Urban Growth NSW

North Ryde Station Site North Infrastructure Works Development Application

Transport impact assessment

20 February 2014

PARSONS BRINCKERHOFF

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Executive summary

This transport impact assessment (TIA) has been prepared to assess the impacts of a Development Application for the opening of a proposed new road, subdivision, public domain and infrastructure works for the North Ryde Station Site. The proposed road and enabling infrastructure works are necessary to facilitate the future development of the site. As such, this development application does not result in the creation of traffic-generating development. Any traffic-generating development will be the subject of future development applications. However, the traffic generating potential of that future development has been considered in order to determine the suitability of the proposed new road.

The TIA examines the consistency or otherwise of the new road against the North Ryde Station Precinct Project Transport Management and Accessibility Plan (TMAP). It includes an assessment of the impacts during the construction of the proposed new road and enabling infrastructure works.

Development changes

Since the submission of the TMAP, there have been changes in land ownership, with Urban Growth NSW purchasing the Station Site North and M2 Site from Transport for NSW. The mix of land use types in the proposed development for the North Ryde Station Sites (North and South) has also changed including.

- increased residential development with approximately 1,120 dwellings combined between the two sites
- removal of the commercial, serviced apartment and student accommodation
- increased retail space.

Traffic generation

The proposed change of the mix of land uses has reduced the traffic generation of the two sites with a change in direction of peak traffic movement. Traffic generation rates for the residential component of the development have been updated based on a new technical direction from the Roads and Maritime Services (RMS). For the Stations Sites (North and South) the traffic generation numbers indicate:

- a 30% reduction in traffic across a typical weekday
- a 45% increase in vehicles leaving the site in the AM peak (20% reduction entering in the PM peak)
- an 85% decrease in vehicles entering the site in the AM peak and leaving the site in the PM peak.

Site access

Access to the Station Sites is proposed at:

- the existing signalised intersection of Delhi Road and The Leighton Way (Road 38)
- a give-way controlled intersection with Road 38 and Station Street
- a new turning circle near potential lower level entry into North Ryde Station on boundary with Station Site South
- a two-way access from Road 38 to Road 18 (Julius Avenue Extension) with left-out only from Road 18 to Road 38
- a one-way southbound to eastbound access from Road 38 to Lucknow Road.

Traffic modelling

The traffic models used to assess the development for the TMAP have been updated using the revised traffic generation forecasts and access arrangements. The results indicate that the reduced traffic generation and change in the balance of in and out trips is likely to result in an improvement to the performance of all of the intersections compared to the TMAP scenario in both the morning and afternoon peaks. The most substantial improvements are forecast at the intersection of Delhi Road/Plassey Road/Julius Avenue and Epping Road/Delhi Road.

As a result of the reduced traffic generation, a modified set of road upgrades are proposed and include:

1. widen Delhi Road eastbound from M2 Motorway to east of Julius Avenue (eastern intersection)
2. retention of the intersection of Delhi Road and Road 38 in its current configuration (apart from the conversion of the kerbside bus lane to a continuous general traffic lane)
3. an additional right-turn bay from Delhi Road westbound to the M2 Motorway westbound on-ramp.

A comparison of these results to the future base, indicates that the upgrade of Delhi Road results in an improvement to the future base conditions, mitigating the impact of the proposed development. At the intersection of Epping Road and Delhi Road, the performance is forecast to improve compared to the base conditions during the AM peak, as the downstream blocking from eastbound congestion on Delhi Road is reduced. The only increase of average delay compared to the future base is during the PM at this intersection. However, as mentioned above, the increase has been substantially reduced when compared to the TMAP scenario. The traffic modelling also indicates that:

- in the event that there is a delay in the opening of connections to Riverside Corporate Park, the site can operate satisfactorily with access only via the intersection of Delhi Road and Road 38
- the intersection of Delhi Road and Road 38 can operate satisfactorily with the development traffic and the existing traffic signal phase and cycle times, if required by RMS. However, the road upgrades proposed improve traffic flow on Delhi Road, enabling optimisation of the traffic signal control and reducing delays for side street traffic whilst still reducing delays for Delhi Road traffic.

Street design

A revised layout for the Station Street turning circle and access streets is proposed in the development application following consultation between Urban Growth NSW and the purchaser of the Station Site South, Country Garden Australia (CGA). The changes include:

- modifications to the shape and dimensions of the turning area
- extension of the shared zone providing access to the western portion of the site
- removal of the pedestrian crossing east of the turning area and addition of a pedestrian crossing on Road 38 south of Station Street
- removal of the central swale within Station Street.

Parsons Brinckerhoff has reviewed the proposed design and makes the following comments:

- The clear radius of the turning circle is able to accommodate City of Ryde's garbage trucks and a NSW Fire Brigades general access appliance. However, it cannot accommodate the requirements of a 12.5 m rigid bus or truck (e.g. removalist van) or a NSW Fire Brigades aerial appliance vehicle in a single forward movement and would require an 8.8m long medium rigid vehicle to come to a stop and then turn on full-lock.

- The line of bollards separating the turning area from the footpath reinforce the restrictions in vehicle turning listed above. The central island blocks larger vehicles that cannot turn in one movement from being able to turn with multiple movements.
- The elongated design is likely to result in drivers misinterpreting it as a passenger set-down / pick up area, resulting in temporary blockages.

The proposed changes to the lane dimensions on Station Street are considered to be suitable. The reduction in footpath width on the northern side of Station Street is considered reasonable on the basis that the main pedestrian and cycle desire line from Riverside Corporate Park is likely to switch to the southern side of the street due to the extension of the shared zone and pedestrian crossing at Road 38 south of the intersection with Station Street/Road 18.

Pedestrian and cycle access

The pedestrian and cycle infrastructure proposed for the Station Sites is essentially unchanged from the TMAP. The extension of the shared zone on Station Street acknowledges that, due to the relatively low traffic volumes using Station Street, pedestrians are likely to walk across the turning area and roadway regardless of whether the shared zone is provided or not. The change will increase the length of road in which vehicles will be travelling at slow speeds, improving pedestrian safety.

Train and bus access

Access to train and bus services are essentially unchanged from the TMAP. The relocation of the eastbound bus stop on Delhi Road from west of Road 38 to east of Road 38 proposed in the TMAP is no longer required, as the pedestrian crossing is now planned to be retained in its current location. This reduces the walk distance for people interchanging between train and bus and residents of the Station sites.

Parking

The changes to the development yield and street layout have changed the provision for on-street and off-street parking. The proposed number of parking spaces, calculated based on the rates in the North Ryde Station Precinct Development Control Plan, has increased by approximately 290 spaces from 902 to 1,190 spaces combined between the two sites. Whilst this is a large increase, the change from commercial land use to residential is likely to result in less intense use of these parking spaces, particularly given the close proximity to North Ryde Station. The DCP also makes provision for encouragement of car share schemes as one element of a strategy to reduce car dependency for commuting and recreational transport use.

The number of on-street parking spaces has increased slightly, the prioritisation of on-street parking for car share, disabled parking, a loading zone, kiss-and-ride, short-stay timed parking and motorcycle parking proposed in the TMAP is retained in the proposed development.

Bicycle parking at North Ryde Station is proposed as per the TMAP. It would be provided in the forecourt area surrounding the Station, with staged introduction to match demand.

Construction impacts

A preliminary Construction Traffic Management Plan (CTMP) for the infrastructure enabling works has been developed. The construction activity is expected to be less than the M2 Motorway widening compounds currently occupying the M2 Site and Station Site North, with fewer trucks and construction staff traffic movements. It is therefore expected that there would be a net reduction in traffic and on-site parking compared to the existing traffic conditions. All construction staff parking is expected to be contained on site. Construction activity would generally be contained within the sites, however, there would be impacts from the construction of spans 1 and 2 of the shared pedestrian and cycle bridge over Delhi Road.

As a construction contractor has not yet been appointed, the exact methodology of construction is not known. A complete CTMP will be submitted for approval before the commencement of construction. The preliminary information contained in this report includes an outline of the principles on which the CTMP should be based, potential mitigation measures, and a communications strategy.

1. Introduction

This Transport Impact Assessment (TIA) report has been prepared in support of a Development Application for subdivision, public domain and infrastructure works for the North Ryde Station Site. The proposed subdivision and enabling infrastructure works are necessary to facilitate the future development of the site.

This TIA summarises the impact of the development recommended in the TMAP, includes an assessment of the impacts during the construction of the subdivision and enabling infrastructure works and demonstrates the consistency with the transport and access improvements/arrangements proposed in the TMAP. It also contains the preliminary Construction Traffic Management Plan (CTMP) for these works.

1.1 Background

A Transport Management and Accessibility Plan (TMAP) was prepared for the five sites covered within the North Ryde Station UAP and lodged in support of a rezoning application. The North Ryde Station Precinct Development Control Plan (2013) was released. This DCP largely reflected the transport aspects of the TMAP.

Since the approval of the rezoning application for these two sites, the ownership of these lands has changed from Transport for NSW to Urban Growth NSW. Further discussions have occurred between Urban Growth NSW and the owner of the Station Site South (Goodman Property Group and Country Garden Australia (CGA)). These discussions have resulted in modifications to the proposed urban design, road network and traffic management. The impacts of these changes are assessed within this report.

1.2 Director General's Requirements

The DP&I issued the Director General's Requirements (DGRs) on 8 February 2012 to guide the preparation of the Environmental Impact Statement (EIS) for the preliminary works for the former State Significant Development. The following DGRs are relevant to the traffic and transport impact of the development.

Table 1.1 Director General's Environmental Assessment Requirements

Study requirement	Refer to section
Identify the proposed road and intersection upgrades, and demonstrate that they provide linkages to key destination points such as public transport nodes, centres, employment lands, and recreation areas, within and surrounding the site.	5, 6
Demonstrate that all aspects of the road design provide adequate capacity having regard to traffic modelling carried out as part of the State Significant Site Study (SSSS).	4
Identify proposed pedestrian and bicycle connections and demonstrate how these provide linkages within the site, and to adjoining areas, including to the train station and major bus stops. This should include identification of adequate bicycle parking at the train station, and within other areas of the public domain.	6, 7
Identify any proposed bus infrastructure upgrades and demonstrate how existing and proposed bus infrastructure will be integrated with the train station and development area.	6

Where applicable, these DGRs will be assessed by comparison between the currently proposed development and the development submitted as part of the rezoning application. Issues will be dealt with by exception, i.e. if the original rezoning application was deemed to have adequately addressed the issue raised and there has been no change to the development on this area/topic, the issue will not be reconsidered in detail.

It is noted that several of the DGRs relate to the impact of the full development, rather than the construction of infrastructure that form the subject of this development application. Many of the issues listed above have been assessed in the TMAP prepared for the rezoning application (and are incorporated in the DCP). This study has assessed both the impacts of the full development, in its revised state for the purposes of demonstrating that the works proposed will provide sufficient capacity for the full development.

1.3 Report structure

This report is structured as follows:

- Section 2 details the proposed development
- Section 3 analyses the trip generation of the proposed development
- Section 4 assesses the impact of the Project on the surrounding road network
- Section 5 assesses the site accesses and street design
- Section 6 assesses the project in terms of its provision for and impact on public transport, pedestrians and cyclists
- Section 7 provides information on parking within the site, including the on-street and off-street provisions, bicycle parking and car share
- Section 8 outlines the anticipated construction details, including traffic generation, and assesses the impact
- Section 9 presents the conclusions of the assessment and lists the recommendations.

2. Proposed development

The UAP comprised five sites clustered around the intersection of Epping Road and Delhi Road and North Ryde Station. It proposed a mixed land-use development, including residential, retail, commercial, community facilities and open space. The five sites included:

- M2 Site (then owned by TfNSW, now owned by Urban Growth NSW)
- Station Site North (then owned by TfNSW, now owned by Urban Growth NSW)
- OSL Site (owned by OSL)
- RMS Site (owned by RMS)
- Station Site South (owned by Goodman International Funds Management Limited (Goodman), developed in conjunction with CGA).

During the rezoning application process community concerns were raised to the development of the OSL site and RMS site. As a result both were removed from the approved scheme. Since the submission of the rezoning application, the M2 Site and Station Site North have been purchased by Urban Growth NSW.

2.1 Site descriptions

A description of the remaining three sites within the North Ryde Station Urban Activation Precinct follows:

Station Site North

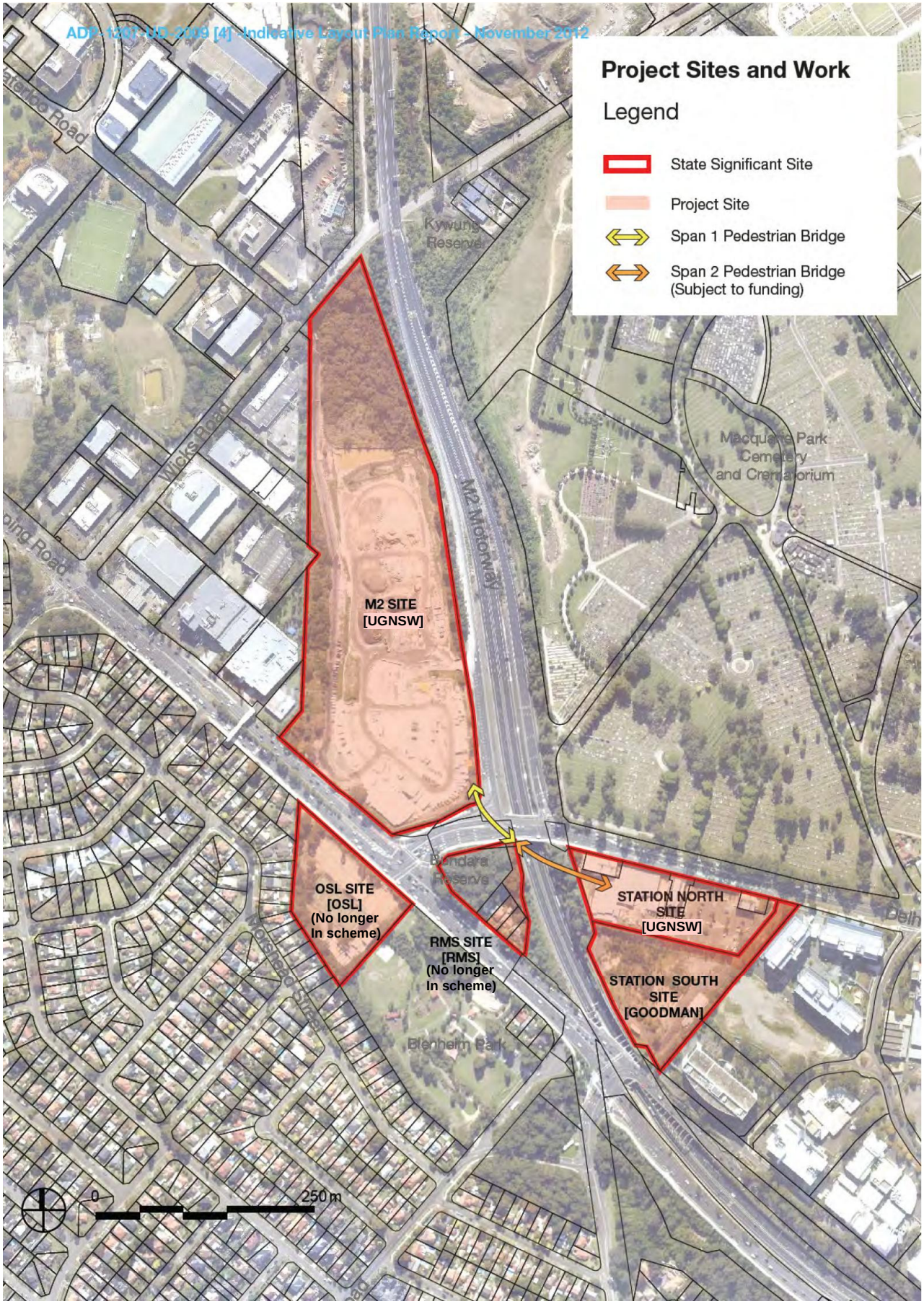
The site contains and surrounds the existing entrance to North Ryde Station, two service buildings and RailCorp easements. The site fronts Delhi Road, with access through Goodman owned land via the traffic signals at the intersection of Delhi Road and The Leighton Way (also known as Road 38 in the City of Ryde (CoR)'s Development Control Plan (DCP)). The site is currently being used by temporary administrative buildings for the M2 Motorway widening project. The Site slopes away from Delhi Road, with a large level differential along the Delhi Road boundary. Currently the site is physically separated from the Riverside Corporate Park.

Station Site South

The North Ryde Station Site South is bounded by the Station Site North, the Riverside Corporate Park and the M2 Motorway. The buildings occupied by its previous use have been demolished and the site is currently vacant. The site includes the Road 38 alignment. Access to the road network is currently gained via a set of traffic signals on Delhi Road to the east of the M2 Motorway ramp intersection.

M2 Site

The M2 Site is located alongside the M2 Motorway and stretching from the intersection of Epping Road and Delhi Road to the intersection of Wicks Road and Waterloo Road. The site slopes down from Delhi Road towards Wicks Road. The Epping to Chatswood Rail Line (ECRL) passes under the M2 Site, and was previously used as a construction site for the project. The site is currently being used as a construction compound for the M2 Motorway widening project. Currently, access is gained from a gate at the intersection of Wicks Road and Waterloo Road. Another temporary access is located on the M2 Motorway on-ramp.



Source: Cox Richardson Architects: Indicative Layout Plan Report Draft November 2012

Figure 2.1 North Ryde Station Precinct sites

2.2 Development type

Rezoning application land use

The rezoning application was submitted on the basis of the mixed-use floor areas and dwelling numbers shown in Table 2.1. The commercial floor space was located in the Station Site north and south adjacent to North Ryde Station and the southern end of the M2 Site to place the high trip-generating land use in the closest proximity to public transport services.

Table 2.1 Rezoning application land use (superseded – see Table 2.2 for currently proposed)

Site name		Station Site north	Station Site south	M2 Site	OSL Site	RMS Site	Total
Ownership		Urban Growth NSW	Goodman Property Group	Urban Growth NSW	OSL	RMS	
Residential	m^2	-	27,890	201,000	11,970	2,700	243,560
	dwellings	*-*	*204*	*2,116*	*126*	*28*	*2,564*
Retail (m^2)		900	-	5,000	200	-	6,100
Commercial (m^2)		20,000	31,225	24,400	-	-	75,625
Community centre (m^2)		-	-	2,500	-	-	2,500
Student housing	m^2	7,500	-	-	-	-	7,500
	beds	*125*	*-*	*-*	*-*	*-*	*125*
Serviced apartments	m^2	10,000	-	-	-	-	10,000
	beds	*125*	*-*	*-*	*-*	*-*	*125*
Total (m^2)		**38,400**	**59,115**	**232,900**	**12,170**	**2,700**	**345,285**

Note: Due to a late change in the average size of serviced apartments and student accommodation, trip generation numbers in the TMAP were calculated based on 118 serviced apartments and 150 student dwellings, i.e. more than the yield proposed in the rezoning application.

Overall, it was estimated that the two could accommodate 2,500 office jobs and approximately 4,600 residents and students.

Currently proposed land use

Since the rezoning application, the mix of land use proposed has changed to assist the NSW Government's strategy of increasing the release of land for new housing in close proximity to infrastructure, transport, services and jobs. The commercial land use has been reduced in favour of more residential and retail.

This development application is for the subdivision and supporting infrastructure works only, and hence does not involve the development of any traffic generating land use activity – other than construction-related traffic (see section 6). However, the currently proposed land use, shown in Table 2.2, is provided for the purposes of assessing the adequacy of the planned transport provision. As the sites are zoned as mixed-use and the actual land use mix will be determined by future development applications for each subdivided lot, this is only an indicative land use scenario.

Table 2.2 Currently proposed land use

Site name		Station Site north	Station Site south	M2 Site	Total
Ownership		Urban Growth NSW	Goodman Property Group	Urban Growth NSW	
Residential	m^2	29,400	61,405	225,419	316,224
	dwellings	*309*	*810*	*2,373*	*3,492*
Retail (m^2)		500	1,000	3,500	6,000
Commercial (m^2)		-	-	10,000	10,000
Community centre (m^2)		-	-	1,500	1,500
Total (m^2)		**29,900**	**62,405**	**240,419**	**332,724**

Based on the revised land uses, it is estimated that the sites could accommodate approximately 220 retail jobs, 330 office jobs and 5,750 residents. The retail space within the three sites would comprise:

- Station Site north: small speciality shops and convenience stores, mainly serving the site and rail passengers on their way to the Station
- Station Site south: a mixture of retail and professional suites
- M2 Site: a small supermarket, restaurants, small shops and professional suites.

2.3 Access arrangements

In general, access to the sites would be gained from non-arterial roads via existing intersections. The proposed vehicle access points for the North Ryde Station Precinct are listed in Table 2.3.

Table 2.3 Proposed vehicle access locations

Access	Rezoning application	Current proposal
Station Sites north and south		
Delhi Road and Road 38	Connect to traffic signals, modified configuration	Connect to traffic signals using existing layout
Road 38 and Lucknow Road	Connection of the two roads in both directions	Connection only in one direction (southbound to eastbound)
Road 38 and Road 18	Give-way sign controlled intersection – one-way eastbound into Riverside Corporate Park	Two-way access with traffic from Road 18 to be left-turn only at Road 38
M2 Site		
Waterloo Road and Wicks Road	Traffic signals with pedestrian crossings	No change
Epping Road	Left-in only with deceleration lane	Left-in only with staged introduction of deceleration lane
M2 Motorway on-ramp	Emergency access at site of current construction access – gates kept closed at other times	No change

Access to the Station Site North is via a right-of-way through Station Site South, along the Road 38 alignment and connecting to the existing traffic signals at Delhi Road. The subdivision provides for the entire length of Road 38. However the DA seeks approval only for the construction of Road 38 adjacent to the Station Site north.

2.4 Staging

Development would be staged, enabling essential infrastructure (the subject of this DA) to be delivered first. The estimated year for release of the first buildings for occupation is 2016, with the last block anticipated to be released around 2021, as outlined in Table 2.4.

Table 2.4 Proposed development staging

Site	Construction start	First dwelling	Completion
Station Site South (CGA)	end 2014	end 2015	end 2016
Station Site North	mid 2015	beginning 2016	end 2016
M2 Site	start 2016	start 2017	end 2021

Source: Parsons Brinckerhoff discussions with Urban Growth NSW

The works included in this development application include access works at the intersection of Road 38, Station Road and Delhi Road enabling Station Site north and south development.

3. Traffic generation

The changes in development yield compared to the TMAP will result in a corresponding change to the amount of vehicle and person trips generated by the sites. Revised trip generation rates and mode shares have been applied to update the analysis and reflect the revised nature of the development. This section recalculates the traffic generation to allow the adequacy of the road network provisions to be reassessed.

3.1 Trip generation rates

Since the submission of the TMAP, RMS has issued a new technical direction for traffic generation rates – *Technical Direction TDT2013-04a Guide to Traffic Generating Developments Updated traffic surveys*. Whereas the previous version – the RMS' Guide to Traffic Generating Developments Version 2.2 (2002) nominated a high density residential rate of 0.24 to 0.29 trips per dwelling during the peak hour, this new publication advises lower rates of 0.19 and 0.15 vehicle trips per dwelling during the AM and PM peak hours respectively.

An assessment of the BTS Household Travel Survey has reinforced this reduction in trip generation. However, the change is also attributable to a slight drop in the percentage of trips occurring during the peak periods (i.e. peak spreading). A comparison of the residential trip generation rates used in the 2012 TMAP and this revised assessment is shown in Table 3.1.

Table 3.1 Comparison of residential trip generation rates

Parameter	TMAP 2012	This assessment
average trips per person per weekday[1]	4.0	3.7
people per dwelling	1.73	1.65
trips per dwelling per day	6.97	6.09
trips per dwelling during the peak hour	0.77	0.67
vehicle trips per dwelling during the AM peak hour	0.23	0.19
vehicle trips per dwelling during the PM peak hour	0.27	0.15

(1) BTS Household Travel Survey summary

The reduction in number of people per dwelling is based on a higher proportion of one-bedroom apartments in the Station Site south. No change was assumed to the commercial, retail or community centre trip generation rates.

3.2 Mode share to reflect trip containment and parking

The change from a mixed residential/commercial/retail development to a higher yield residential development will impact on the travel behaviours of the commuter trips. The analysis undertaken for the TMAP represented internal trip containment through a higher mode share for walking. For the revised development, the walking mode share has been reduced to represent the revised land use mix as outlined in Table 2.2. To be conservative and provide a more rigorous assessment, it has been assumed that all of these people would switch to car driver. Having said this, in practice there is likely to be some switch to public transport. A comparison of the residential commuting mode shares assumed in the TMAP and this analysis is provided in Table 3.2. The mode share assumed for residential shopping, education and other trip purposes, and the mode shared assumed for other land uses are unchanged.

Changes to the amount of parking (see section 7) may have a small impact on the mode share. The new traffic generation rates assume a good level of access to public transport, as is provided at the North Ryde Station Precinct.

Table 3.2 Comparison of residential commuting trip generation rates

Parameter	TMAP 2012	This assessment
Vehicle driver	35%	39%
Vehicle passenger	4%	4%
Train	30%	30%
Bus	17%	17%
Walk	12%	8%
Cycle	2%	2%
Total	**100%**	**100%**

3.3 Trip generation

Based on the revised development yield outlined in Table 2.2, the residential trip generation rates outlined in Table 3.1 and the mode share assumptions for residential commuting outlined in Table 3.2, a modified traffic generation has been established. Table 3.3 shows a comparison of the two sets of data.

Table 3.3 Vehicle trip generation comparison

	Weekday		AM peak hour		PM peak hour	
	In	Out	In	Out	In	Out
TMAP 2012						
M2 Site	4,222	4,222	350	397	399	462
Station Site north	871	871	183	38	54	180
Station Site south	1,005	1,005	272	73	84	270
OSL Site	232	232	10	29	28	19
RMS Site	32	32	2	5	5	3
Total	**6,362**	**6,362**	**817**	**542**	**570**	**934**
This assessment						
M2 Site	3,389	3,389	224	390	270	267
Station Site north	377	377	16	45	30	21
Station Site south	921	921	40	117	78	54
Total	**4,688**	**4,688**	**280**	**551**	**379**	**341**

For the Stations Sites (north and south) only these numbers indicate:

- a 30% reduction in traffic across a typical weekday
- a 45%increase in vehicles leaving the site in the AM peak (20% reduction entering in the PM peak)
- an 85% decrease in vehicles entering the site in the AM peak and leaving the site in the PM peak.

Trip generation by site and time period for the new land use, trip rates and mode share is shown in Table 3.4

Table 3.4 Total trips generated from each site by mode and time of day (updated)

Land parcel	Into development							Out of development						
	Vehicle driver	Vehicle passenger	Train	Bus	Walk	Cycle	Total	Vehicle driver	Vehicle passenger	Train	Bus	Walk	Cycle	Total
AM peak hour trips														
M2 Site	224	66	173	99	146	22	729	390	147	273	184	264	40	1,298
Station Site north	16	6	13	9	15	2	61	45	18	37	25	34	5	164
Station Site south	40	16	34	23	36	5	153	117	48	96	66	86	13	424
Total	**280**	**89**	**220**	**130**	**196**	**28**	**944**	**551**	**213**	**406**	**275**	**384**	**58**	**1,886**
PM peak hour trips														
M2 Site	270	99	206	128	260	32	995	267	82	212	120	240	30	952
Station Site north	30	12	27	17	34	4	125	21	8	19	12	28	3	92
Station Site south	78	32	68	44	80	10	311	54	22	48	30	64	7	225
Total	**379**	**143**	**300**	**190**	**374**	**46**	**1,431**	**341**	**112**	**280**	**162**	**332**	**40**	**1,269**
24 hour weekday trips														
M2 Site	3,389	1,276	1,644	1,127	2,796	368	10,601	3,389	1,276	1,644	1,127	2,796	368	10,601
Station Site north	377	157	201	145	357	43	1,281	377	157	201	145	357	43	1,281
Station Site south	921	390	502	361	868	106	3,148	921	390	502	361	868	106	3,148
Total	**4,688**	**1,823**	**2,347**	**1,633**	**4,022**	**518**	**15,030**	**4,688**	**1,823**	**2,347**	**1,633**	**4,022**	**518**	**15,030**

Coupled with an anticipated decrease in traffic generated by the M2 Site, the decrease in peak direction trips – i.e. commercial trips, is expected to have a positive effect on the performance of the road network. The increase in residential trips in the AM peak is smaller numerically than the reduction in commercial trips. These trips are also counter-peak when compared to the traffic congestion issues associated with the predominant commercial land use in the North Ryde/Macquarie Park area.

3.4 Traffic volumes

The revised traffic volumes forecast on the road network are shown in Appendix B. The scenarios presented include:

1. 2011 existing situation (AM and PM peak hours)
2. 2031 Future base (AM and PM peak hours)
3. 2031 with revised development.

4. Traffic impact

The revised traffic volumes have been entered into the LinSig model developed to meet RMS requirements. The impact of the development is reassessed in this section, using the traffic models developed for the TMAP assessment.

The LinSig model was calibrated to 2011 traffic counts for the following peak times: AM peak 08.00–10.00 and PM peak 17.00–19.00. Details of the model development and calibration are provided in Appendix B of the TMAP 2012.

The model used saturation flows measured by the SCATS traffic controller and included adjustments for green loss – i.e. where a green signal is displayed but traffic cannot proceed because the road in front is full of other vehicles. The models were calibrated to 2011 balanced traffic flows and validated based on the observed queue lengths. Overall, a good fit was determined between the surveyed and modelled flows and queue lengths.

The LinSig corridor models (using LinSig version 3.1.18) were developed for the Epping Road/Delhi Road corridor. The original model developed covered a wider area. However, for this revised assessment for the Station Site North, the intersections from Epping Road/Delhi Road to Delhi Road/Julius Avenue/Plassey Road have been examined as they constitute the main area of influence for the development.

The model results are presented for the following parameters:

- Level of Service (LOS) – a measure of overall performance of the intersection based on average delay
- Average delay –average vehicle delay at the intersection approach
- Degree of Saturation (DoS) – measure of the ratio between traffic volumes and the capacity of the intersection
- Queue length (metres) – due to the variability of traffic volumes and queue lengths, 95th percentile queue lengths are presented. These represent the length of the queue at its maximum during the traffic signal cycle, assessed for the conditions at which it would be equal to or less than that distance for 95% of the time.

4.1 Existing situation

Table 4.1 shows that the modelled intersection level of service for the existing situation using the LinSig models. More detailed modelling results (by intersection approach) are provided in Appendix F.

Table 4.1 2011 two hour overall intersection level of service

Intersection	AM peak		PM peak	
	Average delay (sec/veh)	LoS	Average delay (sec/veh)	LoS
TCS 2993 – Plassey Road/Delhi Road/Julius Avenue	31	C	67	E
TCS 4194 – Delhi Road/Road 38	46	D	93	F
TCS 3160 – Delhi Road/M2 Interchange	33	C	42	C
TCS 551 – Epping Road/Delhi Road	70	E	74	F

4.2 Future base

In order to study the impact of the background traffic growth on the network performance, traffic models for 2031 peak periods were developed. RMS supplied forecast 2031 (two hour) AM and PM peak traffic volumes for the study area from their strategic EMME model. The forecast traffic flows were used to estimate turn counts by applying the difference between the RMS modelled 2011 and 2031 volumes. The growth estimates calculated from the EMME model were adjusted to reflect the physical capacity of the road network. Diagrams of the 2031 future base turn volumes in the AM and PM peak are shown in Appendix B.

In developing the future year traffic models, all network coding including traffic signals and link speeds were assumed to be the same as the existing conditions. The forecast future base traffic conditions in 2031 are summarised in Table 4.2, with detailed results provided in Appendix C. Comparing these results to those shown in Table 4.1, it indicated that a significant increase in traffic congestion if the road network is not improved.

Table 4.2 Delay and Level of Service for 2031 future base conditions

Intersection	AM peak		PM peak	
	Average delay (sec/veh)	LoS	Average delay (sec/veh)	LoS
TCS 2993 – Plassey Road/Delhi Road/Julius Avenue	48	D	176	F
TCS 4194 – Delhi Road/Road 38	55	D	337	F
TCS 3160 – Delhi Road/M2 Interchange	44	D	93	F
TCS 551 – Epping Road/Delhi Road	76	F	97	F

4.3 Future with development

The traffic generation for the Project as outlined in Section 3 were added to the 2031 base flows and the LinSig models were re-run. Diagrams of the 2031 future turn volumes with the Project in the AM and PM peak are shown in Appendix B. The changes to the road network proposed include:

1. widening of Delhi Road eastbound from M2 Motorway to east of Julius Avenue (eastern intersection)
2. an additional right-turn bay from Delhi Road westbound to the M2 Motorway westbound on-ramp
3. extending the right-turn lane from Julius Avenue onto Delhi Road
4. providing an additional left-turn bay from Pittwater Road to Epping Road
5. installation of additional lanes on Wicks Road at Epping Road
6. installation of traffic signals at the intersection of Wicks Road and Waterloo Road
7. provision of additional capacity on Waterloo Road at Lane Cove Road
8. redesign of the on-ramp from Rivett Street/Lucknow Road intersection inside Riverside Corporate Park to Epping Road.

Of these upgrades, items 1, 2 and 7 were mainly due to the impacts of the Station Sites. The reduction of traffic generation compared to the rezoning application has resulted in a reassessment of the need and details of these upgrades. The revised proposed scheme for Delhi Road is shown in Figure 4.1. The main change is associated with the reduced impact at the intersection of Delhi Road and Road 38, which enables the traffic signals to remain in their current configuration (aside from the eastbound kerbside lane becoming a general traffic lane). This in turn removes the need to undertake any further upgrades at the intersection of Delhi Road, Julius Avenue and Plassey Road.

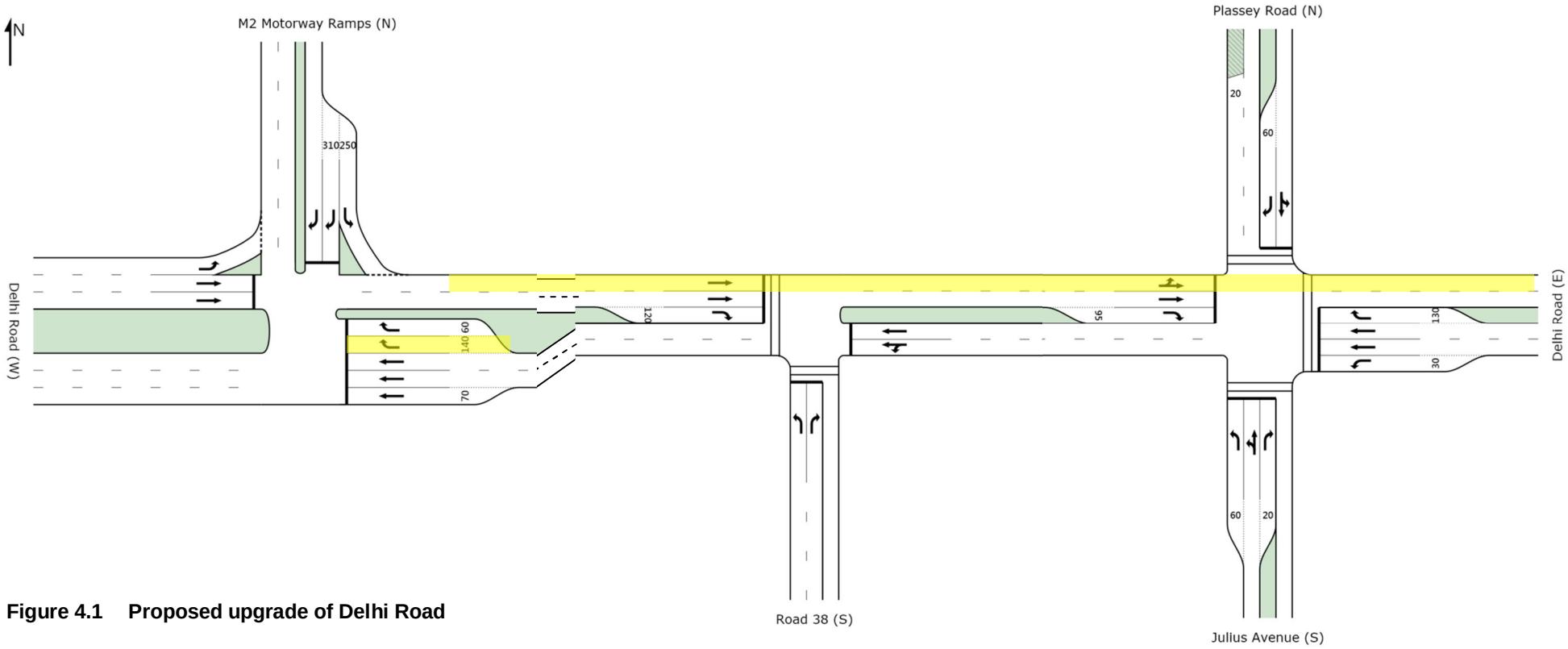


Figure 4.1 Proposed upgrade of Delhi Road

The proposed upgrade includes:

- Delhi Road - widen eastbound direction from one through lane to two through lanes between the M2 Motorway and 100 m east of the eastern intersection with Julius Avenue
- intersection of Delhi Road and M2 Motorway Ramps:
  - move the eastbound cycle lane onto the unused footpath and create kerb ramps to maintain path, relocate stop lines where necessary
  - reduce width of remaining lanes to 3.0 m
  - install second right-turn bay (140 m long) from Delhi Road into the M2 Motorway and adjust length of right-turn bay into Road 38.

The reduced traffic generation has also revised the need for the undertaking of modifications to the on-ramp from Rivett Street/Lucknow Road intersection to Epping Road. The Station Sites are now expected to contribute 37 vehicles to the queue waiting to get onto Epping Road in the AM peak hour and 11 vehicles to this queue in the PM peak hour. As the main congestion concerns at this intersection are during the PM peak (when the impact of the development is low), and the safety and congestion issues predominantly relate to traffic from the Riverside Corporate Park, this upgrade is no longer considered to be a significant issue for the North Ryde Station Precinct. While the development contributes a small amount to the need for the upgrade, it is not a substantial driver for the upgrade.

The results are shown in Table 4.3. More detailed results are provided in Appendix C.

Table 4.3 Delay and Level of Service for 2031 future with development conditions

Intersection	AM peak		PM peak	
	Average delay (sec/veh)	LoS	Average delay (sec/veh)	LoS
TMAP 2012				
TCS 2993 – Plassey Road/Delhi Road/Julius Avenue	72	F	114	F
TCS 4194 – Delhi Road/Road 38	15	B	23	F
TCS 3160 – Delhi Road/M2 Interchange	38	C	31	C
TCS 551 – Epping Road/Delhi Road	107	F	279	F
This assessment				
TCS 2993 – Plassey Road/Delhi Road/Julius Avenue	46	D	65	F
TCS 4194 – Delhi Road/Road 38	7	A	9	A
TCS 3160 – Delhi Road/M2 Interchange	34	C	29	B
TCS 551 – Epping Road/Delhi Road	65	E	202	F

The results indicate that the reduced traffic generation and change in the balance of in and out trips associated with the change of commercial floor space to residential dwellings has resulted in an improvement to the performance of all of the intersections compared to the TMAP scenario in both the morning and afternoon peaks. The most substantial improvements are forecast at the intersection of Delhi Road/Plassey Road/Julius Avenue and Epping Road/Delhi Road.

Comparing these results to the future base, the upgrade of Delhi Road results in an improvement to the future base conditions, mitigating the impact of the proposed development. At the intersection of Epping Road and Delhi Road, the performance is forecast to improve compared to the base conditions during the AM peak, as the downstream blocking from eastbound congestion on Delhi Road is reduced. The only increase is during the PM at this intersection. However, as mentioned above, this increase has been substantially reduced compared to the TMAP scenario.

Single access

In the event that there is a delay in the construction of the connection of Road 38 to Lucknow Road, both the Station Site north and south would need to operate with a single access via the Delhi Road/Road 38 intersection. The impact of the change in traffic flows that this interim access arrangement would create has also been tested in the LinSig model. The results are shown in Table 4.4 and indicate that the traffic from the development could be accommodated on the road network with a single access and the proposed upgrades. It also means that the site does not require access through Riverside Corporate Park, although this is part of the proposed scheme to maintain local permeability.

Table 4.4 Delay and Level of Service for 2031 future with development conditions – single access

Intersection	AM peak		PM peak	
	Average delay (sec/veh)	LoS	Average delay (sec/veh)	LoS
TCS 2993 – Plassey Road/Delhi Road/Julius Avenue	45	D	69	F
TCS 4194 – Delhi Road/Road 38	9	A	12	A
TCS 3160 – Delhi Road/M2 Interchange	32	C	29	B
TCS 551 – Epping Road/Delhi Road	57	E	121	F

4.4 Traffic signal timing

The improved operation of Delhi Road as a consequence of the proposed upgrades is forecast to reduce the amount of exit-blocking currently experienced by traffic during the AM and PM peak periods. The LinSig analysis has attempted to optimise network performance by making traffic signal adjustments to take into consideration the changes to traffic using Road 38 and balance reduced delays for traffic on Delhi Road with reductions to delays on side roads. Whilst traffic signal timings have been adjusted, traffic flow on Delhi Road is improved with lower levels of delay compared to the future base situation.

At a meeting on 14 January 2014 with TfNSW, RMS and City of Ryde Council regarding the Station Sites, RMS advised that due to the road hierarchy priorities in the area, Road 38 receives the lowest priority in terms of traffic signal green time compared to surrounding roads. As a consequence, traffic signal phasing should not be modified. Whilst traffic signal phasing was optimised in the LinSig model, tests conducted using the SIDRA intersection model for the intersection indicate that if necessary, the traffic signal phasing can remain in the current settings with slightly increased delays and queuing for Road 38 traffic (approximately 15 seconds per vehicle) and overall acceptable levels of operation.

Table 4.5 Traffic signal phasing impact on performance of intersection of Delhi Road and Road 38

Intersection	AM peak		PM peak	
	Average delay (sec/veh)	LoS	Average delay (sec/veh)	LoS
TCS 4194 – Existing phasing	4 sec 71sec for Road 38	A	3 sec 68 sec for Road 38	A
TCS 4194 – Modified phasing	4 sec 57sec for Road 38	A	3 sec 56 sec for Road 38	A

Source: SIDRA intersection model results

4.5 Queue length

The impact on queue length has been tested in SIDRA intersection models for the TMAP and currently proposed scenarios. The results are compared in Table 4.6.

Table 4.6 Comparison of impact at Delhi Road and Road 38 intersection

Parameter		TMAP 2012	This assessment	
			Existing phase timing	Modified phasing timing
Traffic movements		Requires right-turn from Road 38 to Delhi Road to be relocated to manage queue lengths and simplify phasing	Full movement - reduced traffic means that right-turn can remain in its current traffic signal phasing	
AM peak hour	*Queue*	*22 m*	*54 m*	*46 m*
	Ave. delay	60 sec	71 sec	57 sec
PM peak hour	*Queue*	*112 m*	*33 m*	*29 m*
	Ave. delay	79 sec	68 sec	56 sec

Source: SIDRA intersection model results

The traffic modelling results indicate that the intersection of Delhi Road and Road 38 can stay in its current layout (with the conversion of the eastbound kerbside lane from 'bus only lane' to general traffic). This configuration is more logical for drivers and reduces the impacts on the neighbouring intersection of Delhi Road, Julius Avenue and Plassey Road. It also has the beneficial impacts of:

- access between Station Street and Road 18 (Julius Avenue extension) within Riverside Corporate Park is now no longer required
- the development of the Station Sites can proceed without any need to connect to the road network within the Riverside Corporate Park
- pedestrian crossing across Delhi Road can stay in its current location
- eastbound bus stop can stay in its present location.

Whilst to connection to Riverside Corporate Park is required, the connection of Road 38 to Lucknow Road assists traffic movement and improves the permeability of the local road network. Connection at this point (as opposed to full access at Road 18) discourages Riverside Corporate Park from overwhelming the intersection of Delhi Road at Road 38. The proposed street network would not preclude this connection from being made at a later date if required.

Pedestrian and cycle access is recommended to remain between Road 18 and Station Street to allow Riverside Corporate Park employees to have convenient access to North Ryde Station.

5. Street layout and access

Aspects of the street layout within the Station Sites have changed as the project moves closer to development. This section outlines and assesses changes to the proposed layout. In general, the road layout are as per the TMAP, with some changes to the turning circle on Station Street.

5.1 Access arrangements

The following road accesses are proposed for the North Ryde Station Sites:

- utilise existing traffic signals at the intersection of Delhi Road and The Leighton Way (Road 38)
- give-way controlled intersection with Road 38 and Station Street
- new turning circle near potential lower level entry into North Ryde Station on boundary with Station Site south
- two-way access from Road 38 to Road 18 (Julius Avenue Extension) with left-out only from Road 18 to Road 38
- one-way southbound to eastbound access from Road 38 to Lucknow Road.

Station Site north and south

Access to the Station Site north and Station Site south (Goodman Property Group site), will utilise the existing intersection of Delhi Road and Road 38 (presently known as The Leighton Way). It is proposed that further upgrades of Delhi Road are required to address current congestion, and make space for traffic generated by the new developments in North Ryde. These upgrades include extending the second eastbound through lane further east through both intersections with Julius Avenue, before merging back to a single lane.

The revised traffic modelling indicates that the Station Sites can operate with the current configuration of the Delhi Road and Road 38 intersection. The proposed layout (schematic diagram) is shown in Figure 5.1.

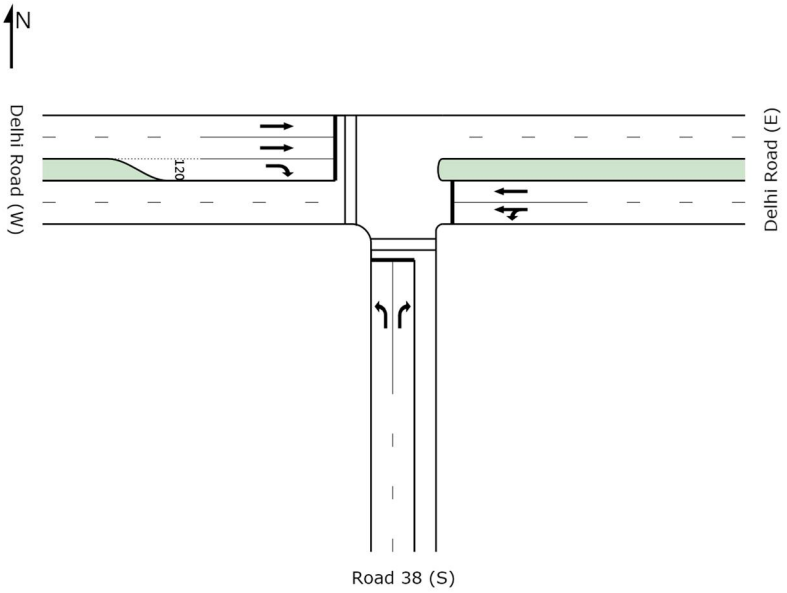


Figure 5.1 Proposed layout of intersection of Delhi Road and Road 38

Intersection of Road 38 and Road 18

A give-way controlled intersection at the junction of Road 38 and Road 18 (Station Street) is proposed with no access into Riverside Corporate Park. The proposed intersection layout is shown in Figure 5.2.

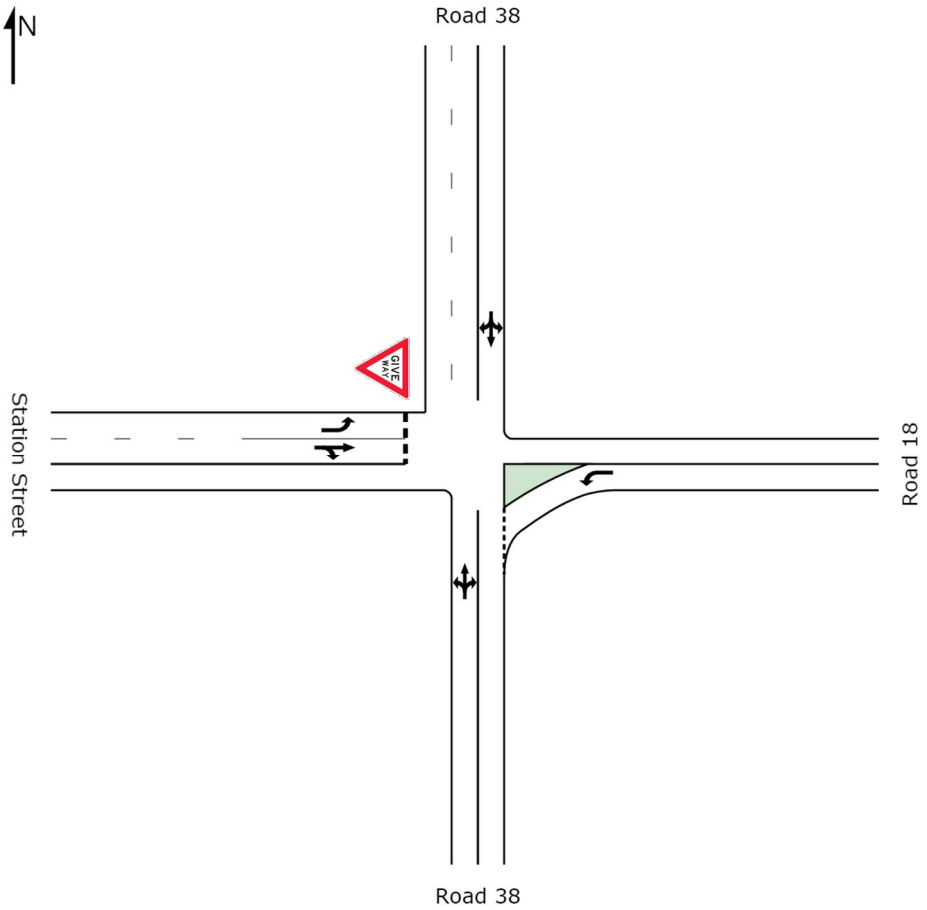


Figure 5.2 Proposed layout of intersection of Road 38 and Station Street

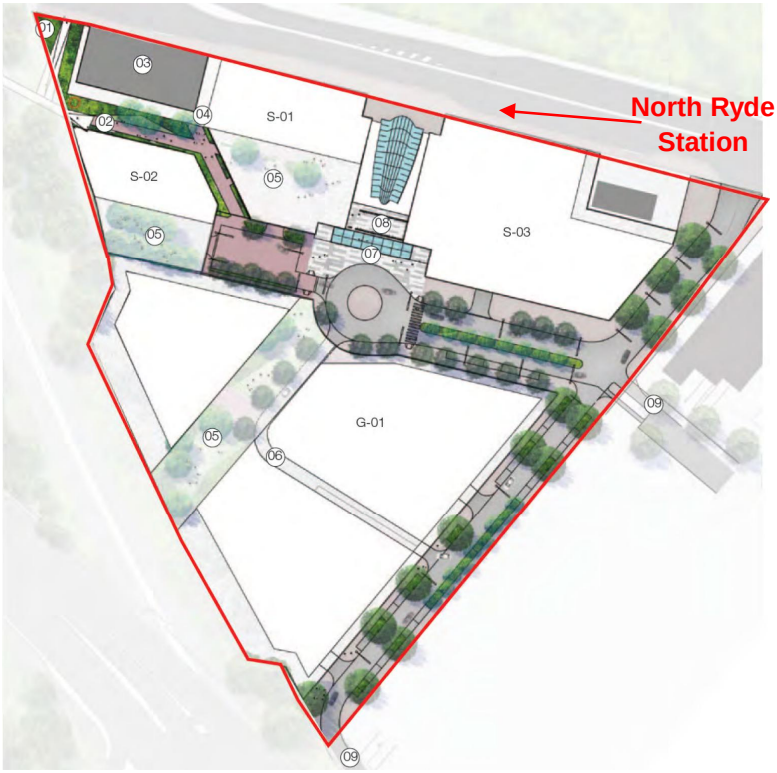
SIDRA intersection modelling indicates that this configuration will operate well with a Level of Service of A and minimal queuing (less than one vehicle on average for all movements) in both the AM and PM peaks.

5.2 Internal road structure – Station Street

Following discussions with Goodman Property Group and Urban Growth NSW, a revised layout for the Station Street turning circle and access streets has been proposed. The changes include:

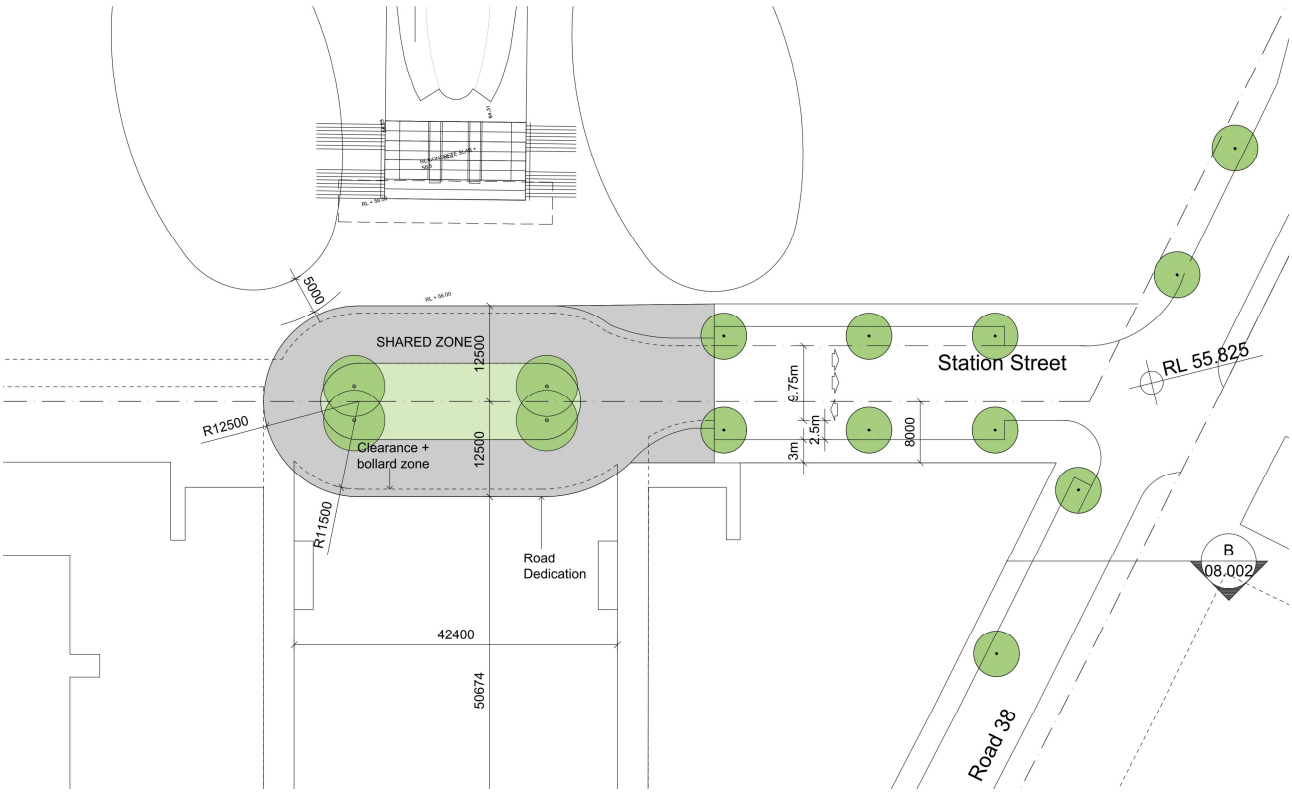
- modifications to the shape and dimensions of the turning area
- extension of the shared zone providing access to the western portion of the site
- removal of the pedestrian crossing east of the turning area and addition of a pedestrian crossing on Road 38 south of Station Street
- removal of the central swale within Station Street.

The reduction in the forecast queue length from the Delhi Road traffic signals means that queuing back into the turning circle is no longer of concern. SIDRA modelling for the intersection of Road 38 and Station Street indicates that queuing at this intersection is forecast to be minor. The previous turning circle is shown in Figure 5.3, while the new shape and dimensions are shown in Figure 5.4.



Source: Cox Richardson Architects: Indicative Layout Plan Report Draft November 2012

Figure 5.3 Previous Station Site north and south internal street layout



Source: Bates Smart, 22 January 2014

Figure 5.4 Revised Station Site internal street layout

Parsons Brinckerhoff has reviewed the proposed design modifications against the access requirements of service vehicles and identified access issues if a future entry to North Ryde Station is opened from the Station Street level. The issues identified are listed in Table 5.1

Table 5.1 Design issues for Station Street turning area

Design element	Design requirement	Issue
Turning circle dimensions	City of Ryde Council has advised that the turning circle should be designed to accommodate its garbage collection vehicle (8.8 m long) and large rigid removalist vans (12.5 m long). Transport for NSW indicated during the TMAP process that the turning area should be designed to accommodate rail replacement buses (12.5 m standard length). Access is required for NSW Fire Brigades appliances.	While the turning area has been designed to the requirements of City of Ryde Councils' Environmental Standards Development Criteria Section 4 Public Civil Works, an analysis using AUSTROADS swept path templates indicates that 12.5 m vehicles cannot fit around the turning area and an 8.8 m service vehicle is required to make a mandatory stop within the turning circle and turn on full-lock – typically an unacceptable solution for a public road.
Elongated shape	Design should be understandable and encourage the intended behaviour.	The elongated design and its proximity to the proposed future station entrance gives the impression that it is a drop-off and pick-up area. If vehicles do dwell in the turning area, other vehicles will not be able to pass due to the tight geometry. This would increase delays for vehicles attempting to turn around and vehicles exiting the building to the west of the station.
	The design should minimise the impediment for pedestrians walking to/from the planned station entry.	The elongated shape increases the area where vehicles and turning vehicles interact, prolonging the exposure to a risk of collision. Driver confusion created by the non-standard design may lead to inattention by drivers.
Placement of trees in the central island	Trees should not encroach on the road space clear zone and should not obscure vision of pedestrians for drivers.	The drawing indicates that the tree canopy could overlap into the turning area space. With an already tight design, drivers of trucks or buses attempting to miss the tree could put them off-line to complete the turn in one movement.

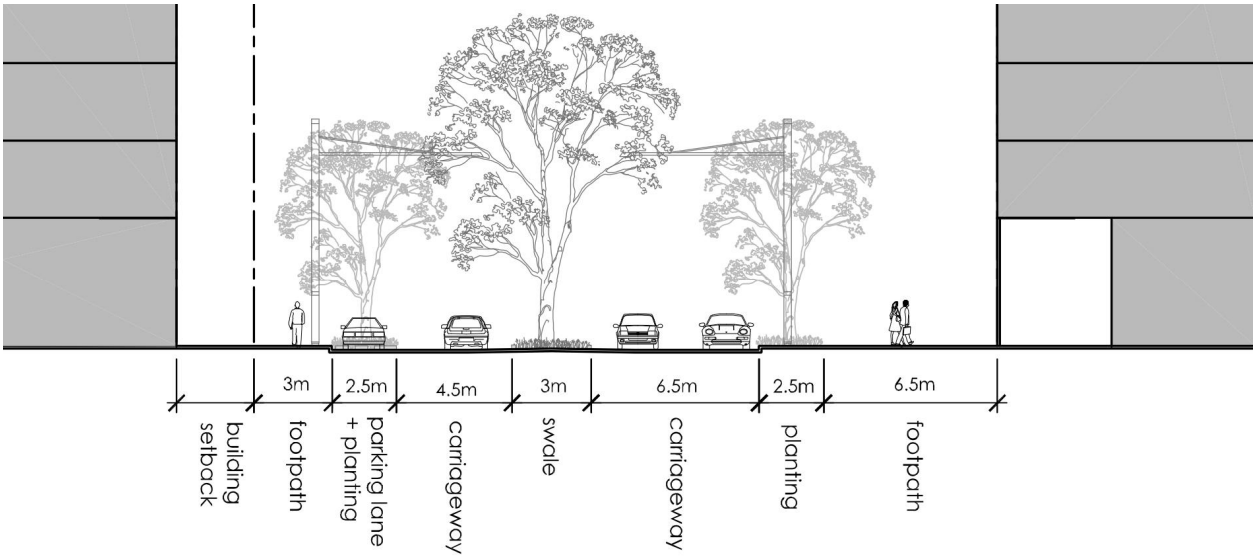
The NSW Fire Brigades *Guidelines for Emergency Vehicle Access* indicate that the turning circle radius required for a general appliance vehicle is a minimum of 11.3 m, while the turning circle required for an aerial appliance is 14.6 m. As the proposed development is high-density residential apartments, it is conceivable that aerial appliances may be required in the event of an emergency.

It is understood that the reason for the request from TfNSW for Station Street to be designed for buses was to allow rail replacement buses to enter Road 38 and Station Street during times of trackwork and rail line closure. Currently, rail replacement buses use the bus stops in each direction on Delhi Road with passengers using the signalised pedestrian crossing at Road 38 (The Leighton Way).

None of the changes proposed to Delhi Road will inhibit the current arrangement from continuing in the future. It is noted that requiring rail replacement buses to turn off Delhi Road onto Road 38, turn around on Station Street and then wait at the traffic signals before rejoining Delhi Road will add travel time to the service, delaying passengers travelling to/from Chatswood. At the meeting on 14 January 2014, TfNSW agreed to confirm the requirement for Station Street to be designed for buses. No advice had been received at the time of writing.

5.3 Street design

The provision of a central swale within Station Street has been reconsidered in light of the increased tree planting in other parts of the development. The street cross-section outlined in the DCP is shown in Figure 5.5.



Source: North Ryde Station Precinct Development Control Plan, NSW Department of Planning and Infrastructure, 4 December 2013

Figure 5.5 DCP Station Street cross-section

A comparison of the individual street elements in the previous and currently proposed designs is provided in Table 5.2.

Table 5.2 Comparison of Station Street elements

Street element	Rezoning application	Current proposal	Comment
Footpath	3 m	3 m	-
Parking + planting	2.5 m	2.5 m	-
Carriageway	4.5 m	3.25 m	Standard lane width sufficient with no swale
Swale	3 m	0 m	No longer required
Carriageway	6.5 m	6.5 m	-
Planting	2.5 m	2.5 m	-
Footpath	6.5 m	3.0 m minimum	Removes provision for cycleway and reduces footpath width by 1 m
Total road reserve	**28.5 m**	**20.75 m minimum**	**Reduction of 4 m**

The footpath dimension (see Figure 5.4) of 5 metres between the turning area and the building adjacent to the western side of the station is less than the 6.5 metres proposed in the TMAP but would allow space for shared use by pedestrians and cyclists. Cyclists travelling between the Delhi Road pedestrian bridge and the Riverside Corporate Park are now expected to use the southern side of Station Street to connect to the crossing facility at Road 38. Dimensions for all footpaths are not provided. However, it is understood that a minimum of 3 metres footpath width will be maintained.

The westbound lane within the road carriageway was widened in the DCP to allow for a vehicle to pass another in the event of a breakdown to avoid a blockage. With the removal of the central swale, vehicles can overtake in the opposing lane, and hence a standard width is appropriate.

The design of the building within the Station Site North (each side of the Station portal) may be able to accommodate increased footpath/cycleway width within the building boundary. The design of this building close to the planned future station entry is important to ensure suitable footpath space for pedestrian access.

6. Transport

The proposed modifications to the development will have a small impact on the movement of people around the site and adjoining area. The revised development yield has implications to the public transport patronage of the site. This section compares the current proposal against the TMAP and assesses the impact of the changes.

6.1 Pedestrian access

The pedestrian and cycle infrastructure proposed for the Station Sites is essentially unchanged from the TMAP. The infrastructure relevant to the Station sites includes:

- a pedestrian bridge from the M2 Site, across Delhi Road, across the M2 Motorway and connecting to the North Ryde Station Site north
- the creation of a continuous shared pedestrian and cycle path from the Riverside Corporate Park, through the North Ryde Station Site North, over the new pedestrian bridge, through the M2 Site and connecting to the new shared paths on Waterloo Road
- a shared zone around the central open space within the M2 Site and pedestrian crossings with raised thresholds on either side to maintain the pedestrian and cycle priority over traffic through the site
- a new set of stairs from Delhi Road to the new station plaza on the western side of the North Ryde Station entry.

The retention of the pedestrian crossing across Delhi Road at Road 38 on the western side of the intersection and the eastbound bus stop in its current position will slightly reduce the distance for people walking between the Station Sites and bus stops provided for services operating between Chatswood and East Ryde/Top Ryde.

Due to the elongation of the turning circle on Station Street, the pedestrian desire line is likely to change to the southern side of Station Street to link to the pedestrian crossing at Road 38. The pedestrian crossing proposed for Station Street in the TMAP has been removed to reflect this change.

6.2 Station Street turning circle and shared zone

The shared zone that covered the access way between the turning area and the vehicle entry to the building west of North Ryde Station is proposed to be extended along Station Street to a point approximately 55 m west of the Road 38 centreline. This will include the turning area within the proposed shared zone.

The shared zone would be designated to be self-enforcing by:

- statutory signs
- raised roadway, flush with the footpath level
- changed pavement type and texture
- bollards defining the vehicle moving space and allowing pedestrian access across the shared zone.

This change acknowledges that due to the relatively low traffic volumes using Station Street, pedestrians are likely to walk across the turning area and roadway regardless of whether the shared zone is provided or not. The change will increase the length of road in which vehicles will be travelling at slow speeds, improving pedestrian safety.

6.3 Train and bus access

Train access

North Ryde Station access for pedestrians and cyclists is essentially unchanged from the TMAP. The proposed street layout would maintain:

- the proposed pedestrian and cycle bridge over Delhi Road
- pedestrian access to Riverside Corporate Park via Road 18 (Julius Avenue Extension)
- pedestrian access to Lucknow Road via Road 38 – adding another option for residents of East Ryde via the traffic signals at Epping Road/Pittwater Road
- new stairs and lift access from the Station Street level to Delhi Road level at North Ryde Station.

Bus access

The relocation of the eastbound bus stop on Delhi Road from west of Road 38 to east of Road 38 is no longer required, as the pedestrian crossing is now planned to be retained in its current location. This reduces the walk distance for people interchanging between train and bus and residents of the Station Sites.

6.4 Public transport patronage

One of the objectives for the North Ryde Station Precinct was to increase the use of North Ryde Station to realise the benefit of the investment in the station. The change in land use from commercial to residential in the Station Sites and reduction of commercial space in the M2 Site is expected to reduce train and bus patronage by 40% in the AM peak and 50% peak periods. However, as residents make more trips during off-peak times, the reduction in daily trips is only approximately 30%. Whilst overall public transport trip numbers reduce, increased off-peak use is a compensating factor.

The change from employees to residents is also likely to change the balance between in and out trips through the Station during the peaks. During the morning peak, it is expected that the change in land use would:

- reduce passenger loads eastbound along the Epping to Chatswood Rail Line between Epping and North Ryde, but;
- increase passenger loads between North Ryde and Chatswood
- reduce passenger loads between Chatswood and North Ryde, but;
- increase passenger loads between North Ryde and Epping.

This impact would be reversed during the PM peak. Overall, taking into consideration the situation after the opening of the North West Rail Link, the land use change will slightly increase the maximum passenger load on the line by adding to the busiest demand in the peak direction.

7. Parking

The changes to the development yield and street layout have changed the provision for on-street and off-street parking. This section assesses the impact on the parking requirements of the revised development.

7.1 Parking rates

It is proposed that the parking rates for the development would comply with those in the North Ryde Station Precinct Development Control Plan (DP&I, 4 December 2013). These rates are different to those recommended in the TMAP for residential dwellings, and are unlikely to result in increased parking space numbers. The DCP parking rates are listed in Table 7.1.

Table 7.1 Car parking rates

Land use	Parking rate
Commercial	1 space per 90 sqm GFA
Retail	1 space per 100 sqm GFA
Supermarket	1 space per 60 sqm GFA
Residential	1 space per 1, 2 or 3 bedroom dwelling 0 space per studio 1 space per 10 dwellings for visitor parking
Community	1 space per 100 sqm GFA
Student housing and serviced apartments	1 space per 5 bedrooms

Using these rates, the number of parking spaces to be provided has been calculated on the assumption is that studio apartments would be 5% of the total dwelling number. A comparison of the parking between the TMAP and proposed development is provided in Table 7.2. While the total number of parking spaces has increased, they are expected to be used less intensely. Some of this increase may be due to the difference in parking rates between the TMAP and DCP, i.e. not attributable to the revised development.

Table 7.2 Estimated number of spaces

Site	TMAP 2012	This assessment	Difference
Station Site north	50 serviced apartments, 222 commercial, 9 retail, 39 student accommodation **320 total**	324 residential, 5 retail **329 total**	+9
Station Site south	235 residential, 347 commercial **582 total**	851 residential 10 retail **861 total**	+279
Total	**902**	**1,190**	**+288**

The DCP requires the preparation of a Parking Management Strategy for the Station precinct to minimise parking overspill into surrounding areas, including the Macquarie Park Cemetery and Crematorium. This will be prepared as part of subsequent development applications for the construction of buildings, when the parking to be provided on site is known.

The DCP also makes provision for encouragement of car share schemes as one element of a strategy to reduce car dependency for commuting and recreational transport use.

7.2 On-street parking

The change in the design of Station Street has resulted in a small increase in on-street parking. The design for Station Street presented in the TMAP had an allowance for five indented bays plus a drop-off area. The revised design has space for eight cars.

The revised number of residential spaces alters the recommended number of car share spaces from 15 to 13 (based on one car share space per 90 regular residential spaces). With the small increase in on-street parking, there is opportunity to increase the number of car share spaces in the public domain. There is scope for the remaining spaces to be provided within the adjacent buildings, on the proviso that 24 hour access is feasible.

The TMAP allocated on-street parking within the Station Sites to car share, disabled parking, a loading zone, kiss-and-ride, short-stay timed parking and motorcycle parking. These priorities remain in the current proposal. The seven spaces on Station Street are assumed to be allocated as:

- One disabled parking space
- Two kiss and ride spaces
- Two car share spaces
- One loading zone (2P parking after hours)
- One space divided for motorcycle parking.

This allocation assumed that short-stay parking for cars will be provided along Road 38. Not providing daytime parking for cars would reduce the amount of traffic using Station Street.

The shift of some commercial to residential development and the increased parking provision within the development is likely to reduce the potential for overspill into surrounding areas associated with the site, including the Macquarie Park Cemetery and Crematorium.

7.3 Bicycle parking

The North Ryde Station Precinct DCP refers to the bicycle parking guidelines in Section 6.3.8 of Part 4.5 of the Ryde DCP 2010. The number of visitor spaces to be provided for residential dwellings is 10% of the number of parking spaces (same as recommended in the TMAP). Ryde DCP 2010 recommends storage in all residential developments. These provisions are lower than those recommended in the TMAP.

The number of bicycle spaces required for commuters was estimated at 45 in the TMAP, with six already provided at the Delhi Road frontage to North Ryde Station. It is envisaged that the remaining spaces would be provided within the Station forecourt area, or potentially alongside the Station structure at the lower level. Access would be maintained to the six existing spaces.

The commuter bicycle parking would be provided in stages as demand increases.

8. Construction

This section describes the following aspects of the construction of the infrastructure works:

- construction details
- the traffic generating activities
- construction affecting public transport and pedestrians.

The following preliminary information has been drawn from information available at the rezoning application stage, including information from the project's civil engineering consultant, Robert Bird Group. These details may change as detailed designs are developed and following appointment of a construction contractor. They are based on the most up-to-date information available at the time of preparation.

8.1 Construction details

The following typical construction work hours have been assumed:

- Monday to Friday 7.00 am to 6.00 pm
- Saturday 8.00 am to 3.00 pm
- no work will be undertaken on Sundays and public holidays.

Out of hours construction on weekends and at night may be required, but would be subject to a separate application.

It is estimated that the peak construction period would cover between one and four months when demolition and site clearing, site grading and material stockpiling works occurs. Pre-construction for the pedestrian bridge would take approximately eight months.

Construction of the pedestrian bridge over Delhi Road and the M2 Motorway (not included in the works proposed for this Development Application) may have to be carried out at night or on weekends to minimise the impacts on peak traffic periods. Traffic Management Plans (TMPs) will to be developed by the design and construct (D&C) contractor for the management of potential closures to Delhi Road and the M2 Motorway during this period. This will also involve the identification of detour routes.

8.2 Construction site and access

The access to the Station Sites would be via the existing Delhi Road/Road 38 (The Leighton Way) intersection. Internal traffic movement would be maintained via existing paved roads and the ultimate proposed road network.

8.3 Construction traffic generation and impact

Traffic generation during construction of the supporting infrastructure works is likely to comprise traffic associated with construction personnel and construction vehicles travelling to and from the site. The level of construction activity, and therefore traffic generation, will vary throughout the construction process. The following estimates are provided for a typical upper limit of activity.

Construction staff movement

It is estimated that there would be approximately 120 construction staff on both the Station Site north and M2 Site during the peak construction period. Construction staff would be encouraged to take advantage of train services at North Ryde Station and buses on Epping Road. However, to estimate potential traffic generation, a conservatively high assumption is made that all construction personnel will arrive and depart at the site using light vehicles, and that the vehicle occupancy rate would be one person per vehicle. During a typical working day, up to 120 vehicles would arrive before the morning peak and depart after the morning peak to minimise the impact on the peak traffic flow.

Traffic generation is expected to be less than the number of vehicles generated by the M2 Motorway widening construction, which is presently occupying the two sites (see section 3.5). This means that when the M2 Motorway widening construction ceases and construction of the North Ryde Station Precinct infrastructure works begins, traffic volumes on surrounding roads are expected to reduce.

It is estimated that the current 760 construction staff associated with the M2 Motorway widening project park approximately 320 vehicles parked on site. If a similar ratio of construction workers to vehicles parked on site can be achieved, construction staff traffic generation would drop to approximately 50 trips into the sites in the morning (before 7.00 am) and 50 trips out of the sites (at around 6.00 pm).

Construction staff parking

It is assumed that 75% of construction personnel would park their vehicles on the M2 Site and 25% would park on the Station Site north, i.e. up to 80 vehicles parked on the M2 Site and 40 vehicles parked on the Station Site north. The numbers of staff involved are less than the number based at the two sites for the M2 Motorway widening. If a similar ratio of construction workers to vehicles parked on site can be achieved, the number of vehicles would drop to approximately 50.

Types of vehicles

Construction vehicles would mainly include: tipper trucks, semi-trailers and ready-mix trucks. In addition, truck and dog will be used for the removal of spoil and delivering construction plant and equipment and bridge erection equipment. It is anticipated that the use of low loaders and vehicles carrying wide loads will be required for the delivery and collection of some equipment and material. It will be the responsibility of the contractor to arrange for Road Occupancy Licences (ROL) for these movements.

The construction vehicle traffic generation by the site will have a similar split as staff parking. The traffic generated during the different stages of construction is shown in Table 8.1.

Table 8.1 Estimated traffic generation during the construction of Stage 1

Construction stage	Duration	M2 Site	Station Site
Demolition/site clearance	10 weeks	15 trucks/day	5 trucks/day
Earthworks and material delivery	10 weeks	19 trucks/day	6 trucks/day
Stage 1a construction	15 weeks	11 trucks/day	4 trucks/day
Delhi Road pedestrian bridge construction	5 weeks	26 trucks/day	9 trucks/day

Source: Robert Bird Group, 2012

(1) The pedestrian bridge construction will occur during the same period as the Stage 1 Construction. Pre-construction of the bridge itself will take approximately 8 months

Estimates from RBG indicate that the peak generation of the heavy vehicles during Stage 1a would occur during the pedestrian bridge abutment construction phase (not included in the works proposed for this Development Application). There would be a maximum of 50 trucks movements (50 truck trips in/50 truck trips out) generated by the M2 Site and Station Site, with some of the truck generation allocated to the construction of the bridge support structure in the RMS Site. Based on an 11 hour working day and assuming a maximum 20% increase during the peak period (worst case scenario), both sites are anticipated to generate a total of 6 trucks per hour. This will be less that 0.2% of the existing peak period traffic on Epping Road, and as a result, have minimal influence to existing traffic conditions.

Traffic impacts

As mentioned, the anticipated maximum traffic generation by both construction sites will be less than the current activity on the M2 Site and Station Site north. As a result there will be minimal impact during the construction period.

Elements of work which require a ROL are to be conducted outside peak periods to minimise the impact to the already congested environment. It will be the responsibility of the D&C contractor to prepare and gain approval for the TCPs and ROLs. The D&C contractor will have to conduct these works outside of peak periods.

8.4 Construction of the pedestrian bridge

The construction of the pedestrian bridge (not included in the works proposed for this Development Application) would be completed over a 15 week period, with some of the construction activity required at night or during other low-traffic periods.

The construction of the end supports can generally be completed within the M2 Site and the Station Site. The construction of the mid support structure (the end of span 1 and start of span 2) would be completed from the RMS Site and directly from Delhi Road with the assistance of traffic control plans (TCPs) and a road occupancy licence (ROL).

The final construction method may also require temporary intermediate supports on Delhi Road. If required, these would be located within existing traffic islands and may need to stand for up to one week. These temporary supports would require protection with concrete barriers to avoid the support being knocked down or weakened in the event of a collision. If a lane has to be closed to provide sufficient space for the protection, these works would be undertaken during a low-traffic periods.

Depending on the construction methodology and approach, the D&C contractor will be responsible for the development and approval of the required TCPs (and ROLs if required) to manage traffic movements. ROLs will be required for concrete pours from Delhi Road, and will need to consider the potential impact created by any reversing movements of the construction vehicles. Also, as the concrete pours will occur over a pedestrian path, the TCP would need to maintain pedestrian movement along the Delhi Road footpath.

During the construction of the two bridge spans (span 1 between the M2 Site and RMS Site and span 2 over the M2 Motorway, between RMS Site and Station Site), Delhi Road will potentially have to be temporarily closed as a minimum when the work on the spans are being undertaken over the relevant road reserves. The D&C contractor will be responsible for the preparation and approval of appropriate TCPs and ROLs with consideration given to detour routes and public communication. As part of the construction of the bridge span, the D&C contractor will also be responsible for the identification of the haulage route for the delivery of the bridge span (if it is required for pre-cast construction) if the load is wider than 3.5 m.

8.5 Impacts on pedestrians and cyclists

There may be some impact on pedestrians and cyclists during construction of the eastern end of Span 1 of the Delhi Road pedestrian bridge. Where construction activities have the potential to impact on pedestrians and cyclists, the D&C contractor will be required to prepare appropriate TCPs to assist in the management of pedestrians and cyclists. Access for pedestrians and cyclists should be maintained at all times, other than short closures for the movement of construction vehicles and goods. If required during these events, a certified Traffic Controller may be required to provide additional guidance.

8.6 Construction vehicle routes

Construction vehicles routes will be developed to minimise the impacts on local roads and maximising use of arterial roads. The selection of these construction vehicle routes will be confirmed by the contractor in agreements during detailed site planning. Figure 8.1 provides potential haulage routes for construction vehicles.

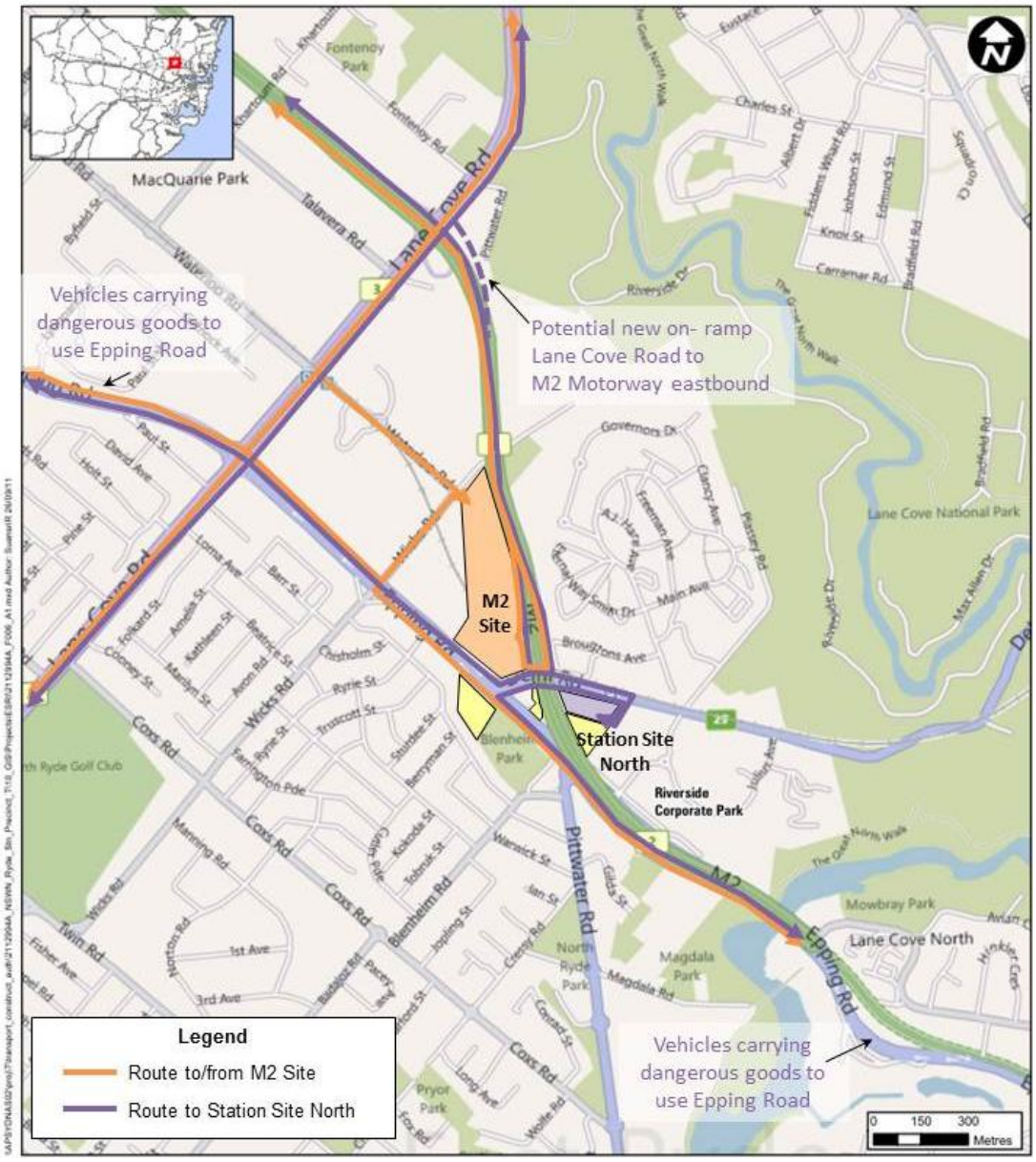


Figure 8.1 Potential construction vehicle haulage routes

The major origins/destination of construction vehicle trips are expected to be:

- West: Access to the M2 Motorway increases the potential distribution of construction vehicles to the wider network with the connection to the M7 Motorway
- West (alternative route and route for vehicles carrying dangerous goods): Epping Road, Carlingford Road and Pennant Hills Road
- North: Lane Cove Road, Ryde Road
- South: Lane Cove Road, Church Street, Concord Road
- East: Epping Road, Lane Cove Tunnel, Gore Hill Freeway
- East (alternative route and route for vehicles carrying dangerous goods): Epping Road, Longueville Road, Gore Hill Freeway.

8.7 Modifications to public transport

During construction of the Station Sites, it is anticipated that access will be maintained to North Ryde Station via its current entry on Delhi Road, and to the bus stops on both sides of Delhi Road. With the retention of the existing layout at the intersection of Epping Road and Delhi Road, there is unlikely to be any disruption to the pedestrian crossing between the Station and the eastbound bus stop.

As part of the works, the D&C contractor will be required to prepare appropriate TCPs and obtain a ROL. Works undertaken on Epping Road or Delhi Road will have to be completed outside peak traffic periods. The D&C contractor will be responsible for consultation with State Transit Authority and TfNSW. Temporary lane closures would be done during out-of-peak times, minimising the impacts on bus services.

8.8 Parking impacts

No on street parking will need to be affected where ROLs are required. There will be no need for a work zone to be located on the road that will influence the supply of parking. As mentioned previously, it is assumed that all construction personnel who drive would park their vehicles within the Project sites.

8.9 Impact on emergency service vehicle access

It is anticipated that there will be minimal impact on emergency vehicles for the majority of the construction period except for the events of the bridge construction where temporary road closures are required. During these events, the D&C contractor will be responsible to inform all the emergency services of the upcoming delays and the proposed detour routes.

9. Conclusion

Parsons Brinckerhoff has undertaken a traffic and transport assessment to support a development application for the proposed new road and supporting infrastructure works associated with the North Ryde Station Site north. The assessment has included a review of the revised development details of the Station Site north and the remaining North Ryde Station Development, for consistency with the transport issues covered in the 2012 TMAP, the DCP and approved rezoning application.

The assessment has included a review of proposed changes to development yield, development type, traffic generation, traffic impact, street layout, intersections and access, public transport, provisions for pedestrians and cyclists, parking and construction impact. The proposed modifications are considered to reduce the traffic impact of the proposed future use of the site, whilst preserving the objectives of the original proposal. The design of the proposed road, access arrangements and turning area on Station Street have been reviewed against the 2012 TMAP.

9.1 Changes proposed from rezoning application

The main changes proposed for the development assessed for this report are listed in Table 9.1 along with a summary of their impacts.

Table 9.1 Proposed changes to the North Ryde Station Precinct and summary of impacts

Change proposed	Details of change	General impact
Trip generation, traffic volumes		
Development yield	▪ Conversion of majority of commercial floor space into residential dwellings. ▪ Small changes to retail floor space.	▪ Reduced overall traffic generation. ▪ Positive change of in/out balance of trips. ▪ Adjustment to mode share required due to reduced trip containment and increased parking.
Traffic generation rates	▪ RMS have issued information on updated traffic generation rates for high-density residential developments close to public transport.	▪ Reduced traffic generation per dwelling.
Access arrangements		
Turning circle on Station Street relocated	▪ Turning circle on Station Street redesigned. ▪ Extended shared zone.	▪ Turning area on Station Street accommodates garbage trucks and general access fire appliances, but does not accommodate the turning requirements of all design vehicles. ▪ Reduced traffic passing through the shared zone during peak times. ▪ Simplified traffic movement.
Street design	▪ Central swale on Station Street removed. ▪ Reduced westbound lane width. ▪ Footpath width reduced.	▪ Widened lane no longer required with removal of swale. ▪ Footpath width still above typical minimum, cycles likely to finish journey at North Ryde Station or use Station Street or southern side footpath to get to Riverside Corporate Park. ▪ Design of building east of North Ryde Station important to preserve footpath space and avoid pinch-point on entry to Station.

Change proposed	Details of change	General impact
Intersection of Delhi Road and Road 38	▪ Eastbound bus queue-jump converted to traffic lane as part of Delhi Road widening. ▪ Intersection to remain in current configuration with the above exception.	▪ Reduced traffic volumes allow right-turn from Road 38 to Delhi Road to be maintained. ▪ Pedestrian crossings can stay in their current location. ▪ More intuitive road layout. ▪ Reduced impact on intersection of Delhi Road, Julius Avenue and Plassey Road. ▪ Intersection can operate with existing traffic signal phasing with acceptable performance. However, signal optimisation may reduce delays further.
Vehicle access to Riverside Corporate Park	▪ Connection to Road 18 proposed with left-turn only for vehicles travelling from Riverside Corporate Park. ▪ One-way southbound to eastbound access proposed between Road 38 and Lucknow Road.	▪ Connection provided in two locations, but movements restricted between Road 18 and Road 38 to avoid Riverside Corporate Park traffic congestion spilling over into Road 38. ▪ One-way access between Road38 and Lucknow Road due to road design requirements. ▪ Development can operate effectively without any vehicle connection to Riverside Corporate Park. ▪ Pedestrian access to Road 18 maintained to encourage use of North Ryde Station.
Pedestrian access		
Marked pedestrian crossings	▪ Pedestrian crossing on Station Street removed. ▪ Pedestrian crossing on Road 38 relocated to southern side of intersection with Station Street/Road18.	▪ No longer required due to shared zone extension. ▪ Pedestrian desire line likely to favour southern side of Station Street.
Signalised pedestrian crossings	▪ Retention of the pedestrian crossing across Delhi Road at Road 38 on the western side of the intersection.	▪ Shorter walk for pedestrians to North Ryde Station than rezoning application scenario.
Public transport		
Bus access	▪ Relocation of eastbound bus stop on Delhi Road no longer required.	▪ Bus stop is in the most convenient location for existing intersection layout at Delhi Road / Road 38.
Patronage	▪ Change in land use from commercial to residential changes the number and patterns of public transport users.	▪ Reduced overall use in the peaks, but higher use off-peak. ▪ Residents using the train and bus during the peaks are likely to increase the peak load.
Parking		
Off-street parking	▪ Change in land use changes parking numbers. ▪ Parking rates slightly higher in DCP than TMAP.	▪ Increased number of parking spaces on-site. ▪ Reduced intensity of use during peak periods.
On-street parking	▪ Slightly increased number of on-street spaces.	▪ Parking priorities from TMAP retained.

Other aspects of the development are maintained as per the TMAP and DCP for the approved rezoning application without modification, such as access to North Ryde Station including the pedestrian bridge across Delhi Road.

9.2 Response to DGRs

Identify the proposed road and intersection upgrades, and demonstrate that they provide linkages to key destination points such as public transport nodes, centres, employment lands, and recreation areas, within and surrounding the site.

As per the TMAP, the road network consists of the formation of Road 38 from its existing connection to Delhi Road and the creation of Station Street running parallel to Delhi Road. These roads will improve access to North Ryde Station for vehicles (including buses, heavy rigid trucks, taxis and kiss-and-ride cars). Intersections include:

- existing signalised intersection of Delhi Road and Road 38
- future give-way intersection of Road 38 and Station Street
- turning circle at the end of Station Street providing access to a shared zone.

Road upgrades include the widening of Delhi Road in the eastbound direction and the creation of a second right-turn lane from Delhi Road onto the M2 Motorway on-ramp.

Access to North Ryde Station is proposed as per the arrangements described in the TMAP. The relocation of the eastbound bus stop on Delhi Road and relocation of the pedestrian crossing at the intersection of Delhi Road and Road 38 that were proposed in the TMAP are no longer required, and will therefore remain as per the current situation.

Recommendations have been made for modification of the proposed Station Street turning circle design to allow it to meet its design requirements including:

- the clear radius of the turning circle should be increased from 11.5 m to 13.5 m (14.6 m if NSW Fire Brigades aerial appliance access is required)
- the line of bollards separating the turning area from the footpath should be placed 600 m outside the clear radius to allow for a margin of error for drivers that are unfamiliar with the area
- elongated design be changed to a standard turning circle
- the location of the trees needs to be checked to ensure they do not further reduce the effective turning area for larger vehicles or obscure vision of pedestrians.

Demonstrate that all aspects of the road design provide adequate capacity having regard to traffic modelling carried out as part of the State Significant Site Study (SSSS).

The changes to the land use mix, traffic generation rates and mode share have affected the amount of traffic that the Sites will generate. In general, traffic generation has reduced, and the main direction of flow has switched with the increase of residential dwellings. The LinSig traffic model has been run with the revised traffic volumes to test the road upgrades recommended in the TMAP. The results indicate:

- Traffic impact on the surrounding intersections is reduced with lower delays and queues.
- Previously recommended upgrades such as the widening of Delhi Road to two lanes eastbound and the creation of a second right-turn lane onto the M2 Motorway are still important to alleviate current congestion and get the traffic from the site onto the road network.
- The existing traffic signals at the intersection of Delhi Road and Road 38 can accommodate the revised traffic generation without modification, i.e. the proposed right-turn ban from Road 38 to Delhi Road and moving of the pedestrian crossing are no longer required.
- Two connections have been proposed between the Station Sites and Riverside Corporate Park at Road 18 (Julius Avenue Extension) (with left-out only access from Road18) and Lucknow Road (one-way southbound to eastbound only) to improve permeability in the local area without encouraging large volumes of traffic from the neighbouring Riverside Corporate Park to use Road 38.
- The existing traffic signals at the intersection of Delhi Road and Road 38 can accommodate the entire traffic generated by the site, i.e. the site can operate with one access in the event that there is a delay to the opening of the connections to Riverside Corporate Park.
- The Sites contribute only a small amount of traffic to the Rivett Road ramp onto Epping Road. Hence the Site is no longer considered to be a driver of the need for improvements to this ramp.

Identify proposed pedestrian and bicycle connections and demonstrate how these provide linkages within the site, and to adjoining areas, including to the train station and major bus stops. This should include identification of adequate bicycle parking at the train station, and within other areas of the public domain.

The arrangements for pedestrians and cyclists are essentially the same as those proposed in the TMAP. This includes the new pedestrian and cycle bridge over Delhi Road and the M2 Motorway. This bridge will link the two largest parts of the development, and will also improve the accessibility of North Ryde Station and connect to other facilities, enabling a continuous pedestrian and cycling corridor to exist from Macquarie University to the Riverside Corporate Park. The need for improved connections for pedestrians from south of Epping Road to the station will be investigated further at a later stage however the TMAP recommends a possible future pedestrian and cycle bridge over Epping Road connecting the Goodman site with Blenheim Road to the south.

The Station Site includes an extended shared zone covering the turning area and the access to the building to the west of North Ryde Station to maintain the pedestrian and cycle priority over traffic through the site. It also includes a new set of stairs from Delhi Road to the new station plaza on the western side of the North Ryde Station entry.

Additional bicycle parking will be provided at North Ryde Station, with the number of spaces increasing as demand increases.

Identify any proposed bus infrastructure upgrades and demonstrate how existing and proposed bus infrastructure will be integrated with the train station and development area.

The retention of the traffic signals at the intersection of Delhi Road and Road 38 in their current configuration has allowed the bus stops on Delhi Road at North Ryde Station to remain in their current location. The pedestrian crossing across Delhi Road at Road 38 will remain on the western side of the intersection, providing convenient access to the current location.

The turning circle on Station Street requires modification to allow a 12.5 m bus to complete a U-turn. However, TfNSW have yet to confirm that rail replacement bus access to the planned rear access to North Ryde Station is required. It is noted that rail replacement buses currently stop along Delhi Road at the eastbound and westbound stops near the Station, and can continue to do so in the future.

9.3 Construction impact

The construction activity for the supporting infrastructure works is expected to be less than the M2 Motorway widening compounds currently occupying the M2 Site and Station Site North, with fewer trucks and construction staff traffic movements. It is therefore expected that there would be a net reduction in traffic and on-site parking with the construction of Stage 1 compared to the existing traffic conditions. All construction staff parking is expected to be contained on site. Construction activity would generally be contained within the sites, however, there would be impacts from the construction of spans 1 and 2 of the shared pedestrian and cycle bridge over Delhi Road.

As a construction contractor has not been appointed, the exact methodology of construction is not yet known. A complete CTMP will be submitted for approval before the commencement of construction, but once the required detail is known. The preliminary information contained in this report includes an outline of the principles on which the CTMP should be based, potential mitigation measures, and a communications strategy.

Appendix A

Level of service criteria

A1. Intersections

A1.1 Level of Service

Level of service (LoS) is one of the basic performance parameters used to describe the operation of an intersection. The levels of service range from A (indicating good intersection operation) to F (indicating over saturated conditions with long delays and queues). At signalised and roundabout intersections, the LoS criteria are related to average intersection delay (seconds per vehicle). At priority controlled intersections, the LoS is based on the average delay (seconds per vehicle) for the worst movement. SIDRA provides analysis of the operating conditions which can be compared to the performance criteria set out in Table A.1.

Table A–1: Level of Service Criteria for Intersections

LoS	Average delay (seconds per vehicle)	Traffic Signals, Roundabout	Give Way and Stop Signs
A	Less than 14	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity and accident study required
E	57 to 70	At capacity. At signals, incidents will cause excessive delays. Roundabouts require other control mode	At capacity; requires other control mode
F	Greater than 71	Unsatisfactory with excessive queuing	Unsatisfactory with excessive queuing; requires other control mode

Source: RMS Guide to Traffic Generating Developments

A1.2 Degree of saturation

Degree of saturation (DoS) is defined as the ratio of demand flow to capacity, and therefore has no unit. As it approaches 1.0, extensive queues and delays could be expected. For a satisfactory situation, DoS should be less than the nominated practical degree of saturation, usually 0.9. The intersection DoS is based on the movement with the highest ratio for all types of intersection.

A1.3 Delay

Delay is the difference between interrupted and uninterrupted travel times through the intersection and is measured in seconds per vehicle. The delays include queued vehicles decelerating and accelerating to and/or from stop, as well as delays experienced by all vehicles negotiating the intersection. At signalised and roundabout intersections, the average intersection delay is usually reported and is taken as the weighted average delay by summing the product of the individual movement traffic volume and its corresponding calculated delays and dividing by the total traffic volume at the intersection. At priority controlled intersections, the average delay for the worse movement is usually reported.

A1.4 Queue length

Queue length is the number of vehicles waiting at the stop line and is usually quoted as the 95th percentile back of queue, which is the value below which 95% of all observed queue lengths fall. It is measured as the number of vehicles per traffic lane at the start of the green period, when traffic starts moving again after a red signal. The intersection queue length is usually taken from the movement with the longest queue length.

A2. Roads

Austroads 2009, 'Guide to Traffic Management Part 3: Traffic Studies and Analysis' includes a description of the Level of Service criteria for roads, which is provided below.

Level of Service is a qualitative measure describing operational conditions within a traffic stream, and their perception by motorists and/or passengers. A level of service definition generally describes these conditions in terms of factors such as speed and travel time, freedom to manoeuvre, traffic interruptions, comfort and convenience, and safety.

In general, there are six levels of service, designated A to F, with Level of Service A representing the best operating condition (i.e. free flow) and Level of Service F the worst (i.e. forced or breakdown flow).

Level of Service A	A condition of free flow in which individual drivers are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to manoeuvre within the traffic stream is extremely high, and the general level of comfort and convenience provided is excellent.
Level of Service B	In the zone of stable flow where drivers still have reasonable freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is a little less than with Level of Service A.
Level of Service C	Also in the zone of stable flow, but most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience declines noticeably at this level.
Level of Service D	Close to the limit of stable flow and approaching unstable flow. All drivers are severely restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is poor, and small increases in traffic flow will generally cause operational problems.
Level of Service E	Traffic volumes are at or close to capacity, and there is virtually no freedom to select desired speeds or to manoeuvre within the traffic stream. Flow is unstable and minor disturbances within the traffic stream will cause breakdown.
Level of Service F	In the zone of forced flow, where the amount of traffic approaching the point under consideration exceeds that which can pass it. Flow breakdown occurs, and queuing and delays result.

Appendix B

Forecast traffic volumes

B1. 2011 existing situation

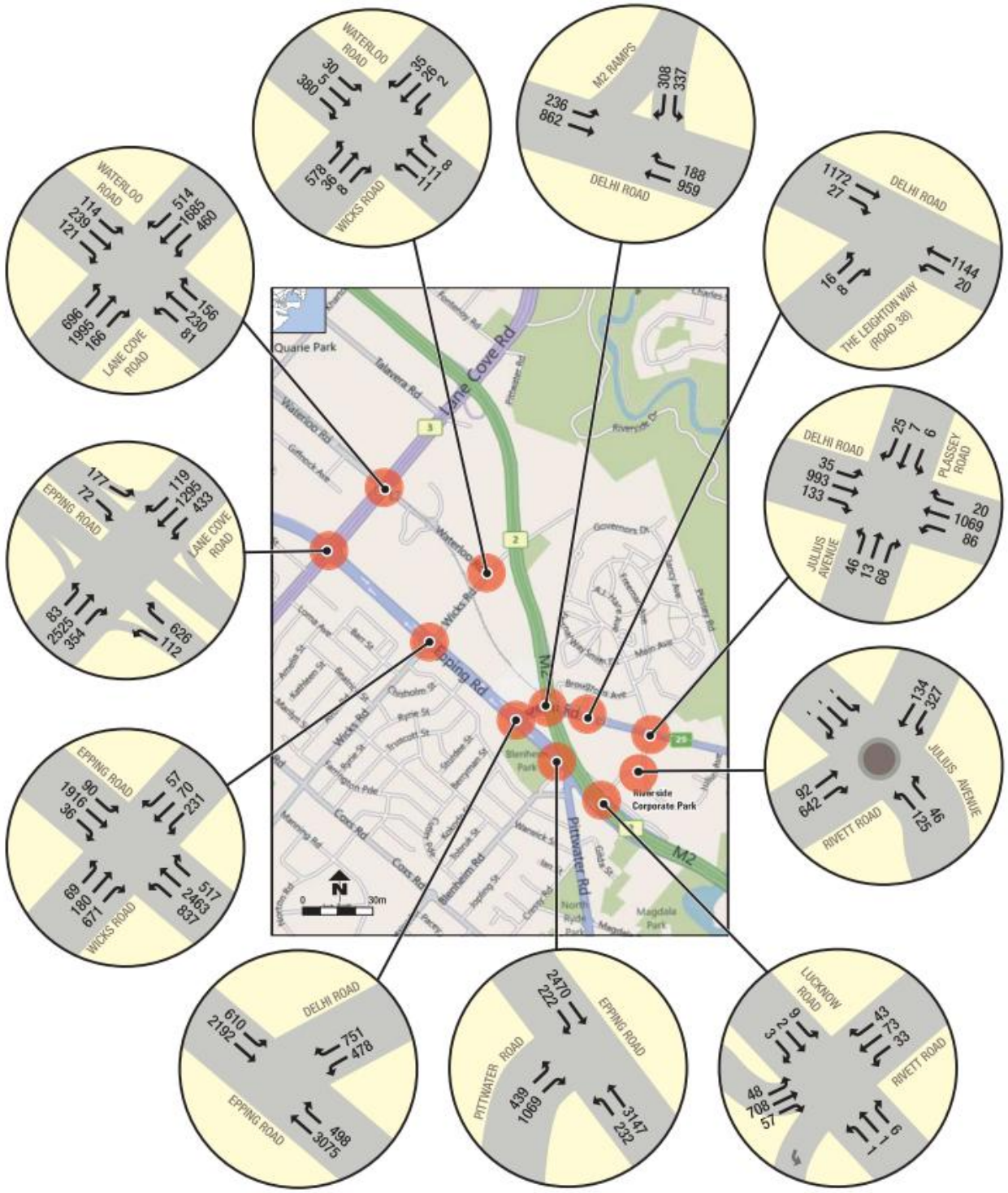


Figure B1.1 2011 AM peak hour traffic volumes (total vehicles)

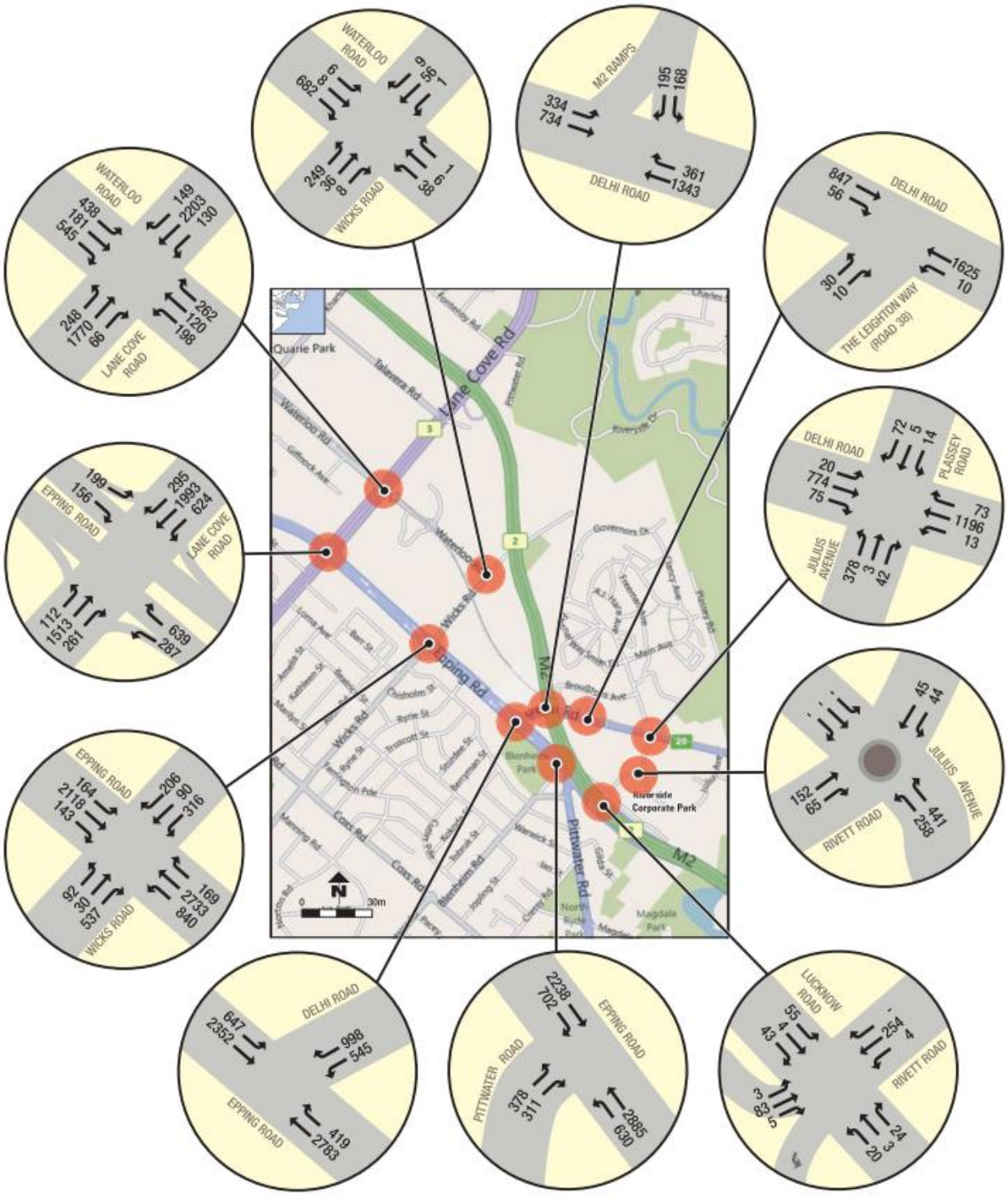
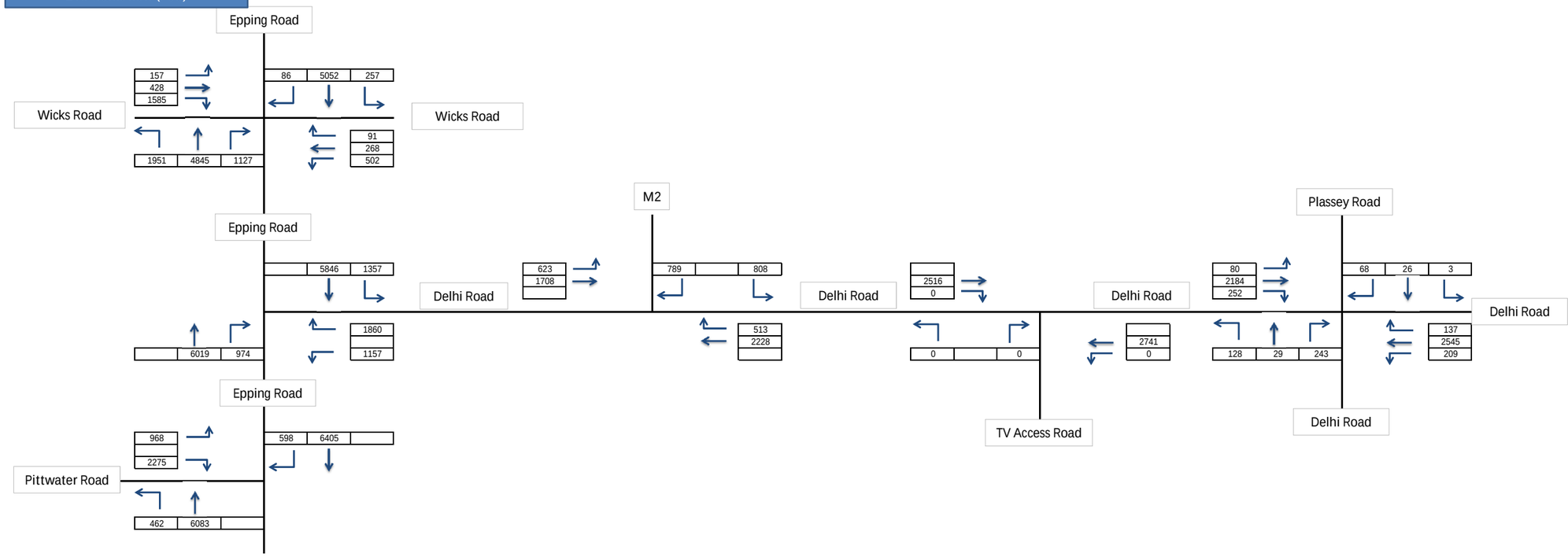
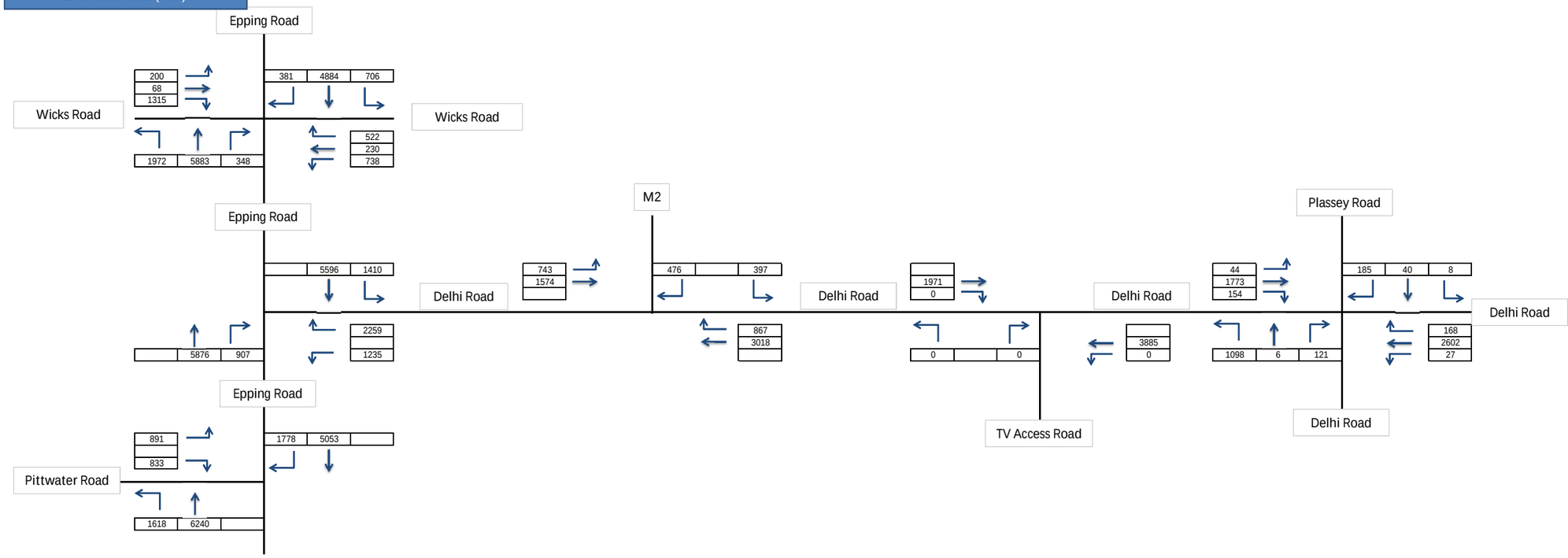


Figure B1.2 2011 PM peak hour traffic volumes (total vehicles)

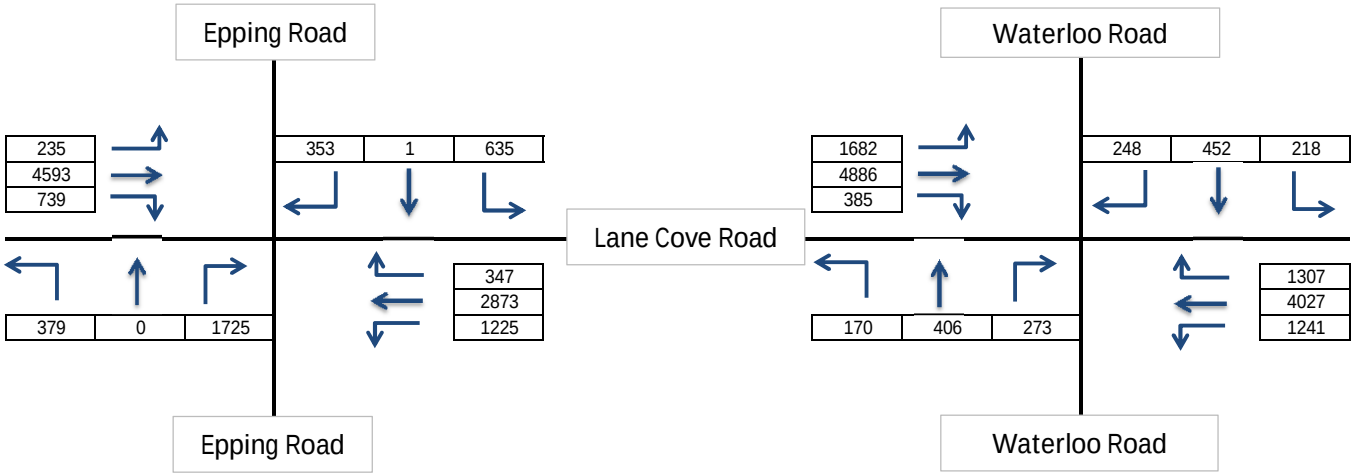
Delhi Road - Epping Road model
2031 Base AM Peak
2 Hr traffic flow (PCU)



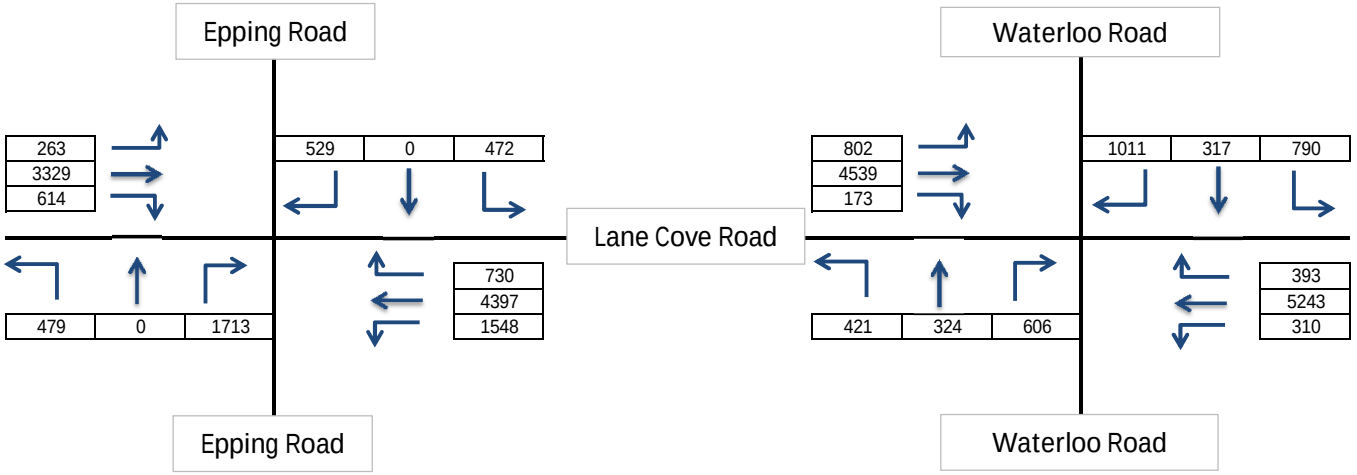
Delhi Road - Epping Road model
2031 Base PM Peak
2 Hr traffic flow (PCU)



Lane Cove Road- Epping Road model
2031 Base AM Peak
2 Hr traffic flow (PCU)

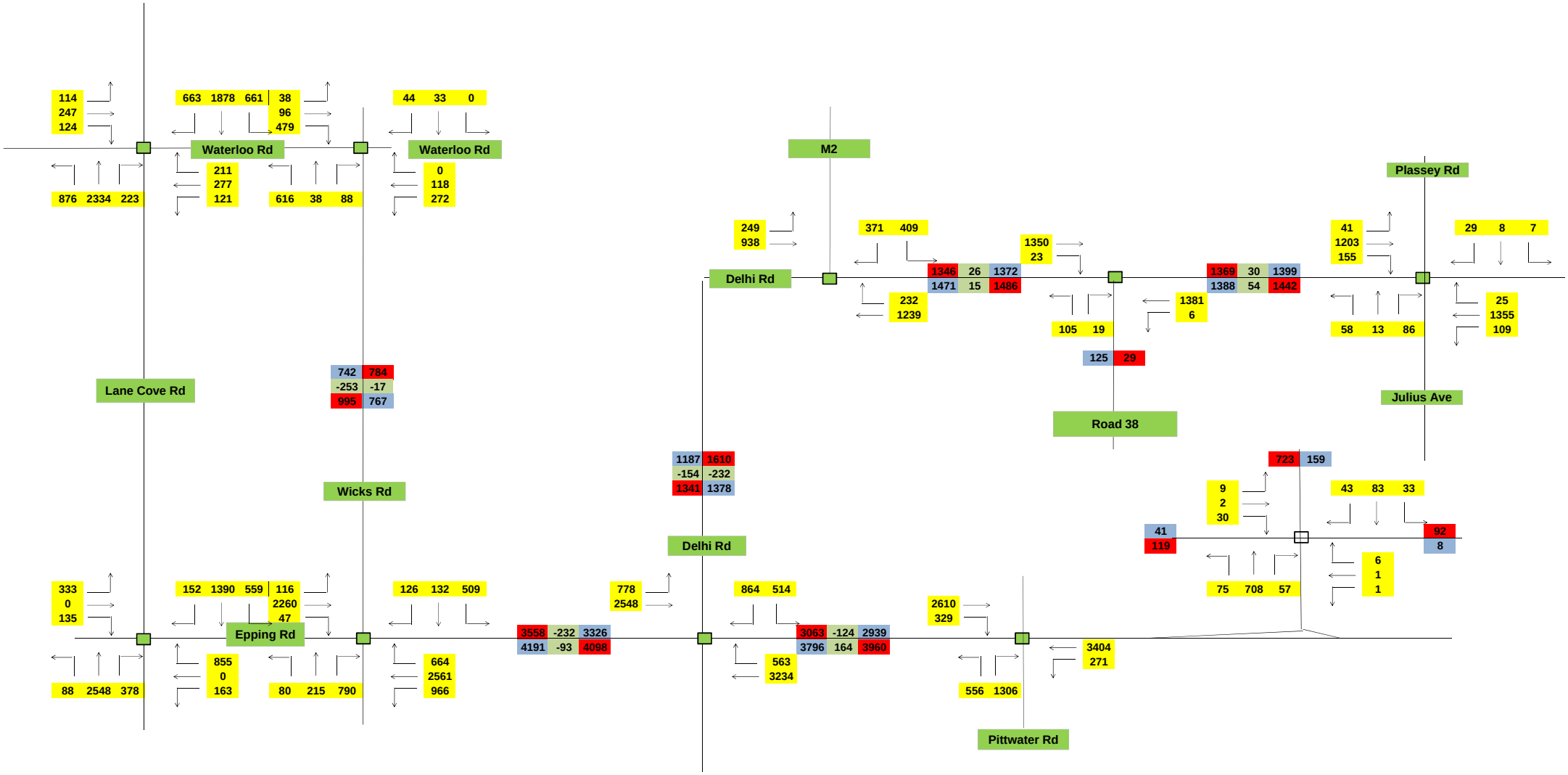


Lane Cove Road- Epping Road model
2031 Base PM Peak
2 Hr traffic flow (PCU)



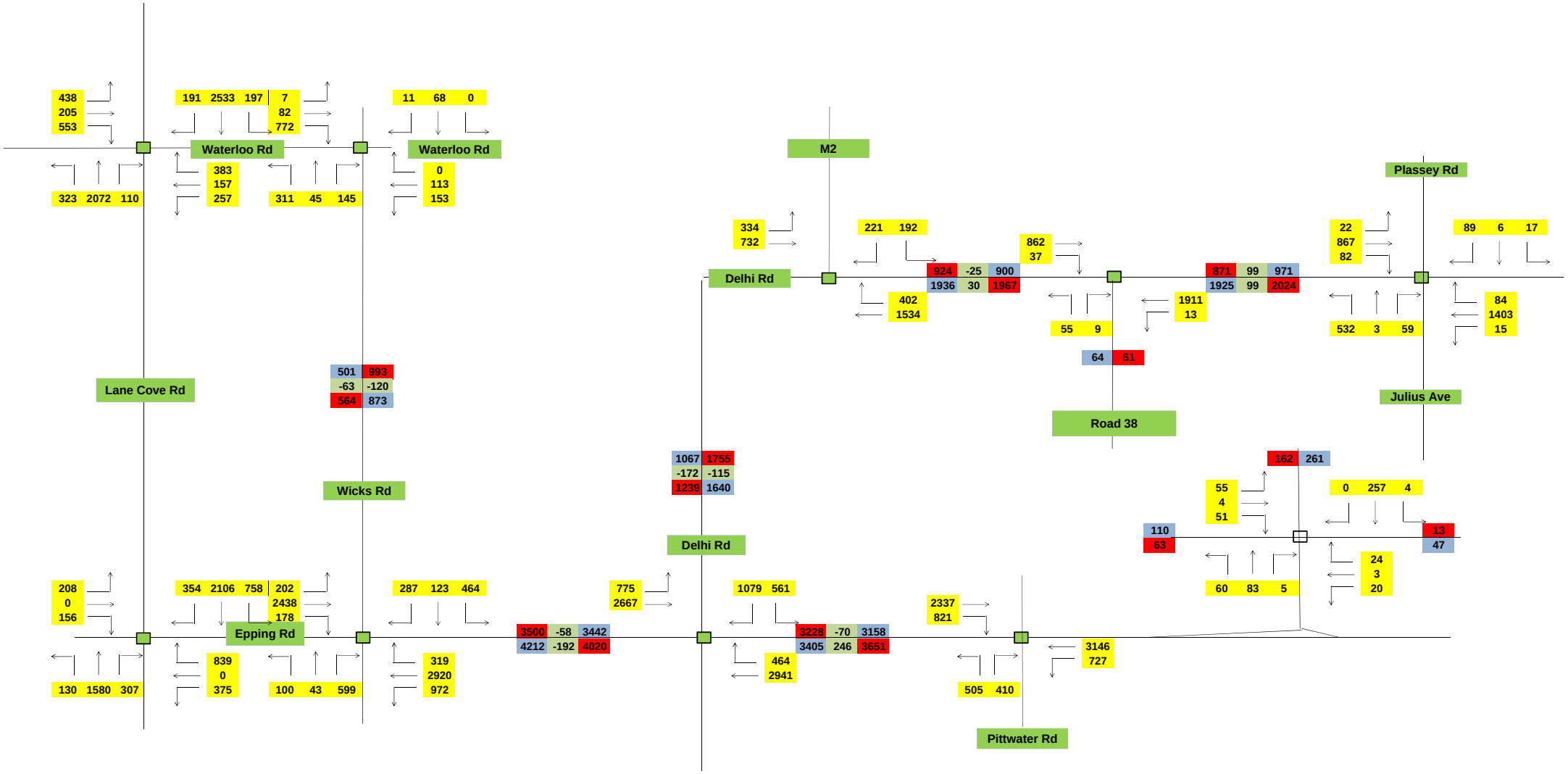
North Ryde Station Sites Development Traffic - 2031 Residential - AM Peak

2031 Base + Development - AM Peak hour



North Ryde Station Sites Development Traffic - 2031 Residential - PM Peak

2031 Base + Development - PM Peak hour



Appendix C

LinSig traffic modelling results

2031 AM peak intersection level of service results

Intersection	07:00–09:00	
	LOS	Average delay
J1: TCS 2993 - Plassey Road/Delhi Road	D	46
J2: TCS 4194 - Delhi Road/ Access Road	A	7
J3: TCS 3160 - M2 Interchange	C	34
J4: TCS 551 - Epping Road/ Delhi Road	E	65
J5: TCS 794 - Pittwater Road/ Epping Road	F	110
J6: TCS 226 - Epping Road / Wicks Road	F	84
J1: TCS 195 - Epping Road - Lane Cove Road	F	378
J2: TCS 1012 - Lane Cove Road / Waterloo Road	F	449

2031 PM peak intersection level of service results

Intersection	17:00–19:00	
	LOS	Average delay
J1: TCS 2993 - Plassey Road/Delhi Road	E	65
J2: TCS 4194 - Delhi Road/ Access Road	A	9
J3: TCS 3160 - M2 Interchange	C	29
J4: TCS 551 - Epping Road/ Delhi Road	F	202
J5: TCS 794 - Pittwater Road/ Epping Road	C	33
J6: TCS 226 - Epping Road / Wicks Road	F	107
J1: TCS 195 - Epping Road - Lane Cove Road	F	448
J2: TCS 1012 - Lane Cove Road / Waterloo Road	F	85

2031 AM peak level of service results- by approach

Intersection	Approach	07:00–09:00			
		LOS	Average delay	Degree of Saturation	Demand Flow (pcu)
J1: TCS 2993 - Plassey Road/Delhi Road	North	F	85	29%	80
	East	E	58	90%	2758
	South	F	74	65%	282
	West	C	32	75%	2794
J2: TCS 4194 - Delhi Road/ Access Road	East	A	6	55%	2798
	South	E	67	40%	234
	West	A	3	55%	2620
J3: TCS 3160 - M2 Interchange	North	F	97	90%	1440
	East	A	13	54%	2802
	West	B	21	71%	2500
J4: TCS 551 - Epping Road/ Delhi Road	North	F	104	101%	6392
	East	F	96	100%	2984
	South	B	18	77%	7388
J5: TCS 794 - Pittwater Road/ Epping Road	North	C	37	103%	6018
	South	F	114	100%	6984
	West	F	223	106%	3538
J6: TCS 226 - Epping Road / Wicks Road	North	D	56	86%	4310
	East	E	64	90%	1450
	South	F	79	110%	8426
	West	F	173	101%	2050
J1: TCS 195 - Epping Road - Lane Cove Road	North	F	73	91%	902
	East	C	33	84%	4116
	South	F	818	125%	1948
	West	F	524	120%	5760
J2: TCS 1012 - Lane Cove Road / Waterloo Road	North	F	606	137%	948
	East	F	342	156%	6212
	South	F	594	127%	1173
	West	F	499	137%	6994

2031 PM peak level of service results- by approach

Intersection	Approach	17:00–19:00			
		LOS	Average delay	Degree of Saturation	Demand Flow (pcu)
J1: TCS 2993 - Plassey Road/Delhi Road	North	F	257	97%	214
	East	E	59	91%	2840
	South	F	122	95%	1128
	West	B	19	74%	1928
J2: TCS 4194 - Delhi Road/ Access Road	East	A	6	48%	1986
	South	E	68	25%	126
	West	A	8	77%	3802
J3: TCS 3160 - M2 Interchange	North	F	82	75%	790
	East	A	12	63%	3886
	West	C	40	81%	2300
J4: TCS 551 - Epping Road/ Delhi Road	North	F	191	105%	6524
	East	F	587	127%	3516
	South	B	17	66%	6886
J5: TCS 794 - Pittwater Road/ Epping Road	North	B	17	91%	6332
	South	C	40	92%	7484
	West	E	63	83%	1784
J6: TCS 226 - Epping Road / Wicks Road	North	F	78	97%	5066
	East	F	356	120%	1696
	South	F	77	99%	8478
	West	F	90	89%	1442
J1: TCS 195 - Epping Road - Lane Cove Road	North	F	88	91%	707
	East	F	329	126%	6442
	South	F	911	129%	2362
	West	F	429	110%	3930
J2: TCS 1012 - Lane Cove Road / Waterloo Road	North	F	168	106%	2327
	East	E	58	93%	5648
	South	F	94	94%	1551
	West	F	74	97%	5069