOS A	49	East	0.63	LOS A	55	East
PM	Garfield Road / Riverstone Parade	1.04	LOS F	466	West	0.98	LOS F	444	West	1.00	LOS F	530	West	1.14	LOS F	962	West
	Garfield Road / Marketown Lane	0.18	LOS A	0	West	0.22	LOS A	0	West	0.23	LOS A	0	West	0.28	LOS A	0	West
	Garfield Road / Pitt Street	0.21	LOS A	6	East	0.26	LOS A	9	East	0.27	LOS A	9	East	0.31	LOS A	12	East
	Garfield Road / Oxford Street	0.26	LOS A	7	West	0.33	LOS A	10	West	0.34	LOS A	11	West	0.38	LOS A	14	West
	Garfield Road / George Street	0.22	LOS A	0	West	0.27	LOS A	0	West	0.27	LOS A	0	West	0.30	LOS A	0	West
	Garfield Road / Piccadilly Street	0.45	LOS A	41	West	0.53	LOS B	52	West	0.56	LOS B	54	West	0.67	LOS B	64	West

6.4.4 Conclusions

The conclusions of the intersection modelling are:

- Garfield Road / Riverstone Parade intersection is operating above capacity in the existing year and the condition is expected to worsen with the growth in background traffic as well as the additional development traffic for the coming years.
- In line with the recommendations proposed by Arup in the previous transport assessment study, the performance and functionality of the road network surrounding the Riverstone town centre will improve with the planned grade separation of the Garfield Road level crossing.
- If the Riverstone town centre development was to occur before the removal of the level crossing, traffic queues along Garfield Road east are likely to extend past Oxford Street with the introduction of development traffic as seen in 2029 With Development High Growth Scenario.
- Garfield Road / Marketown Lane, Garfield Road / Pitt Street, Garfield Road / Oxford Street, Garfield Road / George Street and Garfield Road / Piccadilly Street intersections are expected to operate satisfactorily within the design capacity even under the With Development High Growth Scenario. The introduction of development traffic projected for 2029 does not significantly alter the performance of the road network in these intersections.
- Based on the assumed trip distribution and intersection modelling of Garfield Road / George Street, the priority intersection with the existing geometric layout is expected to operate satisfactorily in each of the scenarios tested.
- In the 2029 High Development Scenario, the minor approach of George Street recorded LOS A / B with 95% back of queue of 6 m. The signalisation of the intersection is not likely to be required for the current modelling assumptions.

6.5 Parking

6.5.1 On-Site Parking

On-site parking within the Riverstone town centre is to be provided in accordance with the relevant provisions for the proposed land use, including the Apartment Design Guide and the Blacktown DCP 2015.

It is noted that there were no site-specific car parking controls developed by the NSW Government for other local centres in the vicinity such as Schofields or Tallawong. The current level of service for public transport in the Riverstone Town Centre is insufficient to support a reduction in car parking rates.

6.5.2 Commuter Car Parking

The formal commuter car parking area located directly adjacent to Riverstone railway station only currently provides 67 all day parking spaces, which are typically fully occupied on a daily basis.

The expansion of the Market Town shopping centre (Block E2 in the Masterplan) involves development over the existing overflow commuter car parking area, which has capacity for approximately 100 vehicles.

Should the Market Town development proceed, it will be important to offset the loss of these 100 existing commuter parking spaces either within the development or elsewhere within the town centre.

6.6 Pedestrian Movements

6.6.1 Summary of Measures

The preferred Masterplan proposes a number of enhancements to the pedestrian network, including:

- New pedestrian crossing opportunity of Garfield Road East through the installation of traffic signals at George Street
- Traffic calming along Market Street including the introduction of a 40km/h high pedestrian activity area
- Pedestrianisation of the western end of Market Street, between Pitt Street and Riverstone Parade, providing a direct connection to Riverstone train station.
- New pedestrian crossing opportunity of Riverstone Parade at Market Street (either via a pedestrian refuge or zebra crossing)
- New north-south pedestrian link between Park Street and Garfield Road East

These initiatives are summarised in Figure 36 below.

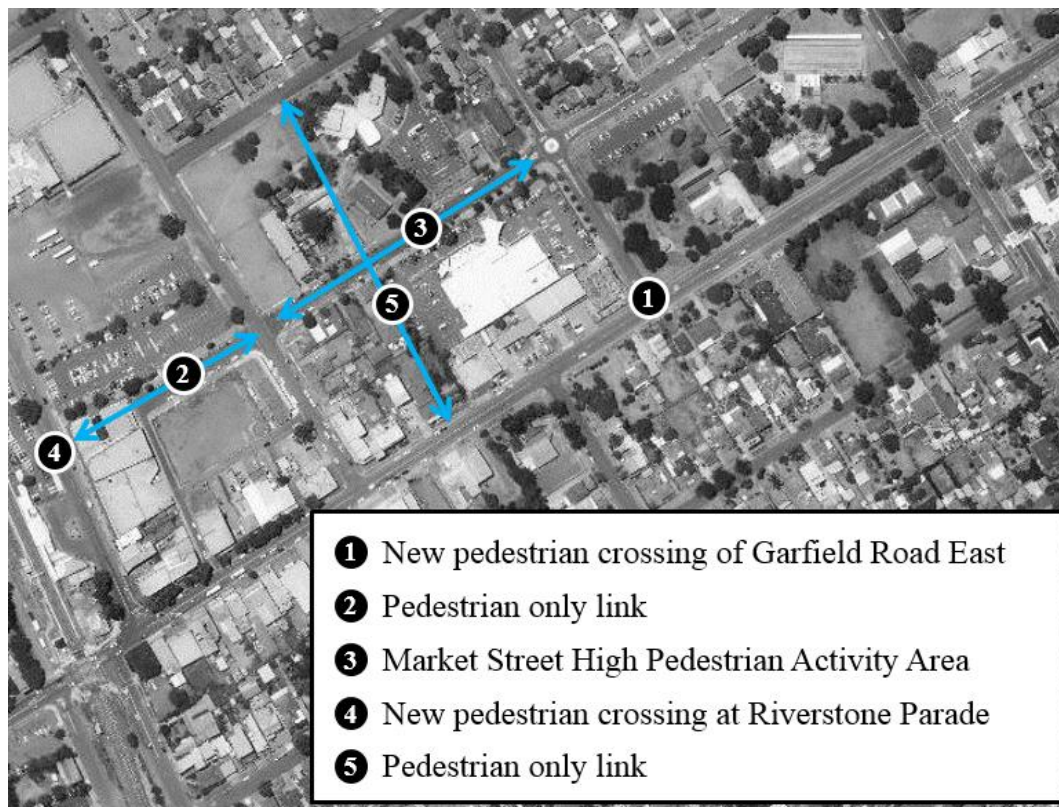


Figure 36 Summary of pedestrian improvement measures

In addition, in conjunction with the development of the town centre, accessible footpaths (ideally 3m wide) should be provided on both sides of streets to provide equitable access for all pedestrians.

6.6.2 Garfield Road Overpass

Pedestrian circulation and accessibility will need to be an important planning consideration of the Garfield Road overpass (expected to be introduced in the next 10 to 20 years). It will be particularly important to consider access for pedestrians travelling between the railway station and the town centre.

Figure 37 below provides an example of a pedestrian connection under a road overpass – at the Lane Cove Road / Epping Road intersection. While pedestrian amenity is not considered desirable at this location, it does provide an example of an environment with a road overpass where pedestrians may safely cross from one side of the road to another.



Figure 37 Lane Cove Road / Epping Road overpass

Source: Google Street View

6.7 Public Transport

6.7.1 Bus Services

It is not expected the existing bus routes servicing the Riverstone town centre would change in the short to medium term. As densification occurs within the Riverstone town centre and the population increases, demand for bus services will naturally increase. This may lead to increased service frequencies of buses which would improve access to and from the town centre.

In the long term, the population increase within the town centre may necessitate the need for new or more direct/express bus routes. Further consultation with the private bus operators (Hills Bus) to confirm this.

6.7.2 Richmond Rail Line Duplication

The NSW Government has postponed the second stage of the duplication of the Richmond Railway Line. This project, which would upgrade the existing tracks between Schofields and Vineyard stations and increase service frequencies, was initially announced in 2003 to increase capacity on the existing network.

Should the duplication of the rail line proceed it would have the effect of significantly enhancing public transport accessibility to and from the Riverstone town centre. As previously noted, the limited frequencies of the heavy rail service, particularly during off-peak and weekend periods, is one of the main contributors to the high reliance on private vehicle travel for residents and workers of the town centre. The upgrade of the rail line would provide these users a more viable travel alternative, reducing localised traffic impacts in the town centre.

6.8 Cycling

As part of the upgrade works planned for Garfield Road East, the provision of a segregated off-road cycleway should be planned. This would provide for a safe and connected bicycle route between the town centre and the shared path along Windsor Road which acts as a regional bicycle route.

Segregated bicycle facilities on other roads within the town centre are not considered warranted based on the level of expected bicycle activity. However, roads should be planned and designed to provide for safe bicycle movements via a number of mechanisms including wide kerbside travel lanes, traffic calming devices to lower vehicle travel speeds and on-road bicycle symbols to notify motorists of the presence of cyclists.

7 Summary

Arup has prepared this transport assessment to support the development of a Masterplan for the Riverstone town centre. It is envisaged that the Masterplan will create a thriving, economically viable, well designed and safe town centre. The assessment aims to:

- Identify existing transport infrastructure and traffic and transport trends;
- Consider the current function of the transport network including local and arterial roads, public transport services, car parking, pedestrian networks and cycling routes;
- Identify any improvements to the transport network that are necessary to implement the recommendations of the town centre Masterplan; and
- Identify future transport needs to manage growth within the area

The Masterplan focuses activity predominantly along the Market Street corridor, centred around the community hub and village green. High density mixed use development is proposed close to the railway station, with medium density residential (up to six storeys) location towards the periphery of the town centre.

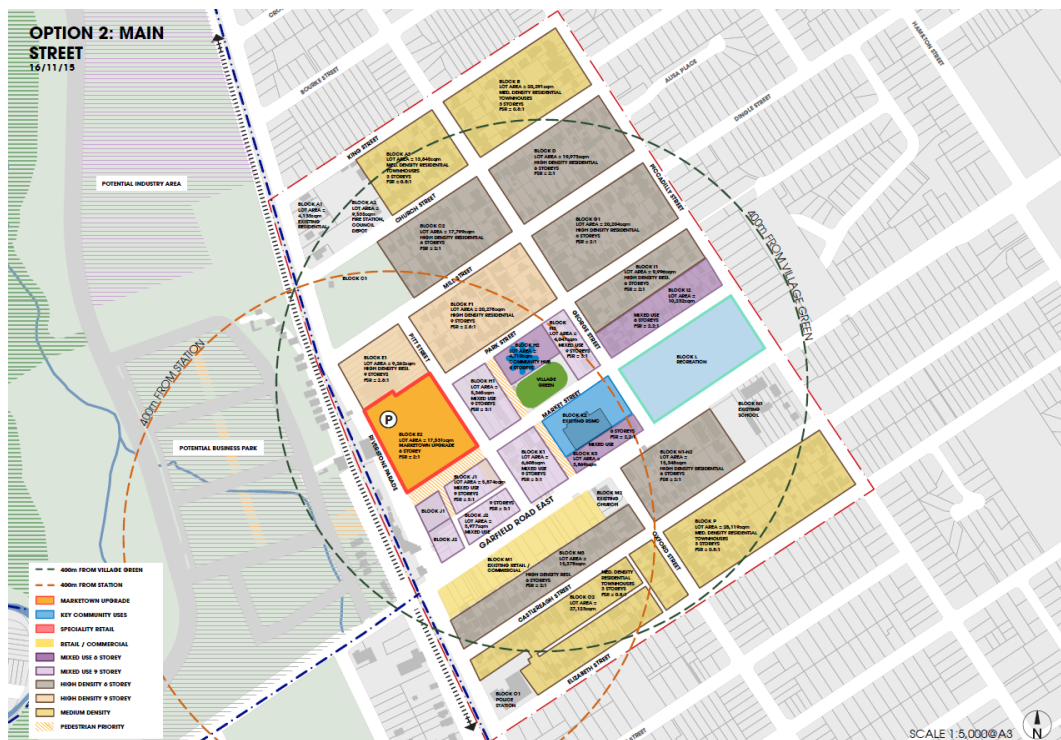


Figure 38 Preferred town centre Masterplan

Source: Group GSA

The transport strategy supporting the Masterplan has identified a number of measures which aim to provide for a coherent, legible transport network that supports movement both to, and within, the Riverstone town centre. These measures include:

- Improve traffic flow within Riverstone town centre to boost capacity and minimise delays at the existing Riverstone Parade / Garfield Road signalised intersection
- Introduction of a 40km/h High Pedestrian Activity Areas on Market Street – the main activity spine of the town centre
- Downgrading the role of Riverstone Parade and introducing a pedestrian crossing opportunity to enhance pedestrian accessibility across Riverstone Parade between the railway station and the town centre
- Maintaining the 100 overflow commuter parking bays as part of any redevelopment of the Market Town site
- Pedestrianisation of the western end of Market Street, between Pitt Street and Riverstone Parade, providing a direct connection to Riverstone train station.
- Introduction of a new north-south pedestrian link between Park Street and Garfield Road East
- Providing for pedestrian crossing opportunities of Garfield Road near Riverstone station following the introduction of the road overpass
- Implementation of paved footpaths on both sides of all streets within the town centre
- Investigating the increase of bus service frequencies as the town centre develops
- Introduction of a segregated off-road cycleway as part of the upgrade of Garfield Road East
- Providing a safe environment for cyclists on all local streets within the town centre.

Appendix A

Riverstone Town Centre – Estimated Development Yields

Riverstone Town Centre: estimated development yields

1. Riverstone Town Centre Masterplan

The Riverstone Town Centre Masterplan (February 2018) was supported by an Economic and Feasibility Analysis report prepared by AEC (prepared 2015 and updated February 2018). That report estimated the following development yields based on the preferred masterplan option:

- Retail floorspace (12,373 sqm), supermarket floorspace (3,500 sqm)
- Commercial floorspace (9,373 sqm)
- Residential floorspace (475,561 sqm or 3,804 units)
- Community/recreation floorspace (5,000 sqm).

These development yields were based on AEC assumptions about possible future planning controls and market demand, particularly for the non-residential uses.

2. Planning Proposal

The exhibited Stage 1 Planning Proposal references these estimated yields provided by AEC for the masterplan area. They don't reflect the true yields generated by the Planning Proposal, being a portion of the masterplan area.

We have now reviewed the estimated residential yields based on the exhibited planning controls and more updated information on development capacity, particularly around flooding. We have no data to suggest that the capacity for the non-residential floorspaces will change.

Non-residential (retail/commercial)

The AEC report provided estimated floorspace for retail and commercial land uses for the ultimate masterplan. The table below shows the current, proposed and increase in retail and commercial floorspace as part of the Planning Proposal.

Land use	Floorspace (sqm)		
	Current	Proposed	Increase
Retail	8,661	12,373	3,712
Commercial	6,561	9,373	2,812
Total	15,222	21,726	6,524

Residential yield

Our revised estimates of residential yield are outlined below, with suggested take-up rates. They reflect the planning capacity generated by the controls in the Planning Proposal and future estimated controls in the remaining area covered by the masterplan. They don't reflect market capacity, which is a more realistic estimate of development yield.

Residential development capacity	Planning Proposal		Remaining area of Masterplan		Total Masterplan area (Planning Proposal + remaining area)	
	Dwellings	Population	Dwellings	Population	Dwellings	Population
Existing	425	1,147	407	1,098	832	2,245
Proposed	3,707	10,010	581	1,499	4,288	11,509
Increase	3,283	8,863	174	401	3,457	9,264

- **Residential take-up**

The take-up is based on the Planning Proposal proposed dwelling yield of 3,707. The remaining area covered by the masterplan will not be rezoned until the regional road network strategy upgrades have been implemented, specifically the replacement level crossing on Garfield Road and Bandon Road extension to Richmond Road.

Growth scenarios	0-5 years (2021-2026)	6-10 years (2027-2031)	11-20 years (2032-2041)	20+ years (2041+)
Low	-	200 (200)	400 (600)	600 (1200)
Medium	-	400 (400)	700 (1100)	1,100 (2,200)
High	-	800 (800)	1,300 (2,100)	1,600 (3,700)

(cumulative total)

Considerations that influence take-up:

- Timing of regional road network improvements
- Timing of public transport improvements, including the duplication of the Richmond Railway Line
- Continued development and population growth in the North West Growth Area precincts
- Investment and local employment opportunities in the Town Centre
- Investment in the public domain and community services in the Town Centre
- Market demand for high density development in the Town Centre
- Developers ability to assemble site for redevelopment – it is assumed that no development will occur in the first 5 years post completion of the Planning Proposal on this basis as developers need to acquire land, obtain planning approvals and undertake any required infrastructure upgrades before dwellings can be made available.

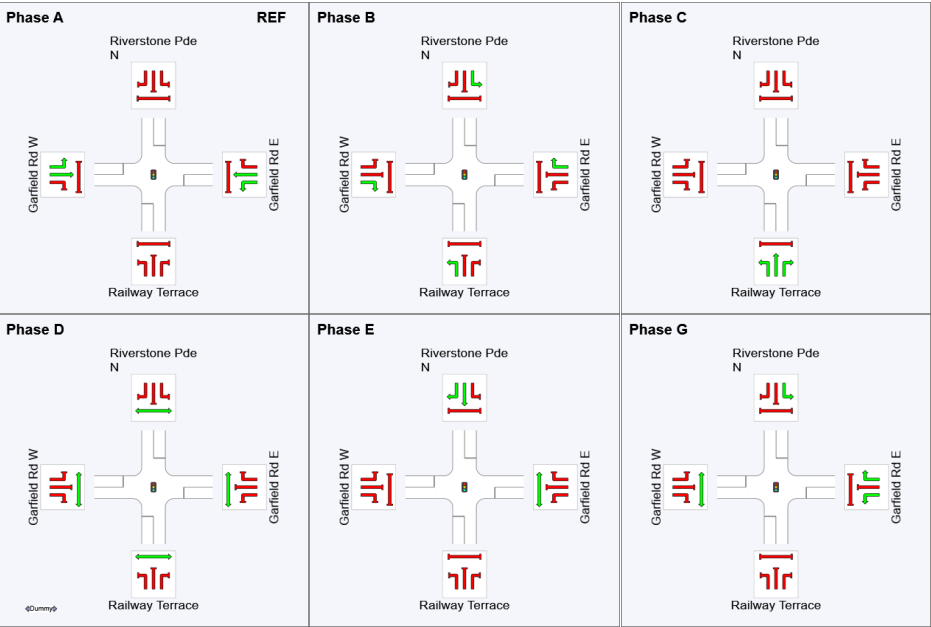
Appendix B

SIDRA – Signal Timings

Draft

Garfield Road / Riverstone Parade / Railway Terrace Signalised Intersection (J1)

Phasing



2019 - Existing

Time Period	Phase	A	B	C	D	E	G
AM Peak (160s User-Given Phase Times)	Phase Change Time (s)	0	52	67	96	118	147
	Green Time (s)	49	9	23	16	23	7
	Yellow Time (s)	4	4	4	4	4	4
	All-Red Time (s)	2	2	2	2	2	2
	Phase Time (s)	55	15	29	22	29	10
	Phase Split	34%	9%	18%	14%	18%	6%
PM Peak (158s User-Given Phase Times)	Phase Change Time (s)	0	43	63	96	118	145
	Green Time (s)	40	14	27	16	21	7
	Yellow Time (s)	4	4	4	4	4	4
	All-Red Time (s)	2	2	2	2	2	2
	Phase Time (s)	46	20	33	22	27	10
	Phase Split	29%	13%	21%	14%	17%	6%

2024 Without Development

Time Period	Phase	A	B	C	D	E	G
AM Peak (160s User-Given Cycle Time)	Phase Change Time (s)	0	67	79	100	122	148
	Green Time (s)	61	6	15	16	20	6
	Yellow Time (s)	4	4	4	4	4	4
	All-Red Time (s)	2	2	2	2	2	2
	Phase Time (s)	67	12	21	22	26	12
	Phase Split	42%	8%	13%	14%	16%	8%
PM Peak (158s User-Given Cycle Time)	Phase Change Time (s)	0	58	70	95	117	146
	Green Time (s)	52	6	19	16	23	6
	Yellow Time (s)	4	4	4	4	4	4
	All-Red Time (s)	2	2	2	2	2	2
	Phase Time (s)	58	12	25	22	29	12
	Phase Split	37%	8%	16%	14%	18%	8%

2029 Without Development

Time Period	Phase	A	B	C	D	E	G
AM Peak (160s User-Given Cycle Time)	Phase Change Time (s)	0	67	79	100	122	148
	Green Time (s)	61	6	15	16	20	6
	Yellow Time (s)	4	4	4	4	4	4
	All-Red Time (s)	2	2	2	2	2	2
	Phase Time (s)	67	12	21	22	26	12
	Phase Split	42%	8%	13%	14%	16%	8%
PM Peak (158s User-Given Cycle Time)	Phase Change Time (s)	0	58	70	95	117	146
	Green Time (s)	52	6	19	16	23	6
	Yellow Time (s)	4	4	4	4	4	4
	All-Red Time (s)	2	2	2	2	2	2
	Phase Time (s)	58	12	25	22	29	12
	Phase Split	37%	8%	16%	14%	18%	8%

2029 With Development (Low Scenario)

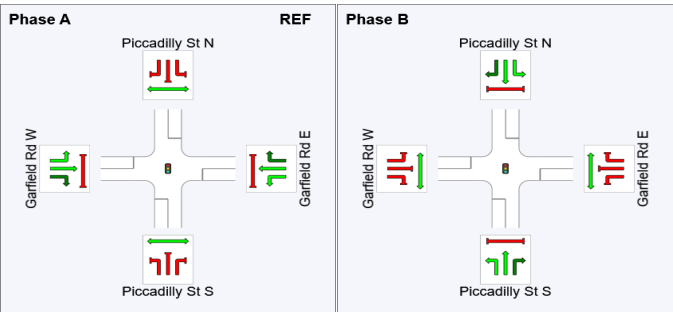
Time Period	Phase	A	B	C	D	E	G
AM Peak (160s User-Given Cycle Time)	Phase Change Time (s)	0	66	78	99	121	148
	Green Time (s)	60	6	15	16	21	6
	Yellow Time (s)	4	4	4	4	4	4
	All-Red Time (s)	2	2	2	2	2	2
	Phase Time (s)	66	12	21	22	27	12
	Phase Split	41%	8%	13%	14%	17%	8%
PM Peak (158s User-Given Cycle Time)	Phase Change Time (s)	0	59	71	96	118	146
	Green Time (s)	53	6	19	16	22	6
	Yellow Time (s)	4	4	4	4	4	4
	All-Red Time (s)	2	2	2	2	2	2
	Phase Time (s)	59	12	25	22	28	12
	Phase Split	37%	8%	16%	14%	18%	8%

2029 With Development (High Scenario)

Time Period	Phase	A	B	C	D	E	G
AM Peak (160s User-Given Cycle Time)	Phase Change Time (s)	0	64	76	98	120	148
	Green Time (s)	58	6	16	16	22	6
	Yellow Time (s)	4	4	4	4	4	4
	All-Red Time (s)	2	2	2	2	2	2
	Phase Time (s)	64	12	22	22	28	12
	Phase Split	40%	8%	14%	14%	18%	8%
PM Peak (158s User-Given Cycle Time)	Phase Change Time (s)	0	59	71	96	118	146
	Green Time (s)	53	6	19	16	22	6
	Yellow Time (s)	4	4	4	4	4	4
	All-Red Time (s)	2	2	2	2	2	2
	Phase Time (s)	59	12	25	22	28	12
	Phase Split	37%	8%	16%	14%	18%	8%

Garfield Road / Piccadilly Street Signalised Intersection (J6)

Phasing



2019 - Existing

Time Period	Phase	A	B
AM Peak (44s User-Given Phase Times)	Phase Change Time (s)	0	23
	Green Time (s)	17	15
	Yellow Time (s)	4	4
	All-Red Time (s)	2	2
	Phase Time (s)	23	21
	Phase Split	52%	48%
PM Peak (53s User-Given Phase Times)	Phase Change Time (s)	0	25
	Green Time (s)	19	22
	Yellow Time (s)	4	4
	All-Red Time (s)	2	2
	Phase Time (s)	25	28
	Phase Split	47%	53%

2024 Without Development

Time Period	Phase	A	B
AM Peak (44s User-Given Cycle Time)	Phase Change Time (s)	0	24
	Green Time (s)	18	14
	Yellow Time (s)	4	4
	All-Red Time (s)	2	2
	Phase Time (s)	24	20
	Phase Split	55%	45%
PM Peak (53s User-Given Cycle Time)	Phase Change Time (s)	0	26
	Green Time (s)	20	21
	Yellow Time (s)	4	4
	All-Red Time (s)	2	2
	Phase Time (s)	26	27
	Phase Split	49%	51%

2029 Without Development

Time Period	Phase	A	B
AM Peak (44s User-Given Cycle Time)	Phase Change Time (s)	0	24
	Green Time (s)	18	14
	Yellow Time (s)	4	4
	All-Red Time (s)	2	2
	Phase Time (s)	24	20
	Phase Split	55%	45%
PM Peak (53s User-Given Cycle Time)	Phase Change Time (s)	0	26
	Green Time (s)	20	21
	Yellow Time (s)	4	4
	All-Red Time (s)	2	2
	Phase Time (s)	26	27
	Phase Split	49%	51%

2029 With Development (Low Scenario)

Time Period	Phase	A	B
AM Peak (44s User-Given Cycle Time)	Phase Change Time (s)	0	23
	Green Time (s)	17	15
	Yellow Time (s)	4	4
	All-Red Time (s)	2	2
	Phase Time (s)	23	21
	Phase Split	52%	48%
PM Peak (53s User-Given Cycle Time)	Phase Change Time (s)	0	26
	Green Time (s)	20	21
	Yellow Time (s)	4	4
	All-Red Time (s)	2	2
	Phase Time (s)	26	27
	Phase Split	49%	51%

2029 With Development (High Scenario)

Time Period	Phase	A	B
AM Peak (44s User-Given Cycle Time)	Phase Change Time (s)	0	22
	Green Time (s)	16	16
	Yellow Time (s)	4	4
	All-Red Time (s)	2	2
	Phase Time (s)	22	22
	Phase Split	50%	50%
PM Peak (53s User-Given Cycle Time)	Phase Change Time (s)	0	26
	Green Time (s)	20	21
	Yellow Time (s)	4	4
	All-Red Time (s)	2	2
	Phase Time (s)	26	27
	Phase Split	49%	51%

Appendix C

SIDRA Modelling Results

Draft

C1 Garfield Road / Riverstone Parade / Railway Terrace Signalised Intersection (J1)

The existing geometric layout of Garfield Road / Riverstone Parade / Railway Terrace signalised intersection is shown in Figure 39. The existing phasing and average signal timing from SCATS data have been modelled for both the AM and PM peaks. These are shown in Figure 40 and Table 10.

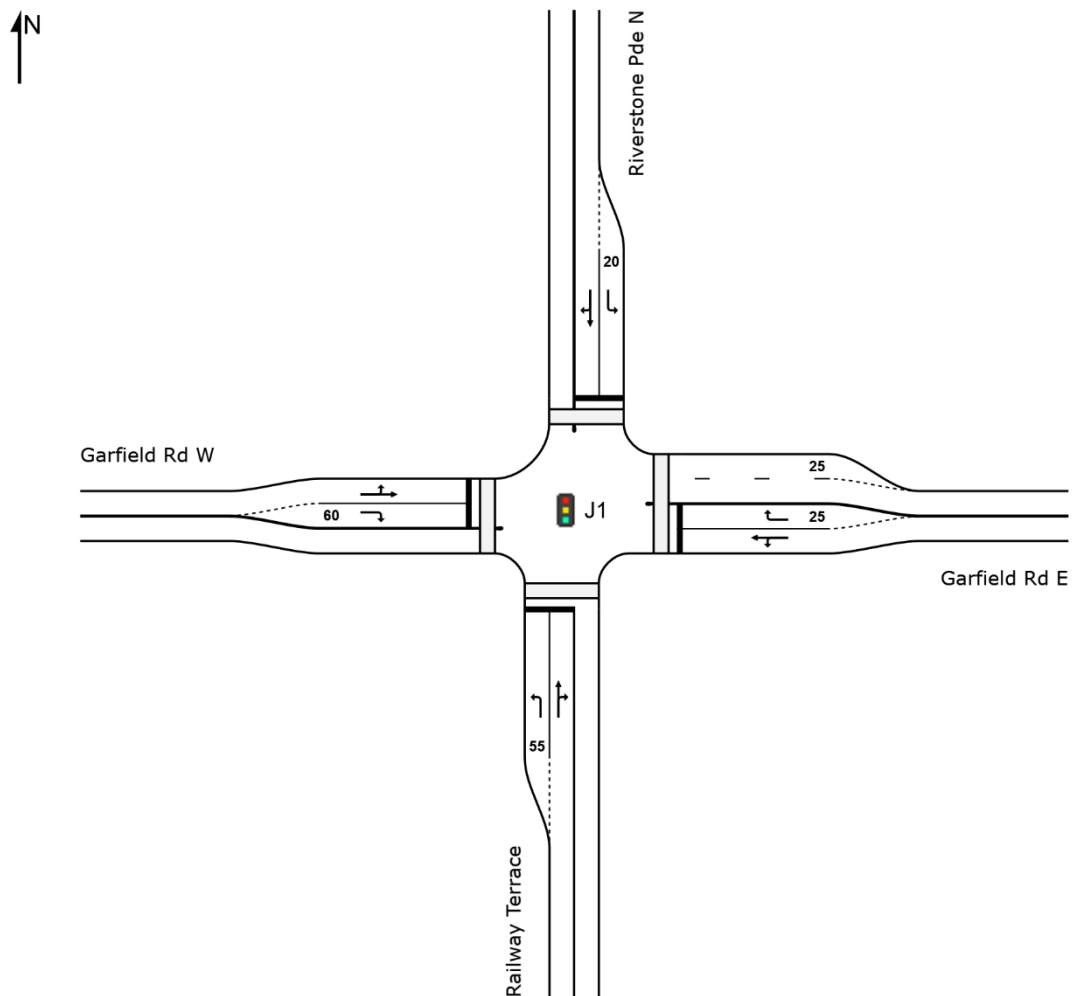


Figure 39 Existing geometric layout of Garfield Road / Riverstone Parade / Railway Terrace Signalised Intersection

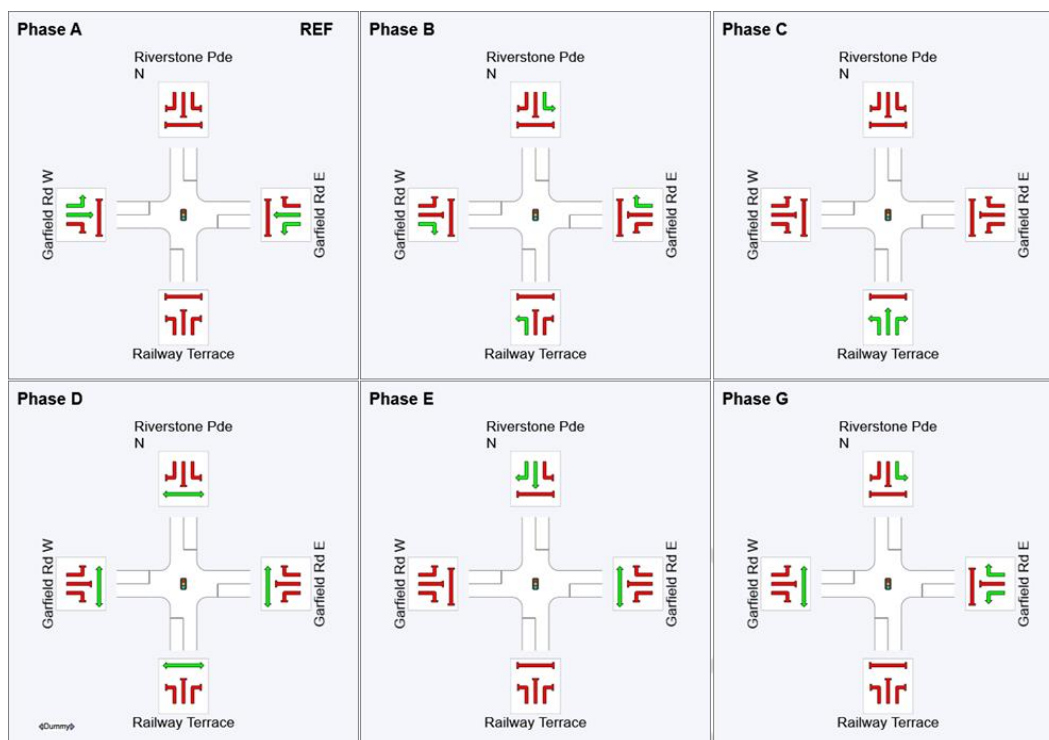


Figure 40 Existing phasing of Garfield Road / Riverstone Parade / Railway Terrace Signalised Intersection

Table 10 Existing phase timing of Garfield Road / Riverstone Parade / Railway Terrace Signalised Intersection

Time Period	Phase	A	B	C	D	E	G
AM Peak (160s User-Given Phase Times)	Phase Change Time (s)	0	52	67	96	118	147
	Green Time (s)	49	9	23	16	23	7
	Yellow Time (s)	4	4	4	4	4	4
	All-Red Time (s)	2	2	2	2	2	2
	Phase Time (s)	55	15	29	22	29	10
	Phase Split	34%	9%	18%	14%	18%	6%
PM Peak (158s User-Given Phase Times)	Phase Change Time (s)	0	43	63	96	118	145
	Green Time (s)	40	14	27	16	21	7
	Yellow Time (s)	4	4	4	4	4	4
	All-Red Time (s)	2	2	2	2	2	2
	Phase Time (s)	46	20	33	22	27	10
	Phase Split	29%	13%	21%	14%	17%	6%

The SIDRA results for the existing intersection performance (2019) are summarised in Table 11. The key findings of the base modelling were:

- The intersection has exceeded capacity in both peaks, with the west approach recorded DoS more than 1
- Several movements registered LOS E / F in both peaks
- The west approach experiences long queues, which is consistent with the site observation

- The east approach queue is noted to extend past Marketown Lane and Pitt Street
- The intersection is operating above capacity under existing conditions.

Table 11 SIDRA results of 2019 Garfield Road / Riverstone Parade / Railway Terrace Signalised Intersection

Time Period	Approach	Movement	2019 – Existing				
			Demand Flows (veh/hr)	Deg. of Sat.	Average Delay (s)	LOS	95% Back of Queue (m)
AM Peak	Railway Terrace (South)	Left	17	0.04	54	LOS D	8
		Through	109	0.54	70	LOS E	79
		Right	22	0.54	75	LOS F	79
	Garfield Road E (East)	Left	23	0.67	52	LOS D	187
		Through	328	0.67	49	LOS D	187
		Right	10	0.06	41	LOS C	3
	Riverstone Parade (North)	Left	11	0.06	43	LOS D	4
		Through	29	0.72	74	LOS F	108
		Right	112	0.72	79	LOS F	108
	Garfield Road W (West)	Left	159	1.03	179	LOS F	599
		Through	334	1.03	174	LOS F	599
		Right	18	0.19	86	LOS F	11
	Overall LOS		LOS F				
PM Peak	Railway Terrace (South)	Left	49	0.09	47	LOS D	19
		Through	118	0.54	65	LOS E	90
		Right	47	0.54	70	LOS E	90
	Garfield Road E (East)	Left	36	0.63	58	LOS E	149
		Through	258	0.63	55	LOS D	149
		Right	10	0.04	39	LOS C	3
	Riverstone Parade (North)	Left	16	0.07	41	LOS C	6
		Through	46	0.86	83	LOS F	121
		Right	137	0.86	87	LOS F	121
	Garfield Road W (West)	Left	163	1.04	184	LOS F	466
		Through	275	1.04	179	LOS F	466
		Right	39	0.24	79	LOS F	21
	Overall LOS		LOS F				

The SIDRA results for the future intersection performance are summarised in Table 12. The optimised phase timings used in these scenarios are documented in Appendix B. The key findings of this analysis are:

- The intersection is expected to exceed its capacity in the future assessment years even without the development traffic.
- Several movements from the south, north and west approaches have registered LOS F in both peaks.
- The west approach experiences the worst queuing, as far back as 1080 m in the AM peak of 2029 With Development (High Scenario) which would likely obstruct several upstream minor intersections outside the study area.
- The east approach queue is relatively long and likely to extend past Oxford Street in the AM Peak of 2029 With Development (High Scenario).
- The intersection is likely to be operating at above capacity for the future scenarios and intervention would be required to improve the traffic flow.

Draft

Table 12 SIDRA results of future Garfield Road / Riverstone Parade / Railway Terrace Signalised Intersection

Time Period	Approach	Movement	2024 – Without Development					2029 – Without Development					2029 – With Development (Low Scenario)					2029 – With Development (High Scenario)				
			Demand Flows (veh/hr)	Deg. of Sat.	Average Delay (s)	LOS	95% Back of Queue (m)	Demand Flows (veh/hr)	Deg. of Sat.	Average Delay (s)	LOS	95% Back of Queue (m)	Demand Flows (veh/hr)	Deg. of Sat.	Average Delay (s)	LOS	95% Back of Queue (m)	Demand Flows (veh/hr)	Deg. of Sat.	Average Delay (s)	LOS	95% Back of Queue (m)
AM Peak	Railway Terrace (South)	Left	20	0.07	65	LOS E	10	22	0.08	65	LOS E	11	26	0.09	65	LOS E	13	36	0.12	64	LOS E	18
		Through	121	0.93	99	LOS F	111	133	1.02	163	LOS F	162	137	1.05	208	LOS F	193	149	1.10	278	LOS F	253
		Right	26	0.93	104	LOS F	111	28	1.02	168	LOS F	162	30	1.05	213	LOS F	193	37	1.10	283	LOS F	253
	Garfield Road E (East)	Left	26	0.60	44	LOS D	191	29	0.66	45	LOS D	215	29	0.69	46	LOS D	229	31	0.81	51	LOS D	279
		Through	363	0.60	41	LOS C	191	398	0.66	42	LOS C	215	418	0.69	43	LOS D	229	479	0.81	48	LOS D	279
		Right	12	0.10	43	LOS D	4	13	0.10	43	LOS D	4	16	0.13	43	LOS D	5	23	0.18	43	LOS D	7
	Riverstone Parade (North)	Left	14	0.11	44	LOS D	4	15	0.12	44	LOS D	5	16	0.13	44	LOS D	5	20	0.15	45	LOS D	6
		Through	33	0.94	106	LOS F	150	36	1.03	180	LOS F	223	40	1.03	184	LOS F	237	51	1.13	322	LOS F	374
		Right	125	0.94	111	LOS F	150	137	1.03	185	LOS F	223	145	1.03	189	LOS F	237	167	1.13	327	LOS F	374
	Garfield Road W (West)	Left	177	0.92	78	LOS F	437	193	1.01	147	LOS F	672	194	1.04	191	LOS F	780	197	1.13	321	LOS F	1080
		Through	370	0.92	74	LOS F	437	405	1.01	142	LOS F	672	416	1.04	186	LOS F	780	446	1.13	317	LOS F	1080
		Right	21	0.33	91	LOS F	14	23	0.36	91	LOS F	15	24	0.38	92	LOS F	15	25	0.39	92	LOS F	16
	Overall LOS		LOS F					LOS F					LOS F					LOS F				
PM Peak	Railway Terrace (South)	Left	56	0.16	61	LOS E	26	61	0.17	61	LOS E	28	62	0.17	61	LOS E	29	64	0.18	61	LOS E	29
		Through	131	0.89	87	LOS F	121	144	0.99	135	LOS F	171	149	1.02	164	LOS F	197	165	1.10	271	LOS F	284
		Right	53	0.89	91	LOS F	121	58	0.99	140	LOS F	171	59	1.02	168	LOS F	197	60	1.10	275	LOS F	284
	Garfield Road E (East)	Left	41	0.55	48	LOS D	152	45	0.60	49	LOS D	170	46	0.60	49	LOS D	173	51	0.64	49	LOS D	187
		Through	286	0.55	45	LOS D	152	313	0.60	46	LOS D	170	320	0.60	46	LOS D	173	341	0.64	46	LOS D	187
		Right	12	0.09	42	LOS C	4	13	0.09	42	LOS C	4	18	0.13	42	LOS C	5	34	0.24	43	LOS D	10
	Riverstone Parade (North)	Left	19	0.15	45	LOS D	7	20	0.16	45	LOS D	7	21	0.16	45	LOS D	7	22	0.17	45	LOS D	7
		Through	52	0.89	85	LOS F	139	56	0.97	114	LOS F	181	59	1.04	183	LOS F	241	67	1.11	289	LOS F	337
		Right	152	0.89	90	LOS F	139	167	0.97	119	LOS F	181	170	1.04	188	LOS F	241	180	1.11	294	LOS F	337
	Garfield Road W (West)	Left	181	0.89	71	LOS F	311	198	0.98	113	LOS F	444	200	1.00	141	LOS F	530	206	1.14	335	LOS F	962
		Through	305	0.89	67	LOS E	311	334	0.98	108	LOS F	444	360	1.00	136	LOS F	530	435	1.14	330	LOS F	962
		Right	44	0.64	92	LOS F	26	48	0.70	93	LOS F	29	50	0.73	94	LOS F	30	57	0.83	96	LOS F	35
	Overall LOS		LOS E					LOS F					LOS F					LOS F				

C2 Garfield Road / Marketown Lane Priority Intersection (J2)

The existing geometric layout of Garfield Road / Marketown Lane priority intersection is shown in Figure 41.

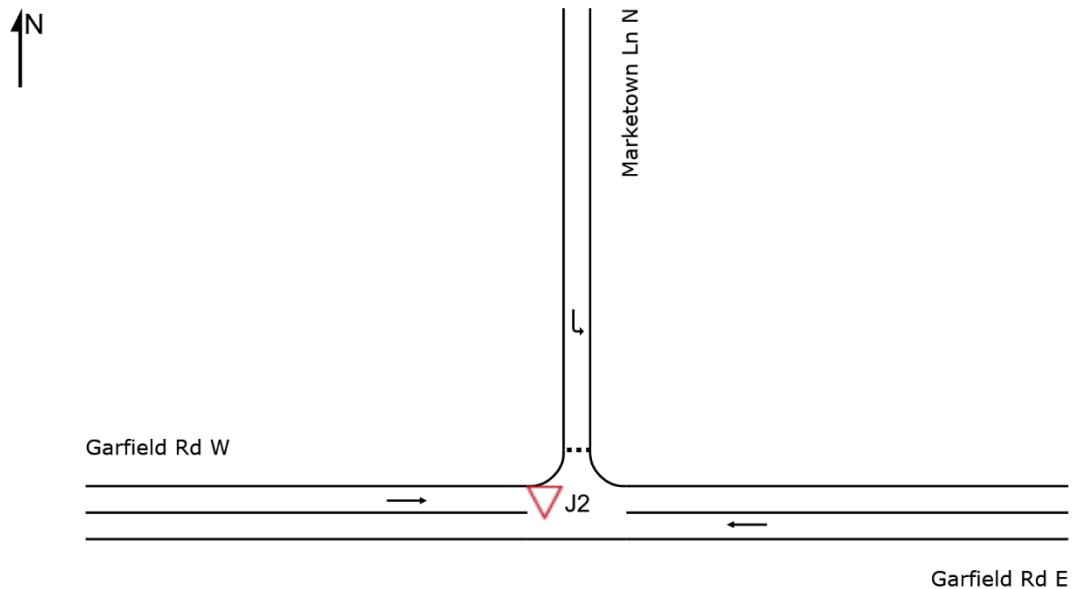


Figure 41 Existing geometric layout of Garfield Road / Marketown Lane Priority Intersection

The SIDRA results for the existing intersection performance (2019) are summarised in Table 13. The key findings of the analysis are:

- The intersection is performing within its design capacity with all movements recorded LOS A
- The intersection operates within capacity under existing conditions.

Table 13 SIDRA results of 2019 Garfield Road / Marketown Lane Priority Intersection

Time Period	Approach	Movement	2019 – Existing				
			Demand Flows (veh/hr)	Deg. of Sat.	Average Delay (s)	LOS	95% Back of Queue (m)
AM Peak	Garfield Road E (East)	Through	353	0.20	0	LOS A	0
	Marketown Lane (North)	Left	1	0.00	6	LOS A	0
	Garfield Road E (West)	Through	367	0.22	0	LOS A	0
	Overall LOS		N/A				

PM Peak	Garfield Road E (East)	Through	278	0.15	0	LOS A	0
	Marketown Lane (North)	Left	41	0.04	6	LOS A	1
	Garfield Road E (West)	Through	338	0.18	0	LOS A	0
	Overall LOS		N/A				

The SIDRA results for the future intersection performance are summarised in Table 14. The key findings of the analysis are:

- The intersection is likely to perform within its design capacity with all movements recording LOS A for each forecast scenario
- The intersection likely operates within capacity for all future scenarios tested.

Table 14 SIDRA results of future Garfield Road / Marketown Lane Priority Intersection

Time Period	Approach	Movement	2024 – Without Development					2029 – Without Development					2029 – With Development (Low Scenario)					2029 – With Development (High Scenario)				
			Demand Flows (veh/hr)	Deg. of Sat.	Average Delay (s)	LOS	95% Back of Queue (m)	Demand Flows (veh/hr)	Deg. of Sat.	Average Delay (s)	LOS	95% Back of Queue (m)	Demand Flows (veh/hr)	Deg. of Sat.	Average Delay (s)	LOS	95% Back of Queue (m)	Demand Flows (veh/hr)	Deg. of Sat.	Average Delay (s)	LOS	95% Back of Queue (m)
AM Peak	Garfield Road E (East)	Through	391	0.22	0	LOS A	0	428	0.24	0	LOS A	0	451	0.25	0	LOS A	0	520	0.29	0	LOS A	0
	Marketown Lane (North)	Left	1	0.00	6	LOS A	0	1	0.00	6	LOS A	0	1	0.00	6	LOS A	0	1	0.00	7	LOS A	0
	Garfield Road E (West)	Through	407	0.25	0	LOS A	0	445	0.27	0	LOS A	0	459	0.28	0	LOS A	0	500	0.30	0	LOS A	0
	Overall LOS		N/A					N/A					N/A					N/A				
PM Peak	Garfield Road E (East)	Through	308	0.17	0	LOS A	0	337	0.18	0	LOS A	0	351	0.19	0	LOS A	0	392	0.21	0	LOS A	0
	Marketown Lane (North)	Left	46	0.04	6	LOS A	2	50	0.05	7	LOS A	2	50	0.05	7	LOS A	2	50	0.06	7	LOS A	2
	Garfield Road E (West)	Through	374	0.20	0	LOS A	0	410	0.22	0	LOS A	0	437	0.23	0	LOS A	0	516	0.28	0	LOS A	0
	Overall LOS		N/A					N/A					N/A					N/A				

C3 Garfield Road / Pitt Street Priority Intersection (J3)

The existing geometric layout of Garfield Road / Pitt Street priority intersection is shown in Figure 42.

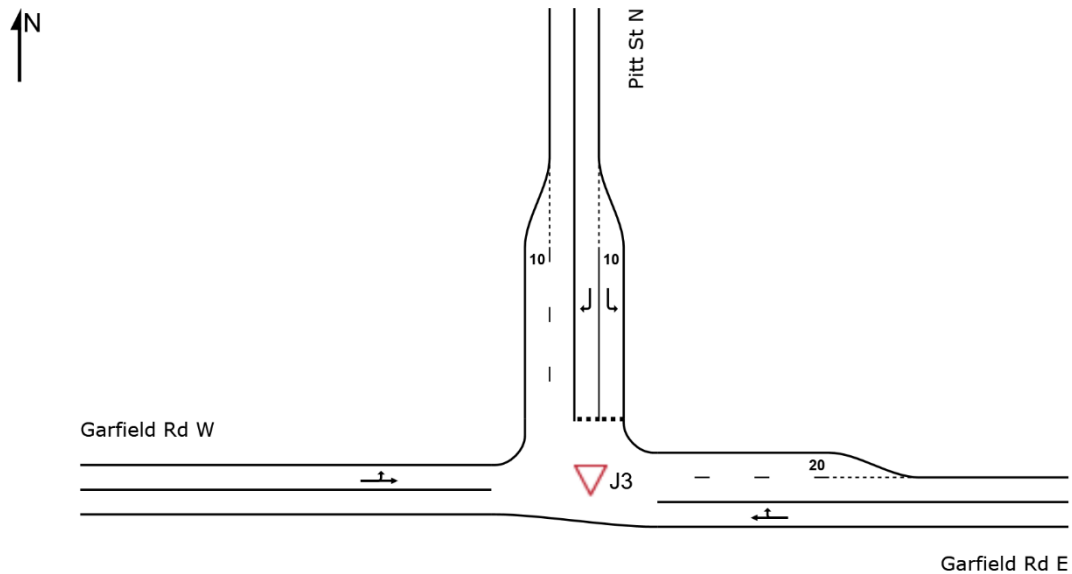


Figure 42 Existing geometric layout of Garfield Road / Pitt Street Priority Intersection

The SIDRA results for the existing intersection performance (2019) are summarised in Table 15. The key findings of this analysis are:

- The intersection is performing within its design capacity with all movements recorded LOS A
- The intersection operates within capacity under existing conditions.

Table 15 SIDRA results of 2019 Garfield Road / Pitt Street Priority Intersection

Time Period	Approach	Movement	2019 – Existing				
			Demand Flows (veh/hr)	Deg. of Sat.	Average Delay (s)	LOS	95% Back of Queue (m)
AM Peak	Garfield Road E (East)	Through	329	0.25	0	LOS A	6
		Right	96	0.25	6	LOS A	6
	Pitt Street (North)	Left	128	0.09	5	LOS A	3
		Right	24	0.04	8	LOS A	1
	Garfield Road E (West)	Left	26	0.13	5	LOS A	0
		Through	199	0.13	0	LOS A	0
	Overall LOS		N/A				
		Through	240	0.21	1	LOS A	6

PM Peak	Garfield Road E (East)	Right	87	0.21	7	LOS A	6
	Pitt Street (North)	Left	150	0.13	6	LOS A	5
		Right	38	0.06	8	LOS A	1
	Garfield Road E (West)	Left	62	0.21	5	LOS A	0
		Through	317	0.21	0	LOS A	0
	Overall LOS		N/A				

The SIDRA results for the future intersection performance are summarised in Table 16. The key findings of the analysis are:

- The intersection is still performing within its design capacity with all movements recording LOS A, even with the additional development traffic along Garfield Road E as well as Pitt Street in both peaks.
- The intersection likely operates within capacity for all future scenarios tested.

Table 16 SIDRA results of future Garfield Road / Pitt Street Priority Intersection

Time Period	Approach	Movement	2024 – Without Development					2029 – Without Development					2029 – With Development (Low Scenario)					2029 – With Development (High Scenario)				
			Demand Flows (veh/hr)	Deg. of Sat.	Average Delay (s)	LOS	95% Back of Queue (m)	Demand Flows (veh/hr)	Deg. of Sat.	Average Delay (s)	LOS	95% Back of Queue (m)	Demand Flows (veh/hr)	Deg. of Sat.	Average Delay (s)	LOS	95% Back of Queue (m)	Demand Flows (veh/hr)	Deg. of Sat.	Average Delay (s)	LOS	95% Back of Queue (m)
AM Peak	Garfield Road E (East)	Through	364	0.28	1	LOS A	8	399	0.31	1	LOS A	9	420	0.32	1	LOS A	9	483	0.36	1	LOS A	10
		Right	107	0.28	6	LOS A	8	117	0.31	6	LOS A	9	118	0.32	6	LOS A	9	119	0.36	7	LOS A	10
	Pitt Street (North)	Left	143	0.11	5	LOS A	4	156	0.12	6	LOS A	4	161	0.13	6	LOS A	4	175	0.14	6	LOS A	5
		Right	28	0.05	9	LOS A	1	30	0.06	9	LOS A	1	32	0.06	10	LOS A	1	38	0.08	11	LOS A	2
	Garfield Road E (West)	Left	30	0.15	5	LOS A	0	33	0.16	5	LOS A	0	37	0.17	5	LOS A	0	49	0.19	5	LOS A	0
		Through	221	0.15	0	LOS A	0	242	0.16	0	LOS A	0	252	0.17	0	LOS A	0	281	0.19	0	LOS A	0
	Overall LOS		N/A					N/A					N/A					N/A				
	PM Peak	Garfield Road E (East)	Through	266	0.23	1	LOS A	8	291	0.26	1	LOS A	9	304	0.27	1	LOS A	9	343	0.31	2	LOS A
Right			97	0.23	7	LOS A	8	106	0.26	7	LOS A	9	107	0.27	8	LOS A	9	111	0.31	8	LOS A	12
Pitt Street (North)		Left	167	0.15	6	LOS A	5	182	0.17	6	LOS A	6	184	0.17	7	LOS A	6	190	0.19	7	LOS A	7
		Right	43	0.07	8	LOS A	2	47	0.08	9	LOS A	2	48	0.09	9	LOS A	2	50	0.11	11	LOS A	3
Garfield Road E (West)		Left	70	0.23	5	LOS A	0	76	0.25	5	LOS A	0	85	0.27	5	LOS A	0	110	0.31	5	LOS A	0
		Through	352	0.23	0	LOS A	0	385	0.25	0	LOS A	0	404	0.27	0	LOS A	0	457	0.31	0	LOS A	0
Overall LOS		N/A					N/A					N/A					N/A					

C4 Garfield Road / Oxford Street Priority Intersection (J4)

The existing geometric layout of Garfield Road / Oxford Street priority intersection is shown in Figure 43.

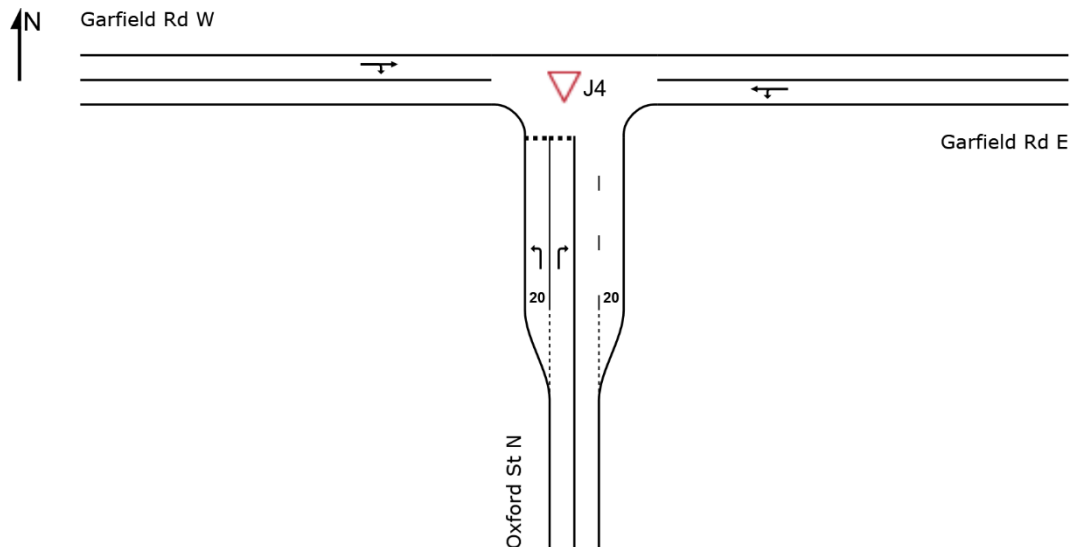


Figure 43 Existing geometric layout of Garfield Road / Oxford Street Priority Intersection

The SIDRA results for the existing intersection performance (2019) are summarised in Table 17. The key findings of the analysis are:

- The intersection is performing within its design capacity with all movements recorded LOS A
- The intersection operates within capacity under existing conditions.

Table 17 SIDRA results of 2019 Garfield Road / Oxford Street Priority Intersection

Time Period	Approach	Movement	2019 – Existing				
			Demand Flows (veh/hr)	Deg. of Sat.	Average Delay (s)	LOS	95% Back of Queue (m)
AM Peak	Oxford Street (South)	Left	35	0.03	6	LOS A	1
		Right	32	0.05	9	LOS A	1
	Garfield Road E (East)	Left	56	0.25	4	LOS A	0
		Through	394	0.25	0	LOS A	0
	Garfield Road E (West)	Through	237	0.21	1	LOS A	6
		Right	86	0.21	8	LOS A	6
	Overall LOS		N/A				
PM Peak	Oxford Street (South)	Left	27	0.02	6	LOS A	1
		Right	47	0.08	9	LOS A	2

	Garfield Road E (East)	Left	55	0.21	4	LOS A	0
		Through	317	0.21	0	LOS A	0
	Garfield Road E (West)	Through	345	0.26	1	LOS A	7
		Right	94	0.26	7	LOS A	7
	Overall LOS		N/A				

The SIDRA results for the future intersection performance are summarised in Table 18. The key findings of the analysis are:

- The intersection is still performing within its design capacity with all movements recording LOS A, even with the additional development traffic along Garfield Road E as well as Oxford Street in both peaks.
- The intersection likely operates within capacity for all future scenarios tested.

Table 18 SIDRA results of future Garfield Road / Oxford Street Priority Intersection

Time Period	Approach	Movement	2024 – Without Development					2029 – Without Development					2029 – With Development (Low Scenario)					2029 – With Development (High Scenario)				
			Demand Flows (veh/hr)	Deg. of Sat.	Average Delay (s)	LOS	95% Back of Queue (m)	Demand Flows (veh/hr)	Deg. of Sat.	Average Delay (s)	LOS	95% Back of Queue (m)	Demand Flows (veh/hr)	Deg. of Sat.	Average Delay (s)	LOS	95% Back of Queue (m)	Demand Flows (veh/hr)	Deg. of Sat.	Average Delay (s)	LOS	95% Back of Queue (m)
AM Peak	Oxford Street (South)	Left	39	0.04	6	LOS A	1	43	0.04	7	LOS A	1	45	0.05	7	LOS A	1	50	0.05	7	LOS A	2
		Right	37	0.07	10	LOS A	2	40	0.08	10	LOS A	2	41	0.09	11	LOS A	2	44	0.11	12	LOS A	3
	Garfield Road E (East)	Left	63	0.28	4	LOS A	0	69	0.31	4	LOS A	0	69	0.32	4	LOS A	0	71	0.35	4	LOS A	0
		Through	436	0.28	0	LOS A	0	478	0.31	0	LOS A	0	498	0.32	0	LOS A	0	558	0.35	0	LOS A	0
	Garfield Road E (West)	Through	263	0.24	1	LOS A	7	288	0.27	2	LOS A	9	302	0.28	2	LOS A	9	343	0.31	2	LOS A	12
		Right	96	0.24	8	LOS A	7	105	0.27	9	LOS A	9	106	0.28	9	LOS A	9	108	0.31	10	LOS A	12
	Overall LOS		N/A					N/A					N/A					N/A				
	PM Peak	Oxford Street (South)	Left	30	0.03	6	LOS A	1	33	0.03	6	LOS A	1	33	0.03	6	LOS A	1	35	0.03	6	LOS A
Right			53	0.10	10	LOS A	2	58	0.12	11	LOS A	3	58	0.13	11	LOS A	3	59	0.15	13	LOS A	4
Garfield Road E (East)		Left	62	0.23	4	LOS A	0	67	0.25	4	LOS A	0	69	0.26	4	LOS A	0	74	0.28	4	LOS A	0
		Through	351	0.23	0	LOS A	0	385	0.25	0	LOS A	0	399	0.26	0	LOS A	0	441	0.28	0	LOS A	0
Garfield Road E (West)		Through	382	0.30	1	LOS A	8	418	0.33	1	LOS A	10	436	0.34	1	LOS A	11	487	0.38	1	LOS A	14
		Right	104	0.30	8	LOS A	8	114	0.33	8	LOS A	10	117	0.34	8	LOS A	11	125	0.38	9	LOS A	14
Overall LOS		N/A					N/A					N/A					N/A					

C5 Garfield Road / George Street Priority Intersection (J5)

The existing geometric layout of Garfield Road / George Street priority intersection is shown in Figure 44.

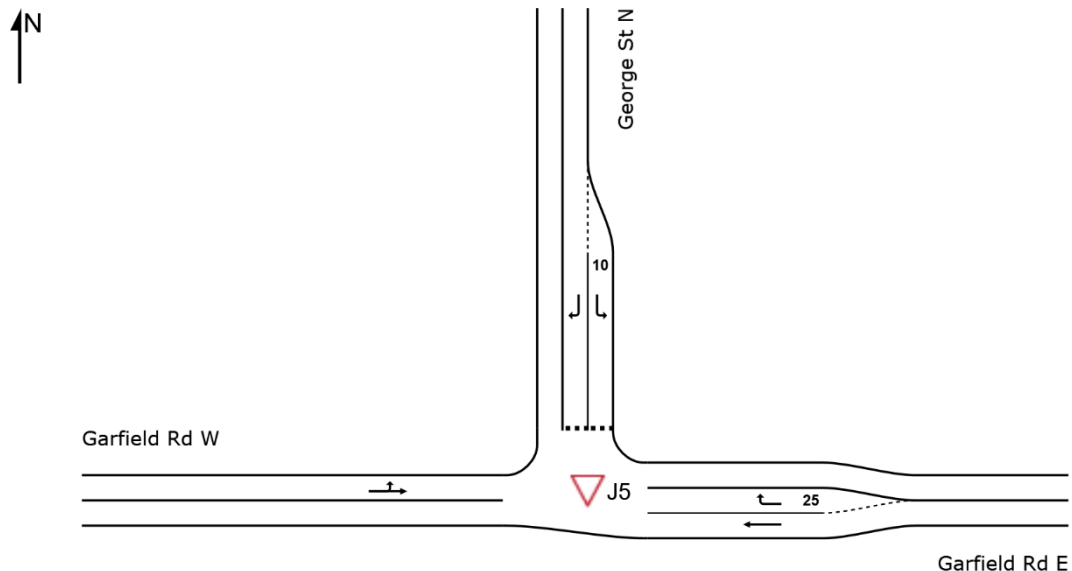


Figure 44 Existing geometric layout of Garfield Road / George Street Priority Intersection

The SIDRA results for the existing intersection performance (2019) are summarised in Table 19. The key findings of the analysis are:

- The intersection is performing within its design capacity with all movements recorded LOS A
- The intersection operates within capacity under existing conditions.

Table 19 SIDRA results of 2019 Garfield Road / George Street Priority Intersection

Time Period	Approach	Movement	2019 – Existing				
			Demand Flows (veh/hr)	Deg. of Sat.	Average Delay (s)	LOS	95% Back of Queue (m)
AM Peak	Garfield Road E (East)	Through	396	0.23	0	LOS A	0
		Right	19	0.01	5	LOS A	0
	George Street (North)	Left	17	0.01	5	LOS A	0
		Right	54	0.10	10	LOS A	3
	Garfield Road E (West)	Left	26	0.15	4	LOS A	0
		Through	228	0.15	0	LOS A	0
	Overall LOS		N/A				
		Through	311	0.17	0	LOS A	0

PM Peak	Garfield Road E (East)	Right	32	0.03	6	LOS A	1
	George Street (North)	Left	36	0.03	6	LOS A	1
		Right	54	0.10	10	LOS A	3
	Garfield Road E (West)	Left	64	0.22	4	LOS A	0
		Through	326	0.22	0	LOS A	0
	Overall LOS		N/A				

The SIDRA results for the future intersection performance are summarised in Table 20. The key findings of the analysis are:

- The intersection is still performing within its design capacity with all movements recorded LOS A / B even with the additional development traffic along Garfield Road E as well as George Street in both peaks.
- The intersection likely operates within capacity for all future scenarios tested.

Table 20 SIDRA results of future Garfield Road / George Street Priority Intersection

Time Period	Approach	Movement	2024 – Without Development					2029 – Without Development					2029 – With Development (Low Scenario)					2029 – With Development (High Scenario)				
			Demand Flows (veh/hr)	Deg. of Sat.	Average Delay (s)	LOS	95% Back of Queue (m)	Demand Flows (veh/hr)	Deg. of Sat.	Average Delay (s)	LOS	95% Back of Queue (m)	Demand Flows (veh/hr)	Deg. of Sat.	Average Delay (s)	LOS	95% Back of Queue (m)	Demand Flows (veh/hr)	Deg. of Sat.	Average Delay (s)	LOS	95% Back of Queue (m)
AM Peak	Garfield Road E (East)	Through	439	0.25	0	LOS A	0	480	0.28	0	LOS A	0	499	0.29	0	LOS A	0	553	0.31	0	LOS A	0
		Right	21	0.02	6	LOS A	0	23	0.02	6	LOS A	1	24	0.02	6	LOS A	1	26	0.02	6	LOS A	1
	George Street (North)	Left	19	0.02	5	LOS A	0	21	0.02	6	LOS A	1	22	0.02	6	LOS A	1	27	0.02	6	LOS A	1
		Right	61	0.13	11	LOS A	4	66	0.15	12	LOS A	4	68	0.17	13	LOS A	5	75	0.21	15	LOS B	6
	Garfield Road E (West)	Left	30	0.17	4	LOS A	0	33	0.18	4	LOS A	0	34	0.19	4	LOS A	0	37	0.21	4	LOS A	0
		Through	253	0.17	0	LOS A	0	277	0.18	0	LOS A	0	291	0.19	0	LOS A	0	332	0.21	0	LOS A	0
	Overall LOS		N/A					N/A					N/A					N/A				
	PM Peak	Garfield Road E (East)	Through	345	0.19	0	LOS A	0	378	0.21	0	LOS A	0	393	0.22	0	LOS A	0	437	0.24	0	LOS A
Right			36	0.03	6	LOS A	1	39	0.04	7	LOS A	1	40	0.04	7	LOS A	1	45	0.04	7	LOS A	1
George Street (North)		Left	40	0.03	6	LOS A	1	44	0.04	6	LOS A	1	45	0.04	6	LOS A	1	46	0.04	6	LOS A	1
		Right	61	0.13	11	LOS A	4	66	0.16	12	LOS A	4	67	0.17	13	LOS A	5	70	0.20	15	LOS B	6
Garfield Road E (West)		Left	72	0.24	4	LOS A	0	79	0.27	4	LOS A	0	81	0.27	4	LOS A	0	88	0.30	4	LOS A	0
		Through	362	0.24	0	LOS A	0	396	0.27	0	LOS A	0	412	0.27	0	LOS A	0	457	0.30	0	LOS A	0
Overall LOS		N/A					N/A					N/A					N/A					

C6 Garfield Road / Piccadilly Street Signalised Intersection (J6)

The existing geometric layout of Garfield Road / Piccadilly Street signalised intersection is shown in Figure 45. The existing phasing and average signal timing are estimated from traffic survey video footage for both the AM and PM peaks. These are shown in Figure 46 and Table 21.

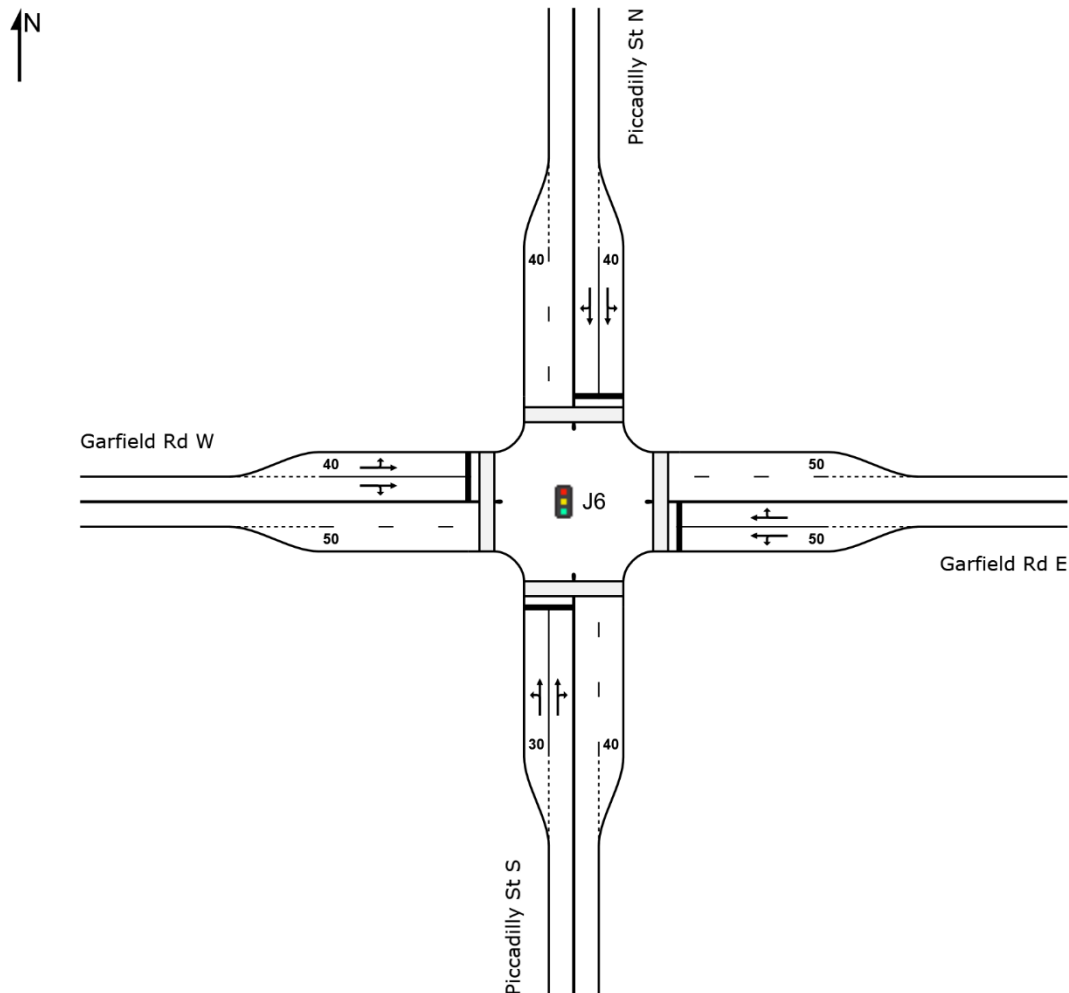


Figure 45 Existing geometric layout of Garfield Road / Piccadilly Street Signalised Intersection

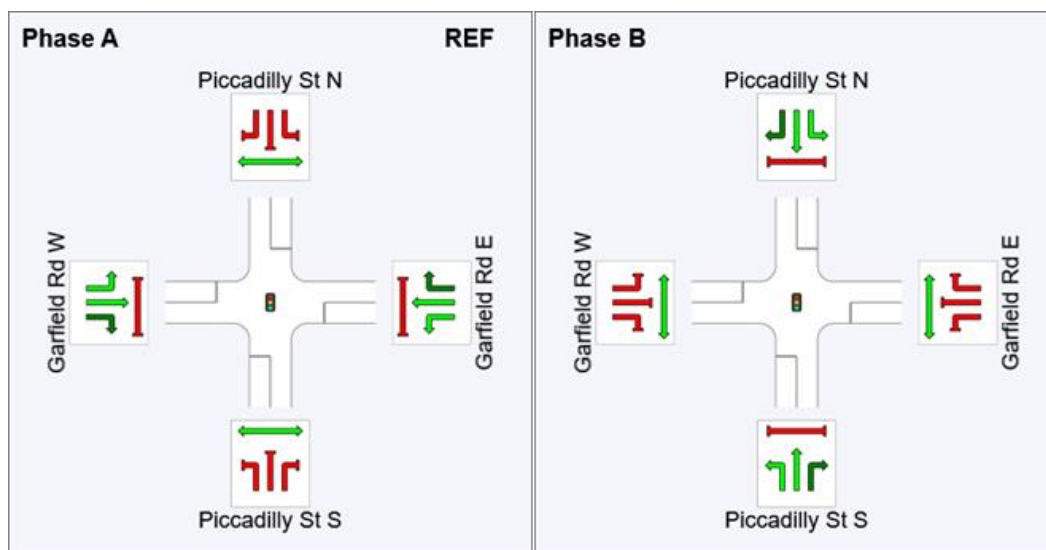


Figure 46 Existing phasing of Garfield Road / Piccadilly Street Signalised Intersection

Table 21 Existing phase timing of Garfield Road / Piccadilly Street Signalised Intersection

Time Period	Phase	A	B
AM Peak (44s User-Given Phase Times)	Phase Change Time (s)	0	23
	Green Time (s)	17	15
	Yellow Time (s)	4	4
	All-Red Time (s)	2	2
	Phase Time (s)	23	21
	Phase Split	52%	48%
PM Peak (53s User-Given Phase Times)	Phase Change Time (s)	0	25
	Green Time (s)	19	22
	Yellow Time (s)	4	4
	All-Red Time (s)	2	2
	Phase Time (s)	25	28
	Phase Split	47%	53%

The SIDRA results for the existing intersection performance (2019) are summarised in Table 22. The key findings of the analysis are:

- The intersection is still performing within its design capacity with an overall LOS A / B during the peaks.
- Modelled queues are reasonably close to the observed data.
- The intersection operates within capacity under existing conditions.

Table 22 SIDRA results of 2019 Garfield Road / Piccadilly Street Signalised Intersection

Time Period	Approach	Movement	2019 – Existing				
			Demand Flows (veh/hr)	Deg. of Sat.	Average Delay (s)	LOS	95% Back of Queue (m)

AM Peak	Piccadilly Street (South)	Left	37	0.10	16	LOS B	7
		Through	128	0.34	12	LOS A	21
		Right	71	0.34	17	LOS B	21
	Garfield Road E (East)	Left	60	0.15	14	LOS A	11
		Through	309	0.45	11	LOS A	38
		Right	21	0.45	16	LOS B	38
	Piccadilly Street (North)	Left	40	0.11	16	LOS B	8
		Through	170	0.39	12	LOS A	27
		Right	65	0.39	17	LOS B	27
	Garfield Road E (West)	Left	18	0.10	14	LOS A	7
		Through	231	0.30	10	LOS A	24
		Right	5	0.30	15	LOS B	24
	Overall LOS		LOS A				
PM Peak	Piccadilly Street (South)	Left	49	0.11	15	LOS B	10
		Through	177	0.39	13	LOS A	32
		Right	91	0.39	18	LOS B	32
	Garfield Road E (East)	Left	68	0.14	17	LOS B	12
		Through	215	0.43	15	LOS B	37
		Right	42	0.43	20	LOS B	37
	Piccadilly Street (North)	Left	55	0.10	15	LOS B	9
		Through	192	0.36	12	LOS A	31
		Right	64	0.36	17	LOS B	31
	Garfield Road E (West)	Left	52	0.15	17	LOS B	13
		Through	287	0.45	14	LOS A	41
		Right	25	0.45	19	LOS B	41
	Overall LOS		LOS B				

The SIDRA results for the future intersection performance are summarised in Table 23. The optimised phase timings used in these scenarios are documented in Appendix B. The key findings of the analysis are:

- The analysis results show that the intersection is still performing within its design capacity with an overall LOS A / B during the peaks.
- Maximum queue of 64 m is recorded at the west approach of Garfield Road E in the PM peak of 2029 With Development (High Scenario) which is still acceptable.
- The intersection likely operates within capacity for all future scenarios tested

Table 23 SIDRA results of future Garfield Road / Piccadilly Street Signalised Intersection

Time Period	Approach	Movement	2024 – Without Development					2029 – Without Development					2029 – With Development (Low Scenario)					2029 – With Development (High Scenario)				
			Demand Flows (veh/hr)	Deg. of Sat.	Average Delay (s)	LOS	95% Back of Queue (m)	Demand Flows (veh/hr)	Deg. of Sat.	Average Delay (s)	LOS	95% Back of Queue (m)	Demand Flows (veh/hr)	Deg. of Sat.	Average Delay (s)	LOS	95% Back of Queue (m)	Demand Flows (veh/hr)	Deg. of Sat.	Average Delay (s)	LOS	95% Back of Queue (m)
AM Peak	Piccadilly Street (South)	Left	41	0.12	16	LOS B	8	45	0.14	16	LOS B	9	51	0.14	16	LOS B	9	68	0.15	15	LOS B	11
		Through	143	0.43	14	LOS A	26	156	0.48	15	LOS A	29	161	0.47	14	LOS A	30	175	0.53	14	LOS A	34
		Right	79	0.43	19	LOS B	26	87	0.48	20	LOS B	29	91	0.47	19	LOS B	30	101	0.53	19	LOS B	34
	Garfield Road E (East)	Left	67	0.15	14	LOS A	12	73	0.17	14	LOS A	13	74	0.18	14	LOS A	14	77	0.21	15	LOS B	15
		Through	343	0.47	10	LOS A	42	375	0.52	11	LOS A	46	380	0.56	12	LOS A	49	393	0.63	13	LOS A	55
		Right	25	0.47	15	LOS B	42	27	0.52	16	LOS B	46	29	0.56	17	LOS B	49	35	0.63	18	LOS B	55
	Piccadilly Street (North)	Left	45	0.14	16	LOS B	9	49	0.15	17	LOS B	10	54	0.15	16	LOS B	11	70	0.18	15	LOS B	13
		Through	189	0.48	14	LOS A	32	207	0.54	14	LOS A	36	214	0.54	14	LOS A	37	236	0.63	14	LOS A	45
		Right	72	0.48	19	LOS B	32	79	0.54	20	LOS B	36	88	0.54	19	LOS B	37	113	0.63	20	LOS B	45
	Garfield Road E (West)	Left	21	0.10	14	LOS A	8	23	0.11	14	LOS A	9	26	0.13	14	LOS A	10	35	0.15	15	LOS B	11
		Through	256	0.32	10	LOS A	27	280	0.35	10	LOS A	30	291	0.38	11	LOS A	32	322	0.47	12	LOS A	38
		Right	7	0.32	15	LOS B	27	7	0.35	15	LOS B	30	8	0.38	16	LOS B	32	13	0.47	17	LOS B	38
	Overall LOS		LOS A					LOS A					LOS A					LOS A				
PM Peak	Piccadilly Street (South)	Left	55	0.14	16	LOS B	12	60	0.15	16	LOS B	14	61	0.16	16	LOS B	14	65	0.20	16	LOS B	18
		Through	197	0.48	14	LOS A	38	215	0.54	15	LOS B	42	221	0.55	15	LOS B	43	237	0.69	18	LOS B	49
		Right	102	0.48	19	LOS B	38	111	0.54	21	LOS B	42	112	0.55	21	LOS B	43	114	0.69	26	LOS B	49
	Garfield Road E (East)	Left	77	0.15	17	LOS B	13	84	0.17	17	LOS B	15	87	0.18	17	LOS B	16	97	0.22	17	LOS B	20
		Through	239	0.47	14	LOS A	41	261	0.52	15	LOS B	46	272	0.55	15	LOS B	48	306	0.68	18	LOS B	59
		Right	48	0.47	19	LOS B	41	52	0.52	20	LOS B	46	56	0.55	21	LOS B	48	68	0.68	24	LOS B	59
	Piccadilly Street (North)	Left	61	0.12	16	LOS B	11	67	0.14	16	LOS B	12	69	0.15	16	LOS B	13	76	0.19	16	LOS B	17
		Through	213	0.44	14	LOS A	37	234	0.49	14	LOS A	42	240	0.51	14	LOS A	43	256	0.66	18	LOS B	51
		Right	72	0.44	19	LOS B	37	78	0.49	19	LOS B	42	82	0.51	20	LOS B	43	92	0.66	25	LOS B	51
	Garfield Road E (West)	Left	58	0.16	17	LOS B	14	64	0.17	17	LOS B	16	71	0.18	17	LOS B	16	90	0.22	17	LOS B	20
		Through	318	0.48	14	LOS A	45	348	0.53	15	LOS B	52	352	0.56	15	LOS B	54	363	0.67	17	LOS B	64
		Right	29	0.48	19	LOS B	45	32	0.53	20	LOS B	52	38	0.56	20	LOS B	54	54	0.67	23	LOS B	64
	Overall LOS		LOS B					LOS B					LOS B					LOS B				