asongroup

Prepared for
Options Funds Management Limited ATF Option St Marys Property Fund

Traffic Impact Assessment

Planning Proposal
Station Street, St Marys

Ref: 0196r01v6
29/09/2016

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1 Introduction

Ason Group has been engaged by Option Funds Management Limited, as trustee for Option St Marys Property Fund, to prepare a Traffic Impact Assessment (**TIA**) report to support a planning proposal in relation to 33-43 Phillip Street, St Marys (the **site**), with a view to amend the *Penrith Local Environmental Plan 2010* (**PLEP 2010**).

The intended outcome of the proposal is to amend the current floor-to-space ratio (**FSR**) controls applicable to the site under PLEP 2010 to achieve the following development scenarios:

- A mix of retail/commercial land uses on the first 2-3 floors, residential units at the upper floors and 2 levels of underground parking
- Amendment to the FSR from 3.5:1 to permit a base FSR of 6:1, with an incentive clause that would allow for a bonus to increase the FSR of 8:1
- For the purpose of assessing the implications of the proposal – including a high-level assessment of traffic impacts – a conceptual mixed-use scheme (the **Concept Plan**) has been developed and is discussed in further detail in Section 2 of this report.

This report has been prepared to assess the potential access, traffic and parking implications of the proposal, identify any potential impacts to the local traffic and transport environment arising from the proposal and identify means by which any such impacts can be appropriately mitigated or managed.

As part of this TIA study, Ason Group has:

- Undertaken site investigations to observe the operation of the local traffic network. This includes surveys to quantify traffic volumes on the surrounding road network.
- Assessed the connectivity of the site with regard to local and sub-regional facilities and services, and specifically public transport and pedestrian accessibility.
- Determined the traffic generating potential of the 8:1 FSR development option and assessed potential impacts arising from that traffic generation on the adjacent road network.

In the preparation of this report, reference is made to the following documents:

- Penrith City Council Development Control Plan 2014 (**DCP 2014**),
- RMS (formerly RTA) *Guide to Traffic Generating Developments* (**RMS Guide**),
- RMS *Technical Direction 2013/04a – Guide to Traffic Generating Developments; Updated traffic surveys* (**TDT 2013/04a**), and

2 Overview of the Proposal

St Marys Plaza Development Pty Ltd is proposing to redevelop the Station Plaza Shopping Centre as gateway mixed use development strategically located at the northern end of the St Marys Town Centre adjacent to the St Marys railway station and bus interchange. The redevelopment of the site will provide a mix of apartments, upgraded retail facilities and commercial floor space together with opportunities to activate streets and increase pedestrian connectivity within the Town Centre, improving both the safety and amenity of the St Marys train station precinct.

Redevelopment of the site will act as a key catalyst for the ongoing revitalisation of the Town Centre and will:

- Reinforce the St Mary's Town Centre as the secondary centre for the Penrith local government area consistent with the St Marys Town Centre Strategy and Master plan;
- Support the increased use of existing public transport infrastructure by locating additional residents and businesses in close proximity to an existing railway station;
- Deliver improved built form outcomes and improvements to the public domain;
- Provide a diversity of housing and retail opportunities close to the station;
- Create an activated, lively, safe and accessible pedestrian environment to encourage the ongoing development of the town centre as a vibrant 24/7 destination.

To facilitate development, the site is the subject of a planning proposal to increase the maximum building height and FSR permissible under the PLEP 2010.

The site is zoned for B4 (Mixed Use) with a maximum building height of 32 metres and a FSR of 3.5:1. The planning proposal seeks to amend the Height of Buildings Map to increase the building height to allow for a building of up to 35 storeys and to amend the FSR Map to increase the FSR to 6:1. It is also proposed to introduce an incentive clause, that would allow for an additional 9 storeys and a bonus to increase the FSR to 8:1.

The vision of the site is the development of a mixed use development consisting of the following land uses:

- Retail uses at ground level (including a supermarket and retail uses on the ground floor fronting Philip Street and Phillip Street)
- A new public urban space linking Station Street to Phillip Street with the potential for passive recreation and markets
- Retail/commercial use at level 1

- 4 levels of car parking with commercial sleeving on lower level
- Up to 30 levels of residential use distributed between two towers, or up to 38 levels where the incentive clause is applied. The lower 4 floors may incorporate some commercial floor space on the Station Street frontage.

At this stage it is envisaged that the site could potentially accommodate between 600 and 880 units together with a 4,500m^2 supermarket, specialty retail space and approximately 2,000m^2 of commercial floor space.

In addition, it is proposed to create a new laneway between Station Street and Phillip Street, along the eastern site boundary. In this regard, reference should also be made to the architectural plans and Urban Design Report prepared by DesignInc which form part of the submission. A reduced copy of the public domain concept plan is included in **Figure 1** below.

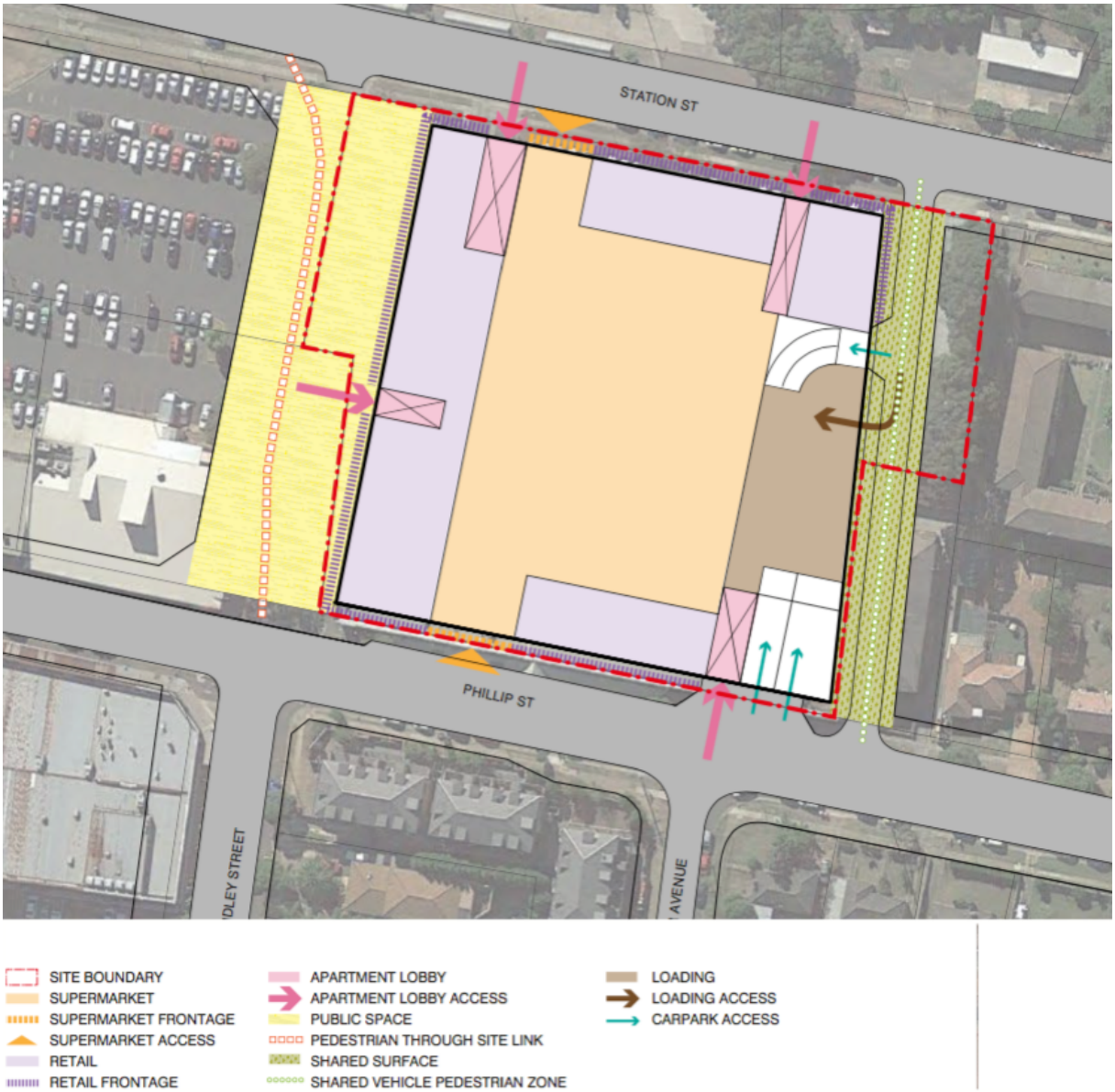

Figure 1: Reduced Plan – Public Domain Plan

2.1 Indicative Yield

The Urban Design Report prepared by DesignInc outlines key development data in relation to the proposal. Having regard for the highest figures envisaged under an FSR control of 8:1 in that report, this assessment has adopted the following indicative development yield (rounding to the nearest 50m^2) for non-residential uses:

- 880 residential units
- 2,200m^2 of commercial floor area
- 3,250m^2 of supermarket floor area
- 7,300m^2 of other retail floor area; and
- Provision of approximately 1,500 car parking spaces

It is emphasised that these figures are indicative only. This report adopts the higher values, based on an FSR of 8:1, to provide a conservative assessment to ensure that sufficient infrastructure upgrades are identified to cater for a range of development outcomes that may reasonably be considered on the site.

3 Existing Traffic and Transport Conditions

3.1 Site Description

The site has a street address of 33-43 Phillip Street, St Marys and is legally described as Lot 7 in DP734738. It is located approximately 22km west of the Parramatta CBD and approximately 8km east of the Penrith CBD. St Marys Station and associated bus interchange is located directly to the north of the site.

Currently, the site is zoned B4 Mixed Use under the PLEP 2010 and occupied by a retail development with a major supermarket chain (Coles) serving as the 'anchor' tenancy. It has an approximate gross leasable floor area (**GLFA**) of 7,800m^2 associated with the existing shopping centre, including a 3,800m^2 supermarket. The total site area of the lot is around 11,805m^2.

Phillip Street forms the southern site frontage and provides the primary pedestrian entry to the site. Station Street forms the northern site frontage which provides the primary vehicular access point to the undercover parking facilities. The eastern site boundary is formed by residential developments. A Council carpark lies to the west of the site, containing approximately 139 parking spaces.

A location and site plan of the site is presented in **Figure 2.**

Figure 2: Site Location

3.2 Surrounding Road Network

3.2.1 Road Hierarchy

With reference to **Figure 3**, the key roads influenced by the Proposal and considered within this traffic study include:

Great Western Highway – an RMS classified State Road (SH 5) that runs in an east-west direction parallel to the M4 Western Motorway. The road provides a key arterial road link between Parramatta to the east and Penrith to the west. The road generally carries 3 lanes of traffic in each direction within a divided carriageway and is subject to a 60 km/h speed limit within the study area. The Great Western Highway intersects with Queen Street and Mamre Road to the southwest of the site, in the form of a signalised intersection. It carries in the order of 35,900 vehicles per day to the west of Mamre Road.

Mamre Road – an RMS State Road (MR 536) that generally runs in a north-south direction between Elizabeth Drive to the south and St Marys to the north. The road generally carries 2 lanes of traffic in each direction and is subject to a 60 km/h speed limit on the approach to the Great Western Highway. Mamre Road intersects with the Great Western Highway towards the southwest corner of the site, in the form of a major signalised intersection. The road provides a key arterial access route to the Western Sydney Employment Area to the south.

Glossop Street – an unclassified Regional Road (RR 7167) that generally runs in a north-south direction between Forrester Road to the north and the Great Western Highway to the south. The road provides a key local collector road connection over the railway line and generally carries 2 lanes of traffic in each direction. It is subject to a 60 km/h speed limit on the approach to the Phillip Street signalised T-junction.

Phillip Street – a local collector road providing an east-west link between Queen Street and Glossop Street. The road runs along the southern boundary of the site, generally carries 2 lanes for both directions and is subject to a 50 km/h speed limit. Parking restrictions apply along the majority of Phillip Street and along the site's frontage with "1P: 8.30am-6.00pm, Mon-Fri; 8.30am-12.30pm, Sat" restrictions in operation.

Queen Street – a local collector road, which runs along the length of the St Marys town centre and connects to the arterial road network at the Great Western Highway to the south. The road generally carries a single lane of traffic in each direction in addition to kerbside parking. Parking restrictions apply along the majority of Queen Street with "1P: 8.30am-6.00pm, Mon-Fri; 8.30am-12.30pm, Sat" restrictions in operation. Queen Street is considered a High Pedestrian Activity Area and is therefore subject to 40 km/h posted speed limits.

Station Street – a local road which runs in an east-west direction along the site's northern frontage and parallel to the train line. Station Street provides access to the local bus interchange to the north of the site. It connects with Queen Street and a significant portion of the street forms part of the High Pedestrian Activity Area subject to 40km/h posted speed limits that generally applies within the St Marys town centre. Unrestricted on-street parking is available along the eastern portion of the street.

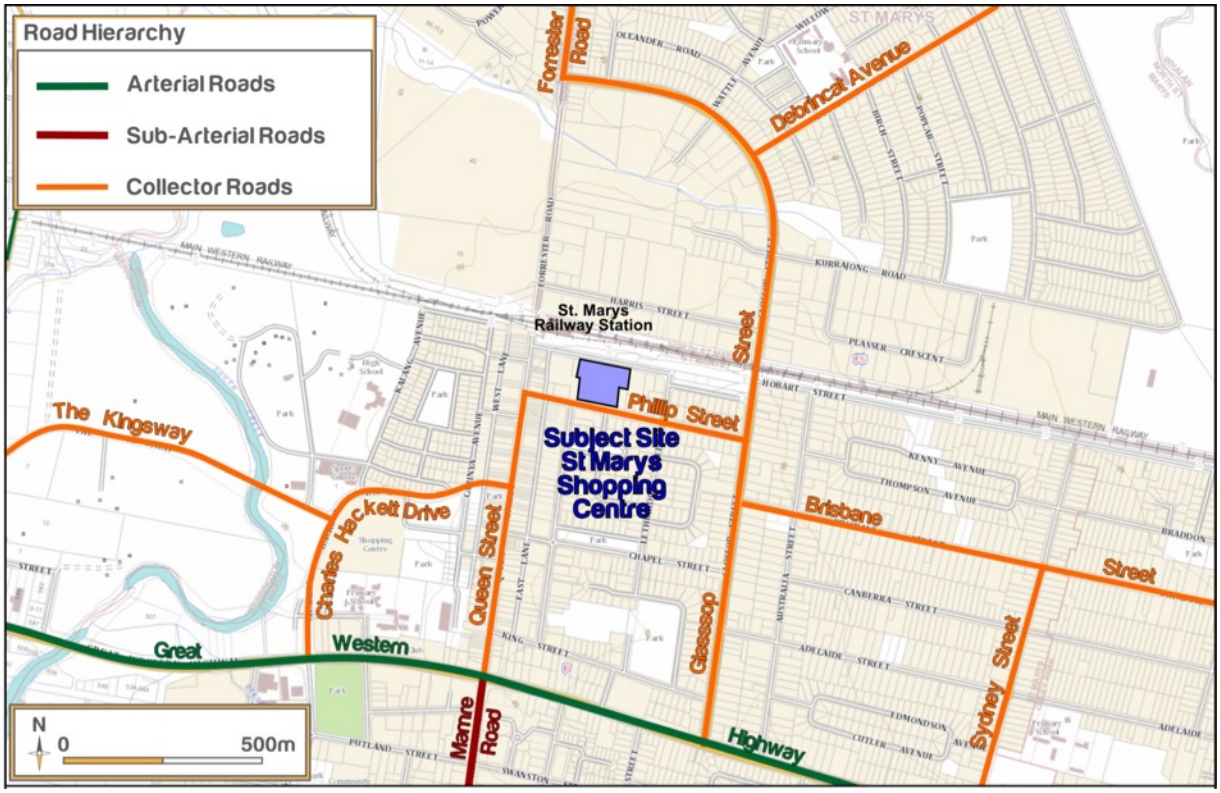

Figure 3: Road Hierarchy

Section 10.3 of the Penrith Council DCP identifies the following key transport corridors that need protection:

- Main Western Railway Corridor
- Great Western Highway
- Gipps Street / Werrington Road
- Mamre Road

It is noted that a number of improvements are proposed to the surrounding arterial road network including the Werrington arterial to the west of the site which will provide a new connection to the M4 Motorway and potentially alleviate pressure at the existing intersection of Great Western Highway with Mamre Road.

3.2.2 Traffic Volumes on Surrounding Roads

In order to determine local traffic flows, surveys were undertaken in May 2016 at the following key intersections for the morning and evening peak periods:

- Great Western Highway / Mamre Road,
- Glossop Street / Phillip Street,
- Phillip Street / Lethbridge Street, and
- Queen Street / Phillip Street.

These intersections have been selected as they represent the locations that have potential to be impacted by the Proposal, as they provide the primary access paths between the site and the broader arterial road network. The peak hour volumes surveyed are summarised in **Figure 4** and **Figure 5** for the respective survey periods.

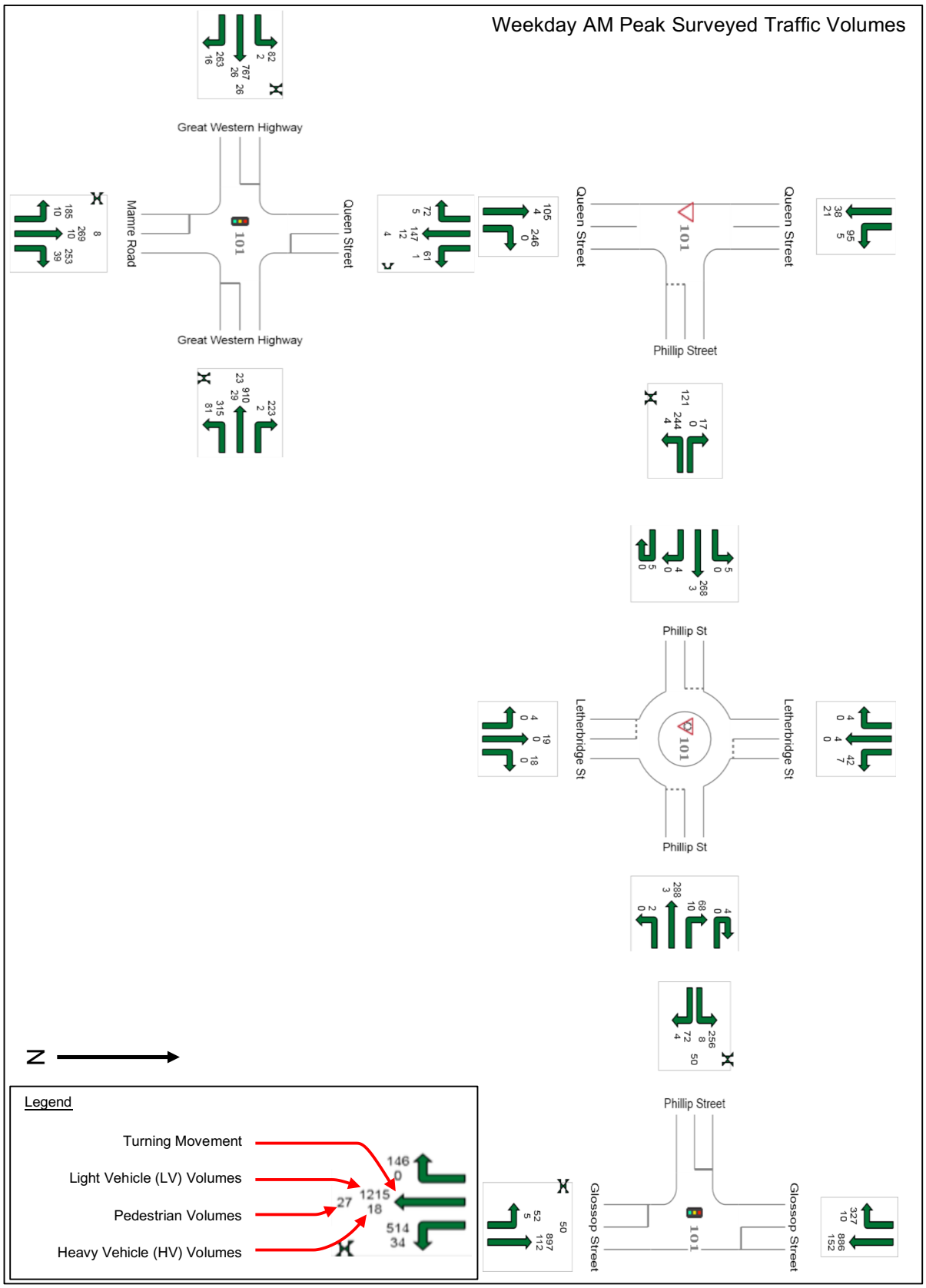

Figure 4: Morning Peak Hour Traffic Volumes

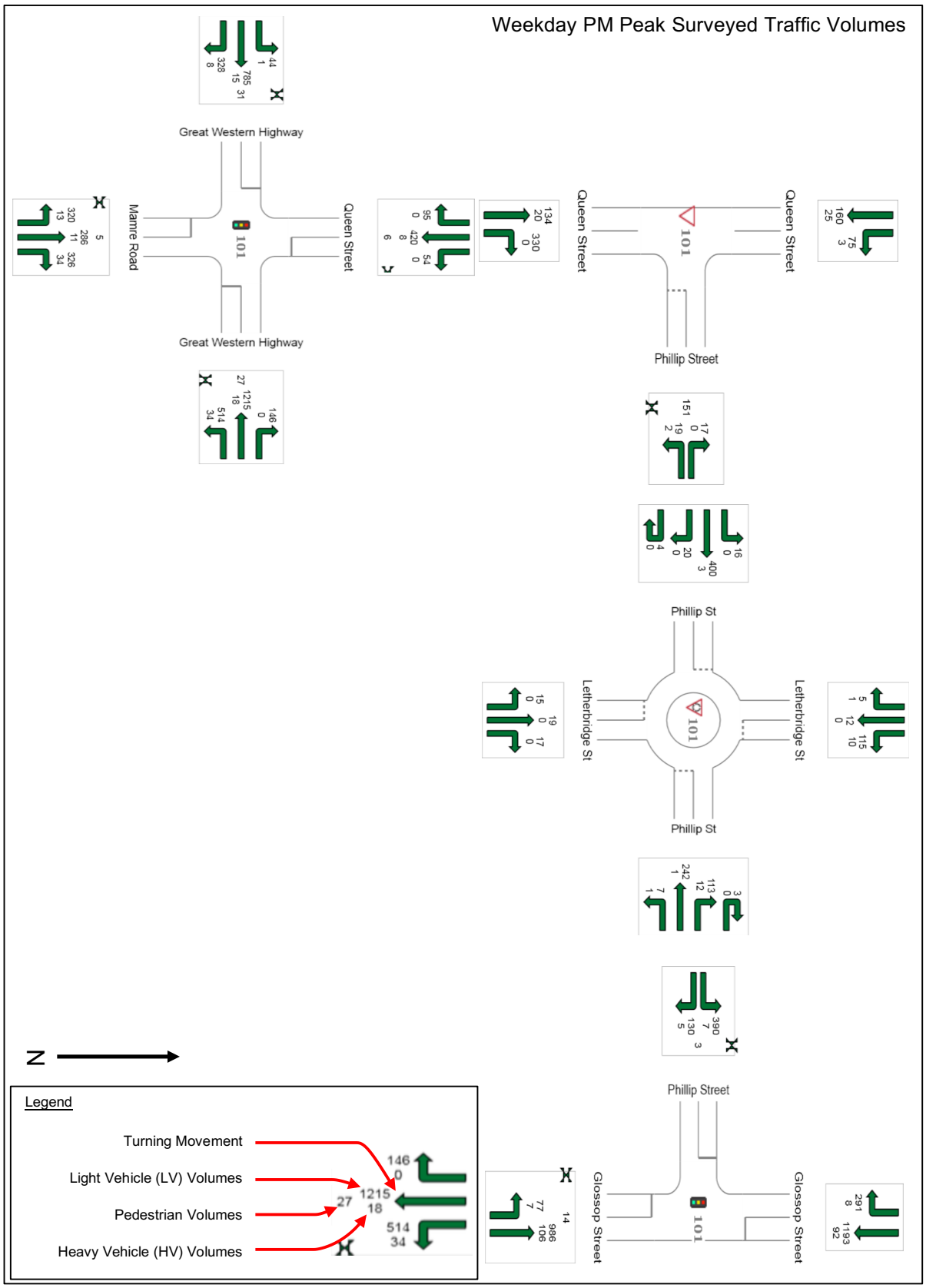

Figure 5: Evening Peak Hour Traffic volumes

3.2.3 Road Network Performance

The results of the 'Existing Scenario' SIDRA analysis are summarised in **Table 1**. Relevant SIDRA outputs and intersection layouts are attached to this report at **Appendix A**.

Table 1: Existing Intersection Performance

Intersection	Scenario	Period	Degree of Saturation (DOS)	Average Vehicle Delay (AVD)	Level of Service (LOS)
Great Western Hwy / Mamre Rd / Queen St	Existing	AM	0.81	51.2	D
		PM	1.06	115.3	F
Glossop St / Phillip St	Existing	AM	0.85	20.3	B
		PM	0.89	18.6	B
Phillip St / Lethbridge St	Existing	AM	0.26	5.7	A
		PM	0.37	6.1	A
Queen St / Phillip St	Existing	AM	0.25	6.4	A
		PM	0.37	8.8	A

The results demonstrate that the operation of the intersection of Great Western Highway and Mamre Road is operating near capacity with a Level of Service D during the morning peak period and exceeds capacity with a Level of Service F during the evening peak period.

All other key intersections operate with acceptable delays, with a Level of Service B or better during both peak periods. Accordingly, these intersections have spare capacity to accommodate future growth in traffic volumes.

3.3 Public Transport

The site lies opposite the St Marys Interchange along Station Street, which is serviced by train (T1 Western Line) and numerous bus routes. A summary of the public transport options available in close proximity to the site is provided in **Figure 6** and discussed below.

3.3.1 Bus services

St Marys is located in 'Region 1' of the NSW Government Bus Contract System, and is serviced by Busways. Region 1 includes Penrith, Richmond, Mount Druitt, St Marys, Blacktown and Rouse Hill. A summary of the bus routes servicing the area surrounding the site and typical bus service frequencies are provided in **Table 2**.

Table 2: Bus Service Frequencies

Route Number	Service Description	Weekday			Saturday	Sunday
		AM Peak Hour	Off-Peak Hour	PM Peak Hour		
745	St Marys to Castle Hill via Plumpton	30 min	60 min	30 min	120 min	-
758	Mt Druitt to St Marys via Shalvey and Tregear	15 min	30 min	15 min	30 min	60 min
759	Mt Druitt to St Marys via Ropes Crossing	30 min	60 min	30 min	60 min	60 min
770	Penrith to Mt Druitt via St Marys & Claremont Meadows	30 min	30 min	30 min	60 min	60 min
771	St Marys to Mt Druitt via Colyton	30 min	30 min	30 min	60 min	60 min
774	Penrith to Mt Druitt via St Marys & Oxley Park	30 min	30 min	30 min	60 min	60 min
775	Penrith to Mt Druitt via St Marys & Erskine Park	30 min	30 min	30 min	60 min	60 min
776	Penrith to Mt Druitt via St Marys & St Clare	30 min	30 min	30 min	60 min	60 min
779	St Marys to Erskine Park Industrial Area	30 min	-	30 min	-	-
782	Penrith to Werrington and St Marys via Cambridge Park	30 min	60 min	30 min	60 min	60 min

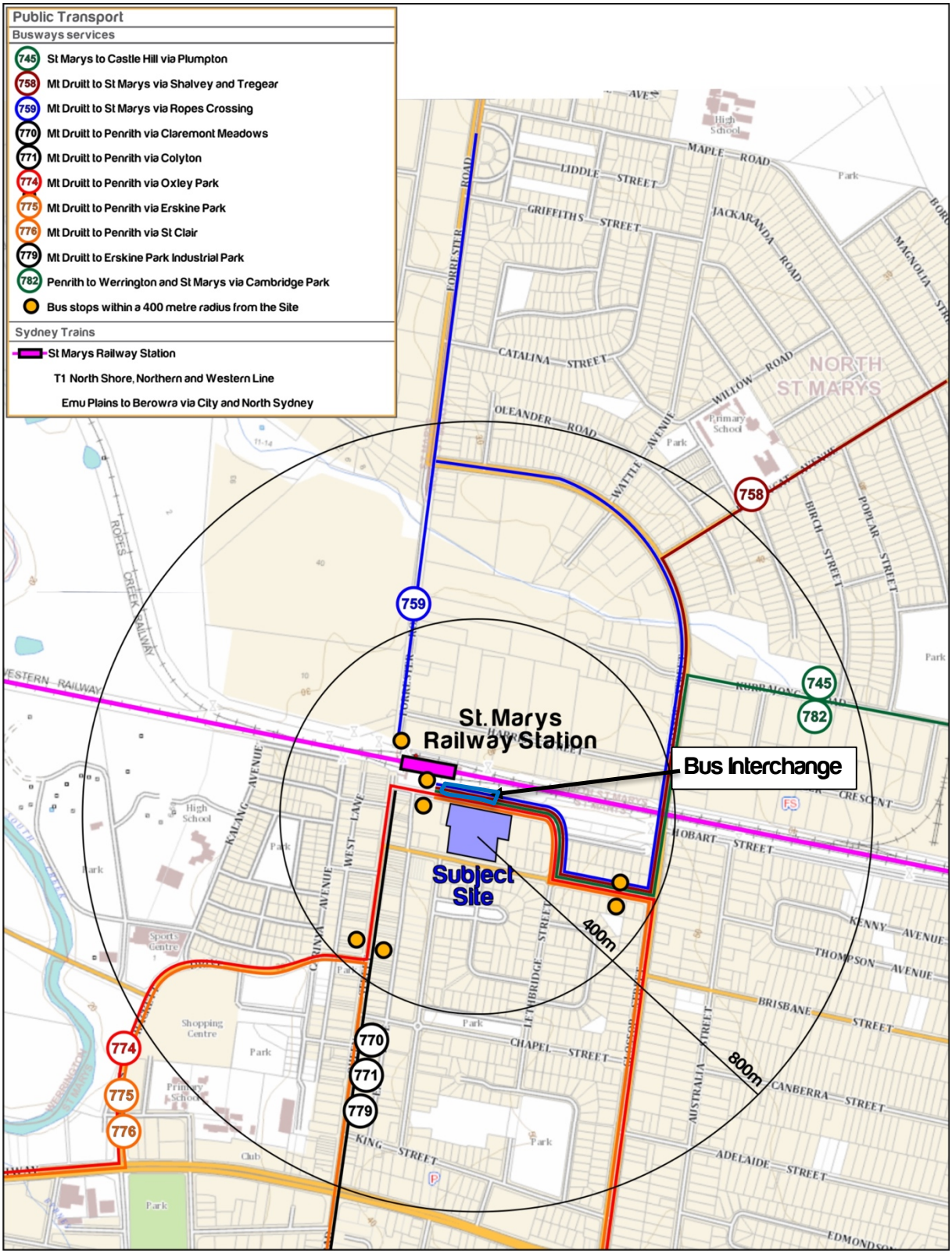

Figure 6: Public Transport Routes

The *Integrated Public Transport Service Planning Guidelines* (TfNSW, 2013) states that bus services influence the travel mode choices of sites located within 400 metres (approximately 5 minutes' walk) of a bus stop. In this regard, the site is highly accessible by bus where it is anticipated that residents within the catchment areas would use these services to travel to the site.

3.3.2 Rail services

The site is located within 150m of St Marys railway station, which is serviced by the Western Line, as shown in **Figure 7** below.

Figure 7: Sydney Trains Suburban Network Map

This service provides frequent trains to key centres including Penrith (approx. 10 minutes), Parramatta (approximately 30 minutes) and the Sydney CBD. Connections to Intercity train services are available at Penrith and Parramatta with further connections to services to Liverpool and Campbelltown provided from Granville. **Table 3** summarises the peak hour train frequencies servicing the station.

Table 3: Train Frequencies

Station / Line	To City	From City	Total
St Marys Station - via Western Line			
Morning Peak Hour (7-8am)	8	3	11
Off Peak Hour	4	4	8
Afternoon Peak Hour (5-6PM)	4	4	8

As demonstrated above, the site is within close walking distance of St Marys train station at which frequent train services would provide access for future residents, employees, visitors and customers.

3.4 Pedestrian and Bicycle Networks

The existing site is highly accessible for pedestrians with relatively flat topography, well-defined routes and pedestrian crossing facilities to key points of interest within the town centre. Footpaths are provided within the local area along both sides of Station Street, Queen Street and Phillip Street. Improvements to footpaths, lighting and landscaping are currently being undertaken by Council within the St Marys town centre. Pedestrian crossing facilities are provided along these routes in the form of raised pedestrian crossings, which prioritises pedestrian movements over vehicular movements, providing convenient access to and from the site.

With reference to **Figure 8**, there are potential opportunities available to extend existing bicycle routes towards the site to improve connectivity to the local bicycle network. This could include:

- A southbound connection along Queen Street to Charles Hackett Drive, and
- An eastbound connection along Phillip Street and Brisbane Street to the Sydney Street Path in Oxley Park.

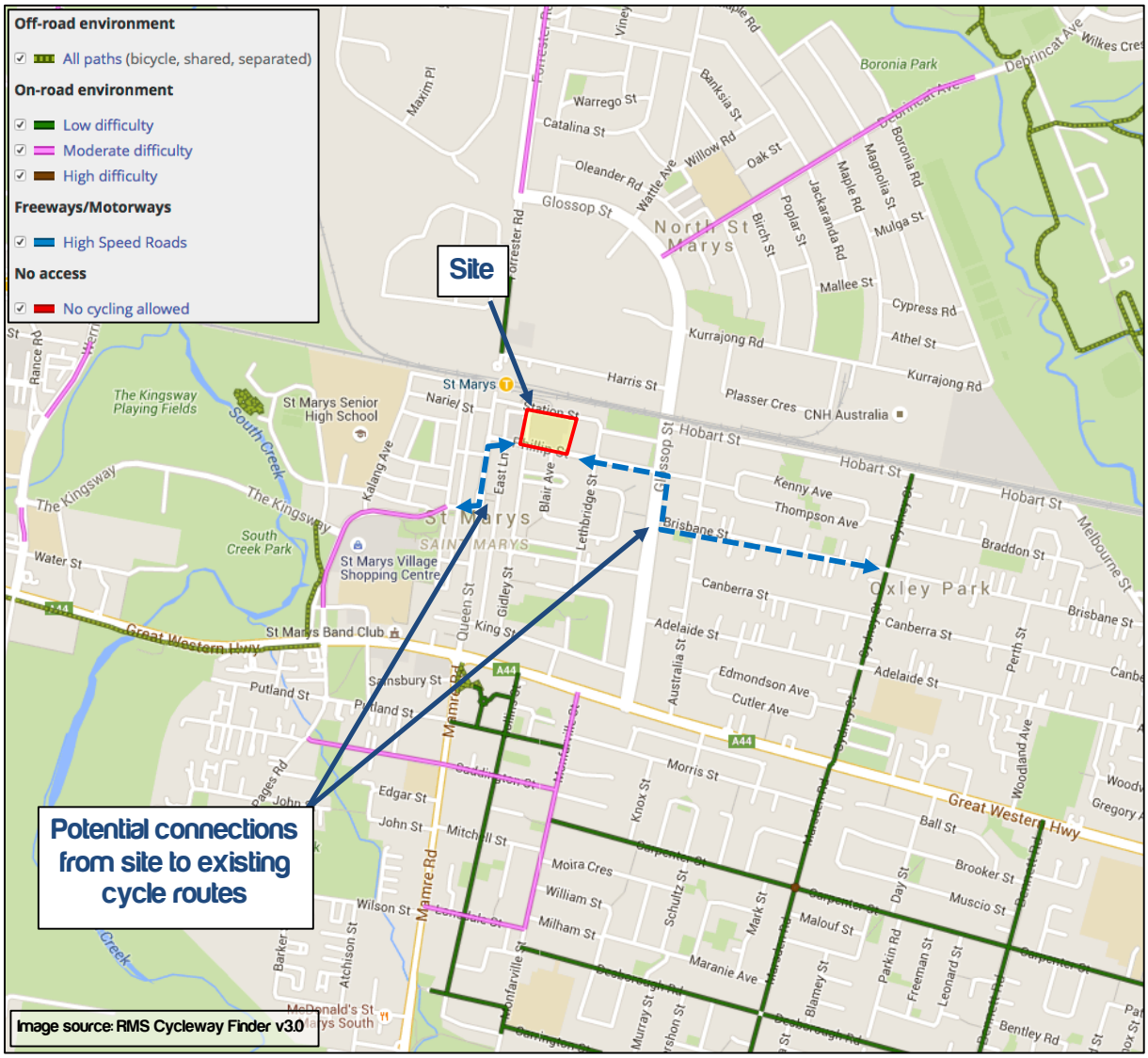

Figure 8: Cycle Routes Surrounding the Site

3.5 Travel Mode Analysis

The existing travel patterns of residents and employees within the surrounding locality was surveyed within the 2011 Census and presented in the Journey to Work (**JTW**) data provided by the Bureau of Transport Statistics (**BTS**). A summary of key travel modes for both residents and persons employed within the locality (Travel Zones 5016 and 5018 – refer **Figure 9**) is presented in **Table 4** below.

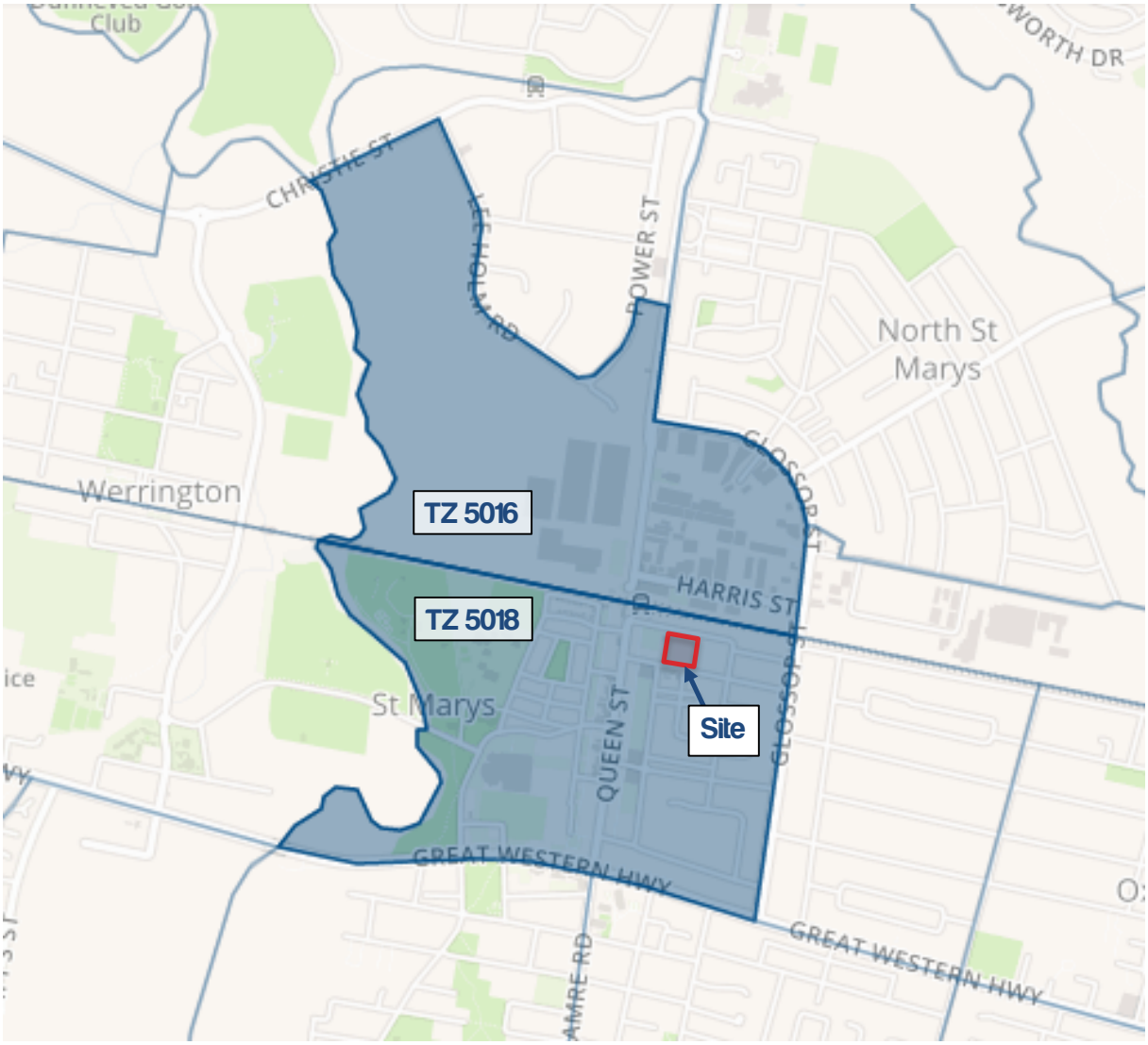

Figure 9: Travel Zones

Table 4: Existing Travel Mode Summary

Travel Mode	Residents	Employees
Train	25%	5%
Bus	3%	2%
Walked only	4%	2%
Vehicle passenger	9%	8%
Vehicle driver	54%	81%
Other mode	1%	1%
Mode not stated	3%	2%

It can be seen from above that a relatively high proportion of residents and employees rely on public transport. This is particularly relevant to persons residing in close proximity to St Marys station with 28% of residents relying on trains or buses, and a further 4% relying only on walking travel modes.

4 Parking Requirements

4.1 Relevant Parking Requirements

Clause 10.5.1 of the Penrith DCP 2014 requires car parking to be provided at the rates outlined in **Table 5** below for the land uses envisaged for the site under this planning proposal.

Table 5: Penrith Council DCP Parking Rates

Land Use		Parking Requirement
Residential Flat Buildings		
Residents		
	1 Bedroom	1 space / dwelling
	2 Bedroom	1 space / dwelling
	3 (or more) Bedroom	2 spaces / dwelling
Residential Visitor		1 space / 5 units, (or part thereof)
Car Wash		1 space / 50 units (to a max. of 4 spaces per building)
Service Vehicles		1 space / 40 units
Non-Residential		
Business and Office Premises		1 space / 60m^2 GFA
Retail Premises		1 space / 30m^2 GFA
Other Uses		In accordance with RMS *Guide to Traffic Generating Developments*, or if there are no parking guidelines for a specific use, then a site specific car parking analysis will be required. This may require the Applicant to submit a car parking report from a suitably qualified traffic consultant.
Total Parking Spaces		

NOTES: Supermarkets require parking to be provided at a rate of 1 space per 10m^2 of floor area that is to be used for retailing activities. However, this requirement is assumed to apply only outside of the Penrith City Centre and St Marys Town Centre localities.

Having regard for the indicative yields discussed in Section 2, the development would be expected to require in the order of between 1,630 - 1,850 parking spaces, depending on whether the car parking rate of 1 space / 10m^2 is adopted for the supermarket floor area.

Notwithstanding, Council reserves discretion to waive or reduce the number of car spaces required for a particular site having consideration for:

i) Proximity to public transport nodes;

ii) Opportunity to share parking with another use

4.2 SEPP 65 Requirements

Having regard for the proximity of the site to St Marys Station, the minimum car parking requirement provisions of SEPP 65 would apply to any future development of the site and supersede any minimum requirement imposed by Council. Accordingly, the RMS *Guide to Traffic Generating Developments* (**RMS Guide**) parking rates for high density residential development would be considered to supersede the minimum parking rates outlined by Council above. This is relevant in the context of a development strategy whereby provision of car parking at the minimum rates may be sought to encourage, as far as practicable, the use of other (non-car) forms of transport. SEPP 65 does not specify any minimum parking requirements in relation to non-residential uses.

Table 6: SEPP 65 Minimum Residential Parking Requirements

Land Use		Parking Requirement
Residential Flat Buildings		
Residents		
	1 Bedroom	0.6 spaces / dwelling
	2 Bedroom	0.9 spaces / dwelling
	3 (or more) Bedroom	1.4 spaces / dwelling
Residential Visitor		1 space / 5 units
Total Parking Spaces		

Notes: Parking rates based on RMS Guide rates for high density residential development within a sub-regional centre.

Having regard for the above, a minimum of approximately 950 parking spaces would be required for the residential component according to SEPP 65, resulting in a total requirement for approximately 1,340 - 1,560 parking spaces (including the non-residential uses).

In summary, the site is well served by public transport in the form of close proximity to both rail and bus services. Accordingly, reduced parking provision rates would be considered suitable for a development in this location. Notwithstanding, provision has been made for sufficient parking .on-site and thus final parking numbers can be determined as part of a subsequent Development Application.

5 Model Assumptions

5.1 Background Traffic Growth

A review of historic traffic data for the Great Western Highway, to the west of Mamre Road (Station ID: 86008), resulted in the following average daily traffic count volumes. At the time of this study, the last complete (two-way) data set is for 2012.

- 2006 37,466 vehicles per day
- 2012 36,823 vehicles per day

It can be seen from above that there has been minimal, if any, growth in traffic volumes over that period. Indeed, traffic daily traffic volumes actually reduced marginally.

Furthermore, the future Werrington Arterial connection to the M4 Motorway to the west would be expected to alleviate some of the existing regional traffic volumes seeking to use Mamre Road to access the wider arterial road network. This is a result of regional traffic from the west travelling to or from destinations to the east no longer requiring the use of Mamre Road to access the M4 as these vehicles will be afforded more direct access via the new Werrington Arterial.

Accordingly, nil background growth has been adopted for the purposes of this assessment.

5.2 Traffic Generation Rates

Traffic generation rates adopted by this study are generally based on the published rates included within Technical Direction 04a, or the RMS Guide where appropriate. Relevant traffic generation rates adopted are summarised below for the morning and evening peak periods.

Table 7: Traffic Generation Rates - AM Peak

Land Use	Traffic Generation Rate	Distribution	
		IN	OUT
Residential	0.19 veh/hr per unit	20%	80%
Commercial	1.6 veh/hr per 100m^2 GFA	90%	10%
Supermarket	4.65 veh/hr per 100m^2 GFA	70%	30%
General Retail	1.38 veh/hr per 100m^2 GFA	70%	30%

NOTE: AM rate for supermarket and retail uses assumed to be 30% of peak PM peak trip rates

Corresponding evening peak traffic generation rates and distribution are as follows.

Table 8: Traffic Generation Rates - PM Peak

Land Use	Traffic Generation Rate	Distribution	
		IN	OUT
Residential	0.15 veh/hr per unit	30%	70%
Commercial	1.2 veh/hr per 100m^2 GFA	20%	80%
Supermarket	15.5 veh/hr per 100m^2 GFA	50%	50%
General Retail	4.6 veh/hr per 100m^2 GFA	50%	50%

Traffic generation analysis in relation to both existing and proposed development scenarios is discussed further in Section 6.

5.3 Traffic Distribution

The adopted traffic distribution has been developed having regard for the journey-to-work data outlined previously and likely routes to/from relevant centres. In this regard, a high proportion of vehicle trips will be distributed to/from the M4 Motorway to the south. Other key routes will be via Great Western Highway for vehicles travelling east to centres such as Mt Druitt and Blacktown.

6 Traffic Impacts

6.1 Site Traffic Generation

6.1.1 Existing

The existing shopping centre has a total floor area of some 7,800m^2 GFA, including 3,800m^2 of supermarket floor area. Application of the traffic generation rates outlined in Section 5.2 to these floor areas results in a total existing traffic volume of up to 773 vehicles per hour during peak periods, as summarised in **Table 9** below.

Table 9: Traffic Generation - Existing

Land Use	No. / Area	AM Peak			PM Peak		
		Two-way Volume	IN	OUT	Two-way Volume	IN	OUT
Residential		0	0	0	0	0	0
Commercial		0	0	0	0	0	0
Supermarket	3,800	177	124	53	589	295	294
General Retail	4,000	55	39	16	184	92	92
TOTAL		232	163	69	773	387	386

6.1.2 Proposed Development

Similarly to the above, application of the adopted traffic generation rates to the indicative yield under consideration would result in a total traffic generation of up to 998 vehicles per hour during the critical evening peak period, as shown in **Table 10** below.

Table 10: Traffic Generation - Proposed (FSR 8:1)

Land Use	No. / Area	AM Peak			PM Peak		
		Two-way Volume	IN	OUT	Two-way Volume	IN	OUT
Residential	880	167	33	134	132	92	40
Commercial	2,200	35	32	3	26	5	21
Supermarket	3,250	151	106	45	504	252	252
General Retail	7,300	101	71	30	336	168	168
TOTAL		454	242	212	998	517	481

6.1.3 Net Increase

From comparison between Tables 9 and 10, it can be seen that the proposal (with an FSR of 8:1) has the potential to increase traffic volumes on the surrounding road network by:

- 222 veh/hr during the morning peak; and
- 225 veh/hr during the evening peak.

The impact of this additional traffic is discussed further below.

6.2 Future Intersection Operation

The future performance of the key intersections identified having regard for the additional traffic identified above is summarised in **Table 11** below. This analysis adopts the following peak hourly traffic volumes from an earlier yield analysis:

- 245 veh/hr during the morning peak
- 280 veh/hr during the evening peak

These adopted traffic volumes are marginally higher than outlined in Section 6.1.3 and therefore the corresponding analysis should be regarded as conservative.

Table 11: Future Intersection Performance – No Improvements

Intersection	Scenario	Period	Degree of Saturation (DOS)	Average Vehicle Delay (AVD)	Level of Service (LOS)
Great Western Hwy / Mamre Rd / Queen St	Existing	AM	0.81	51.2	D
		PM	1.06	115.3	F
	Future	AM	0.834	53.2	D
		PM	1.104	119.9	F
Glossop St / Phillip St	Existing	AM	0.85	20.3	B
		PM	0.89	18.6	B
	Future	AM	0.897	22.3	B
		PM	0.869	19.3	B
Phillip St / Lethbridge St	Existing	AM	0.26	5.7	A
		PM	0.37	6.1	A
	Future	AM	0.052	9.1	A
		PM	0.406	9.5	A
Queen St / Phillip St	Existing	AM	0.25	6.4	A
		PM	0.37	8.8	A
	Future	AM	0.265	6.4	A
		PM	0.416	7.0	A

It can be seen from Table 11 that there is no change to existing Level of Service as a result of the proposed development. All intersections will continue operate within capacity post development of the site, with the exception of Great Western Highway / Mamre Road intersection which fails under existing conditions.

Increased average delays at this intersection will be minimal (4.6 seconds) and the intersection exceeds capacity only during the evening peak hour periods. As such, this increased delay may not warrant any special improvements in isolation.

Notwithstanding, further modelling of the intersection with the removal of parking on the western side of Queen Street (north approach) for a distance of 15 metres would mitigate any increased delays associated with the Proposal. In fact, this minor modification to on-street parking would potentially reduce average delays to less than occurs currently during the evening peak period. Solutions to mitigate the impact of removing these parking spaces is a matter that could be addressed, if required, as part of future redevelopment of the St Marys Town Centre more generally. A summary of the modelling results for this improvement option is provided in **Table 12** below.

Table 12: Future Intersection Performance – With Improvements

Intersection	Scenario	Period	Degree of Saturation (DOS)	Average Vehicle Delay (AVD)	Level of Service (LOS)
Great Western Hwy / Mamre Rd / Queen St	Existing	AM	0.81	51.2	D
		PM	1.06	115.3	F
	Future (with improvements)	AM	0.825	52.2	D
		PM	1.088	113.0	F

The potential impacts of the proposed development are considered acceptable and can be accommodated within the existing road network without significant impacts on the level of service or to the operation of key intersections.

6.3 Network Infrastructure Requirements

Congestion at the intersection of the Great Western Highway / Mamre Road is an existing issue and has been identified as a part of the *St Marys Town Centre Strategy* (Penrith City Council, July 2006) as potentially requiring upgrade works. The extent of works is a matter for RMS and Council as part of its road management responsibilities generally and will be subject to ongoing review as development within the locality occurs. As such, capacity issues at this intersection is not solely a result of the

proposed development and, accordingly, no road network improvements works are specifically considered necessary as a result of the proposal.

6.4 Cumulative Impact of Neighbouring Development

This submission relates to the subject site only. However, the site forms only part of the larger urban block bound by Station Street to the north, Lethbridge Street to the east, Phillip Street to the south and Queen Street to the east. In this regard, consideration has been given to the cumulative impact of redevelopment of the adjoining Council (Veness Place) car park site and the adjoining residential area to the east as part of a larger development precinct.

Assuming similar development controls, these adjoining sites could be expected to provide additional residential units and commercial and retail floor area. **Table 13** below provides a summary of the indicative yield and associated traffic volumes that may be associated with the redevelopment of these sites.

Table 13: Traffic Generation - Council Car Park & Eastern Residential Precinct Sites (FSR 8:1)

Land Use	No. / Area	AM Peak			PM Peak		
		Two-way Volume	IN	OUT	Two-way Volume	IN	OUT
Residential	1,220	232	46	186	183	128	55
Commercial	1,450	23	21	2	17	3	14
Supermarket	0	0	0	0	0	0	0
General Retail	7,100	98	69	29	327	164	163
TOTAL		353	136	217	527	295	232

It can be seen from Table 13 that these adjoining sites could generate substantial traffic volumes. However, this development traffic would be partially offset by existing traffic volumes associated with the residential precinct to the east. It is likely that any redevelopment of the Council car park site would retain this existing public parking in addition to any parking required for the new development. As such, existing traffic associated with the adjoining Council public car park would be expected to be retained and therefore discounts on account of existing traffic for the Council car park site may not be appropriate, depending on whether the full 139 parking spaces are to be retained for that purpose as part of any redevelopment.

Having regard for the discussion in Sections 6.2, this additional traffic would be most likely to have consequences for the critical intersection of the Great Western Highway and Mamre Road which is

already at capacity. However, as discussed in Section 6.3, this intersection has already been identified as a part of the *St Marys Town Centre Strategy* as potentially requiring upgrade works. Accordingly, any uplift planned within the wider St Marys Town Centre would be just one of many considerations when investigating the required improvements works and not necessarily required as a result of a single proposal. Indeed, congestion at the periphery of the Town Centre may even assist to promote a higher proportion of localised trips within the Town Centre and increase the perceived attractiveness of public transport services such as the train line. Promoting the use of public transport services is a key objective of increased development density in close proximity to major transport interchanges.

In any event, all other intersections assessed operate with a Level of Service B or better during peak periods with the additional traffic generated by the proposed development. That is, there is spare capacity at the Phillip Street intersections even with the additional traffic likely to be generated by the proposed development to accommodate additional uplift within the wider precinct should this be required as a result of other proposals at some point in the future.

7 Conclusion

The key findings of this Traffic Impact Assessment are:

- Locating development within close proximity to public transport services is sound transport planning and has been shown to reduce reliance on the use of private vehicles, particularly for commuter trips. The site is located in close proximity to St Marys Station and a bus interchange and is therefore consistent with these transport planning objectives.
- Reduced car parking provisions would be considered appropriate for a development in this location to further encourage the use of these public transport services and limit increased car usage by future residents and staff. Notwithstanding, car parking provision are considered a detailed matter that can addressed as part of subsequent Development Application submissions.
- The surrounding road network generally operates with spare capacity during morning and evening peak periods, with the exception of the intersection of Great Western Highway / Mamre Road which exceeds capacity during the weekday PM peak.
- This is an existing issue and has been identified as an intersection that may require potential upgrade works at some point in the future as part of the *St Marys Town Centre Strategy* prepared by Penrith City Council (July 2006). It should be noted that the provision of an alternate connection to the M4 Motorway, such as the Werrington Arterial, may reduce traffic volumes at this intersection and hence alleviate the existing congestion, thus releasing further capacity for additional development within the locality.
- The development will generate a total of 454 weekday morning peak period vehicle trips and 998 evening weekday peak vehicle trips . This represents an increase of some 222 and 225 vehicles per hour (veh/hr), respectively, above that of the existing use of the site.
- These trips will be distributed onto the surrounding road network with the resultant increase at any one intersection substantially less than indicated above. This increased traffic can be readily accommodated by the surrounding road network without adverse impacts.
- Minor increases to average delays at the intersection of Great Western Highway / Mamre Road during the PM peak may be offset by future changes to the surrounding road network, including completion of the Werrington Arterial and potential local improvements to this intersection.
- All other intersections assessed will operate with spare capacity that may be available for further development within the larger precinct should this be proposed at some point in the future by surrounding landowners at which time further studies may be required.
- In the absence of formal proposals for these adjoining sites it is evident that the traffic impacts arising from the subject development can be accommodated which is all that is required to be demonstrated at this stage.

- The proposed access arrangements and establishment of the new laneway are considered supportable, subject to detailed design. In this regard, consideration should be given to the separation of access driveways from other major driveway and to ensure sufficient offset to public road intersections is achieved in compliance with AS2890. This, along with the design of the basement car park areas, is a detailed matter that can be progressed further as part of subsequent DA submission.

In summary, the planning proposal is considered supportable on transport planning grounds. The traffic impacts of the development can be accommodated by the surrounding road network and therefore considered acceptable.

Appendix A

The performance of the key intersections has been analysed using the SIDRA Intersection modelling program. SIDRA modelling outputs a range of performance measures, in particular:

- *Degree of Saturation (DOS)* – The DOS is defined as the ratio of demand (arrival) flow to capacity. The DOS is used to measure the performance of intersections where a value of 1.0 represents an intersection at theoretical capacity, above 1.0 represent over-saturated conditions (demand flows exceed capacity) and degrees of saturation below 1.0 represent under-saturated conditions (demand flows are below capacity). As the performance of an intersection approaches DOS of 1.0, queue lengths and delays increase rapidly. It is usual to attempt to keep DOS to less than 0.9, with satisfactory intersection operation generally achieved with a DOS below 0.8.
- *Average Vehicle Delay (AVD)* – Delay represents the difference between interrupted and uninterrupted travel times through an intersection and is measured in seconds per vehicle. Delays include queued vehicles accelerating and decelerating from/to the intersection stop lines, as well as general delays to all vehicles travelling through the intersection. The AVD (or average delay per vehicle in seconds) for intersections also provides a measure of the operational performance of an intersection and is used to determine an intersection's Level of Service (see below). For signalised intersections, the AVD reported relates to the average of all vehicle movements through the intersection. For priority (Give Way, Stop & Roundabout controlled) intersections, the AVD reported is that for the movement with the highest AVD.
- *Level of Service (LOS)* – This is a comparative measure that provides an indication of the operating performance, based on AVD. For signalised and roundabout intersections, LOS is based on the average delay to all vehicles, while at priority controlled intersections LOS is based on the worst approach delay. The following table provides a recommended baseline for assessment as per the RMS Guide:

Level of Service	Average Delay per Vehicle (sec/veh)	Traffic Signals, Roundabout	Give Way and Stop Signs
A	less than 14	Good operation	Good operation
B	15 to 28	Good with acceptable delays & spare capacity	Acceptable delays & spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity & 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	More than 70	Unsatisfactory and requires additional capacity.	Unsatisfactory and requires other control mode or major treatment.

Appendix A1

Existing

LANE SUMMARY

Site: Mamre Rd x GWH - EX AM

Existing Scenario
Signals - Fixed Time Isolated Cycle Time = 140 seconds (User-Given Cycle Time)
Variable Sequence Analysis applied. The results are given for the selected output sequence.

Lane Use and Performance

	Demand Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Mamre Road													
Lane 1	195	5.4	1228	0.159	100	12.0	LOS A	4.1	30.3	Short	60	0.0	NA
Lane 2	155	3.7	547	0.284	35[6]	44.3	LOS D	8.2	59.0	Full	350	0.0	0.0
Lane 3	394	11.6	490	0.805	100	58.4	LOS E	26.3	202.2	Full	350	0.0	0.0
Approach	744	8.3		0.805		43.3	LOS D	26.3	202.2				
East: Great Western Highway													
Lane 1	332	25.7	1114	0.298	100	10.7	LOS A	6.4	54.4	Short	60	0.0	NA
Lane 2	294	3.2	365[1]	0.804	100	56.7	LOS E	19.3	138.6	Full	550	0.0	0.0
Lane 3	357	3.2	443	0.804	100	58.1	LOS E	24.1	173.6	Full	550	0.0	0.0
Lane 4	308	3.2	383[1]	0.804	100	57.2	LOS E	20.4	146.7	Full	550	0.0	0.0
Lane 5	235	0.9	358	0.657	100	61.7	LOS E	14.9	105.2	Short	70	0.0	NA
Approach	1524	7.7		0.804		47.9	LOS D	24.1	173.6				
North: Queen Street													
Lane 1	157	5.5	217	0.724	100	63.2	LOS E	9.6	70.6	Short (P)	120	0.0	NA
Lane 2	138	7.5	190	0.724	100	70.9	LOS F	9.6	71.7	Full	450	0.0	0.0
Approach	295	6.4		0.724		66.8	LOS E	9.6	71.7				
West: Great Western Highway													
Lane 1	298	3.1	444	0.672	100	54.1	LOS D	18.6	133.5	Full	400	0.0	0.0
Lane 2	298	3.4	443	0.672	100	52.5	LOS D	18.5	133.5	Full	400	0.0	0.0
Lane 3	298	3.4	443	0.672	100	52.5	LOS D	18.5	133.5	Full	400	0.0	0.0
Lane 4	277	6.1	345	0.803	100	68.1	LOS E	19.2	141.6	Short	110	0.0	NA
Approach	1171	4.0		0.803		56.6	LOS E	19.2	141.6				
Intersection	3734	6.6		0.805		51.2	LOS D	26.3	202.2				

Level of Service (LOS) Method: Delay (RTA NSW).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

1 Reduced capacity due to a short lane effect. Short lane queues may extend into the adjacent full-length lanes. Some upstream delays at entry to short lanes are not included.
6 Lane under-utilisation due to downstream effects

LANE SUMMARY

Site: Mamre Rd x GWH - EX PM

Existing Scenario
Signals - Fixed Time Isolated Cycle Time = 150 seconds (Practical Cycle Time)
Variable Sequence Analysis applied. The results are given for the selected output sequence.

Lane Use and Performance

	Demand Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Mamre Road													
Lane 1	337	4.1	1091	0.309	100	18.7	LOS B	11.6	83.8	Short	60	0.0	NA
Lane 2	180	3.8	484	0.371	35[6]	52.2	LOS D	10.8	77.9	Full	350	0.0	0.0
Lane 3	465	8.7	442	1.052	100	150.2	LOS F	53.7	404.0	Full	350	0.0	18.0
Approach	981	6.2		1.052		87.1	LOS F	53.7	404.0				
East: Great Western Highway													
Lane 1	541	6.6	932[1]	0.580	100	18.8	LOS B	19.0	140.8	Short	60	0.0	NA
Lane 2	324	1.5	304[1]	1.064	100	197.4	LOS F	39.2	277.7	Full	550	0.0	0.0
Lane 3	513	1.5	482	1.064	100	152.6	LOS F	60.5	429.0	Full	550	0.0	0.0
Lane 4	443	1.5	416[1]	1.064	100	164.5	LOS F	52.7	373.7	Full	550	0.0	0.0
Lane 5	154	0.0	444	0.346	100	34.7	LOS C	6.4	45.1	Short	70	0.0	NA
Approach	1974	2.8		1.064		116.8	LOS F	60.5	429.0				
North: Queen Street													
Lane 1	309	1.6	293	1.056	100	124.5	LOS F	27.4	194.5	Short (P)	120	0.0	NA
Lane 2	290	1.2	275	1.056	100	152.5	LOS F	32.9	232.6	Full	450	0.0	0.0
Approach	599	1.4		1.056		138.0	LOS F	32.9	232.6				
West: Great Western Highway													
Lane 1	292	2.0	293	0.998	100	114.9	LOS F	28.9	205.8	Full	400	0.0	0.0
Lane 2	290	1.9	291	0.998	100	114.2	LOS F	28.7	204.3	Full	400	0.0	0.0
Lane 3	290	1.9	291	0.998	100	114.2	LOS F	28.7	204.3	Full	400	0.0	0.0
Lane 4	345	2.4	330	1.046	100	149.5	LOS F	38.8	277.3	Short	110	0.0	NA
Approach	1218	2.1		1.046		124.4	LOS F	38.8	277.3				
Intersection	4772	3.1		1.064		115.3	LOS F	60.5	429.0				

Level of Service (LOS) Method: Delay (RTA NSW).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

1 Reduced capacity due to a short lane effect. Short lane queues may extend into the adjacent full-length lanes. Some upstream delays at entry to short lanes are not included.
6 Lane under-utilisation due to downstream effects

LANE SUMMARY

Site: Phillip St x Glossop St - EX AM

Existing Scenario
Signals - Fixed Time Isolated Cycle Time = 60 seconds (Practical Cycle Time)

Lane Use and Performance

	Demand Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Glossop Street													
Lane 1	498	12.2	584	0.854	100	29.3	LOS C	16.8	129.9	Full	750	0.0	0.0
Lane 2	501	12.5	586	0.854	100	28.7	LOS C	16.9	130.7	Full	750	0.0	0.0
Approach	999	12.3		0.854		29.0	LOS C	16.9	130.7				
North: Glossop Street													
Lane 1	466	17.2	1123	0.415	100	5.9	LOS A	6.8	54.8	Full	450	0.0	0.0
Lane 2	466	17.2	1123	0.415	100	5.9	LOS A	6.8	54.8	Full	450	0.0	0.0
Lane 3	344	3.1	412	0.835	100	36.3	LOS C	11.4	82.0	Short	100	0.0	NA
Approach	1277	13.4		0.835		14.1	LOS A	11.4	82.0				
West: Phillip Street													
Lane 1	269	3.1	883	0.305	100	14.8	LOS B	4.8	34.7	Full	180	0.0	0.0
Lane 2	76	5.6	299	0.253	100	29.2	LOS C	2.0	14.9	Full	180	0.0	0.0
Approach	345	3.7		0.305		18.0	LOS B	4.8	34.7				
Intersection	2621	11.7		0.854		20.3	LOS B	16.9	130.7				

Level of Service (LOS) Method: Delay (RTA NSW).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

LANE SUMMARY

Site: Phillip St x Glossop St - EX PM

Existing Scenario
Signals - Fixed Time Isolated Cycle Time = 50 seconds (Practical Cycle Time)

Lane Use and Performance

	Demand Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Glossop Street													
Lane 1	558	10.5	632	0.883	100	28.2	LOS B	17.2	131.0	Full	750	0.0	0.0
Lane 2	561	10.8	636	0.883	100	27.3	LOS B	17.3	132.0	Full	750	0.0	0.0
Approach	1119	10.6		0.883		27.7	LOS B	17.3	132.0				
North: Glossop Street													
Lane 1	628	7.7	1201	0.523	100	5.3	LOS A	8.4	62.5	Full	450	0.0	0.0
Lane 2	628	7.7	1201	0.523	100	5.3	LOS A	8.4	62.5	Full	450	0.0	0.0
Lane 3	306	2.7	343	0.893	100	37.5	LOS C	9.5	68.2	Short	100	0.0	NA
Approach	1562	6.7		0.893		11.6	LOS A	9.5	68.2				
West: Phillip Street													
Lane 1	411	1.8	774	0.530	100	16.5	LOS B	7.7	54.5	Full	180	0.0	0.0
Lane 2	137	3.8	218	0.628	100	29.8	LOS C	3.5	25.6	Full	180	0.0	0.0
Approach	547	2.3		0.628		19.8	LOS B	7.7	54.5				
Intersection	3228	7.3		0.893		18.6	LOS B	17.3	132.0				

Level of Service (LOS) Method: Delay (RTA NSW).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

LANE SUMMARY

Site: Phillip St x Letherbridge St - EX AM

Existing Scenario
Roundabout

Lane Use and Performance

	Demand Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Letherbridge St													
Lane 1[d]	43	0.0	862	0.050	100	8.7	LOS A	0.3	1.9	Full	330	0.0	0.0
Approach	43	0.0		0.050		8.7	LOS A	0.3	1.9				
East: Phillip St													
Lane 1[d]	381	3.6	1495	0.255	100	5.5	LOS A	0.9	6.3	Full	200	0.0	0.0
Approach	381	3.6		0.255		5.5	LOS A	0.9	6.3				
North: Letherbridge St													
Lane 1[d]	53	14.0	918	0.057	100	6.7	LOS A	0.2	1.9	Full	500	0.0	0.0
Approach	53	14.0		0.057		6.7	LOS A	0.2	1.9				
West: Phillip St													
Lane 1[d]	297	1.1	1253	0.237	100	5.3	LOS A	0.8	5.7	Full	350	0.0	0.0
Approach	297	1.1		0.237		5.3	LOS A	0.8	5.7				
Intersection	774	3.1		0.255		5.7	LOS A	0.9	6.3				

Level of Service (LOS) Method: Delay (RTA NSW).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

d Dominant lane on roundabout approach

LANE SUMMARY

Site: Phillip St x Letherbridge St - EX PM

Existing Scenario
Roundabout

Lane Use and Performance

	Demand Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Letherbridge St													
Lane 1[d]	54	0.0	859	0.062	100	8.4	LOS A	0.3	2.4	Full	330	0.0	0.0
Approach	54	0.0		0.062		8.4	LOS A	0.3	2.4				
East: Phillip St													
Lane 1[d]	384	3.8	1392	0.276	100	5.9	LOS A	1.0	7.2	Full	200	0.0	0.0
Approach	384	3.8		0.276		5.9	LOS A	1.0	7.2				
North: Letherbridge St													
Lane 1[d]	139	8.3	841	0.165	100	7.5	LOS A	0.8	6.1	Full	500	0.0	0.0
Approach	139	8.3		0.165		7.5	LOS A	0.8	6.1				
West: Phillip St													
Lane 1[d]	463	0.7	1240	0.374	100	5.5	LOS A	1.5	10.3	Full	350	0.0	0.0
Approach	463	0.7		0.374		5.5	LOS A	1.5	10.3				
Intersection	1040	2.8		0.374		6.1	LOS A	1.5	10.3				

Level of Service (LOS) Method: Delay (RTA NSW).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

d Dominant lane on roundabout approach

LANE SUMMARY

Site: Queen St x Phillip St - EX PM

Existing Scenario
Giveway / Yield (Two-Way)

Lane Use and Performance

	Demand Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Queen Street													
Lane 1	488	4.3	1327	0.368	100	6.3	LOS A	2.5	18.0	Full	500	0.0	0.0
Approach	488	4.3		0.368		6.3	NA	2.5	18.0				
East: Phillip Street													
Lane 1	38	5.6	700	0.054	100	8.8	LOS A	0.2	1.3	Full	500	0.0	0.0
Approach	38	5.6		0.054		8.8	LOS A	0.2	1.3				
North: Queen Street													
Lane 1	247	11.9	1562	0.158	100	2.2	LOS A	0.6	4.6	Full	500	0.0	0.0
Approach	247	11.9		0.158		2.2	NA	0.6	4.6				
Intersection	774	6.8		0.368		5.1	NA	2.5	18.0				

Level of Service (LOS) Method: Delay (RTA NSW).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

LANE SUMMARY

Site: Queen St x Phillip St - EX AM

Existing Scenario
Giveway / Yield (Two-Way)

Lane Use and Performance

	Demand Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Queen Street													
Lane 1	369	1.1	1507	0.245	100	5.0	LOS A	1.3	9.5	Full	500	0.0	0.0
Approach	369	1.1		0.245		5.0	NA	1.3	9.5				
East: Phillip Street													
Lane 1	275	1.5	1307	0.210	100	6.4	LOS A	0.9	6.6	Full	500	0.0	0.0
Approach	275	1.5		0.210		6.4	LOS A	0.9	6.6				
North: Queen Street													
Lane 1	140	19.5	1347	0.104	100	4.5	LOS A	0.5	3.8	Full	500	0.0	0.0
Approach	140	19.5		0.104		4.5	NA	0.5	3.8				
Intersection	784	4.6		0.245		5.4	NA	1.3	9.5				

Level of Service (LOS) Method: Delay (RTA NSW).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Appendix A2

Existing + Development

LANE SUMMARY

Site: Mamre Rd x GWH - FU AM

Development Scenario
Signals - Fixed Time Isolated Cycle Time = 140 seconds (User-Given Cycle Time)
Variable Sequence Analysis applied. The results are given for the selected output sequence.

Lane Use and Performance

	Demand Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Mamre Road													
Lane 1	195	5.4	1229	0.158	100	12.0	LOS A	4.1	30.3	Short	60	0.0	NA
Lane 2	163	3.4	562	0.290	35[6]	43.6	LOS D	8.5	61.5	Full	350	0.0	0.0
Lane 3	416	11.1	505	0.824	100	59.2	LOS E	28.2	216.2	Full	350	0.0	0.0
Approach	774	8.0		0.824		44.0	LOS D	28.2	216.2				
East: Great Western Highway													
Lane 1	332	25.7	1097	0.302	100	11.4	LOS A	6.8	57.8	Short	60	0.0	NA
Lane 2	291	3.2	348[1]	0.834	100	60.1	LOS E	19.7	141.8	Full	550	0.0	0.0
Lane 3	359	3.2	430	0.834	100	61.3	LOS E	25.1	180.5	Full	550	0.0	0.0
Lane 4	309	3.2	370[1]	0.834	100	60.5	LOS E	21.2	152.4	Full	550	0.0	0.0
Lane 5	235	0.9	345	0.681	100	62.9	LOS E	15.1	106.6	Short	70	0.0	NA
Approach	1524	7.7		0.834		50.3	LOS D	25.1	180.5				
North: Queen Street													
Lane 1	179	4.7	228	0.785	100	68.3	LOS E	11.7	85.3	Short (P)	120	0.0	NA
Lane 2	161	6.6	205	0.785	100	72.0	LOS F	11.5	84.9	Full	450	0.0	0.0
Approach	340	5.6		0.785		70.1	LOS E	11.7	85.3				
West: Great Western Highway													
Lane 1	301	3.0	430	0.699	100	55.4	LOS D	19.0	136.1	Full	400	0.0	0.0
Lane 2	300	3.4	429	0.699	100	53.6	LOS D	18.9	136.2	Full	400	0.0	0.0
Lane 3	300	3.4	429	0.699	100	53.6	LOS D	18.9	136.2	Full	400	0.0	0.0
Lane 4	277	6.1	333	0.832	100	71.2	LOS F	19.8	145.8	Short	110	0.0	NA
Approach	1178	3.9		0.832		58.2	LOS E	19.8	145.8				
Intersection	3816	6.4		0.834		53.2	LOS D	28.2	216.2				

Level of Service (LOS) Method: Delay (RTA NSW).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

1 Reduced capacity due to a short lane effect. Short lane queues may extend into the adjacent full-length lanes. Some upstream delays at entry to short lanes are not included.
6 Lane under-utilisation due to downstream effects

LANE SUMMARY

Site: Mamre Rd x GWH - FU PM

Development Scenario
Signals - Fixed Time Isolated Cycle Time = 150 seconds (Practical Cycle Time)
Variable Sequence Analysis applied. The results are given for the selected output sequence.

Lane Use and Performance

	Demand Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Mamre Road													
Lane 1	337	4.1	1094	0.308	100	18.3	LOS B	11.5	83.0	Short	60	0.0	NA
Lane 2	194	3.3	499	0.389	35[6]	51.7	LOS D	11.6	83.7	Full	350	0.0	0.0
Lane 3	504	8.1	456	1.104	100	189.7	LOS F	65.5	490.6	Full	350	0.0	35.8
Approach	1035	5.9		1.104		108.0	LOS F	65.5	490.6				
East: Great Western Highway													
Lane 1	541	6.6	926[1]	0.584	100	18.8	LOS B	19.1	141.0	Short	60	0.0	NA
Lane 2	326	1.5	300[1]	1.088	100	214.2	LOS F	41.5	294.1	Full	550	0.0	0.0
Lane 3	510	1.5	469	1.088	100	171.1	LOS F	63.5	450.2	Full	550	0.0	0.0
Lane 4	442	1.5	407[1]	1.088	100	182.6	LOS F	55.5	393.1	Full	550	0.0	0.0
Lane 5	154	0.0	324	0.475	100	65.4	LOS E	10.2	71.2	Short	70	0.0	NA
Approach	1974	2.8		1.088		130.8	LOS F	63.5	450.2				
North: Queen Street													
Lane 1	327	1.5	300	1.090	100	149.4	LOS F	31.9	225.8	Short (P)	120	0.0	NA
Lane 2	313	1.2	287	1.090	100	178.1	LOS F	38.5	272.0	Full	450	0.0	0.0
Approach	640	1.3		1.090		163.4	LOS F	38.5	272.0				
West: Great Western Highway													
Lane 1	294	1.9	471	0.625	100	55.1	LOS D	19.2	136.3	Full	400	0.0	0.0
Lane 2	292	1.9	468	0.625	100	54.1	LOS D	19.0	135.4	Full	400	0.0	0.0
Lane 3	292	1.9	468	0.625	100	54.1	LOS D	19.0	135.4	Full	400	0.0	0.0
Lane 4	345	2.4	318	1.085	100	178.7	LOS F	42.4	303.0	Short	110	0.0	NA
Approach	1224	2.1		1.085		89.5	LOS F	42.4	303.0				
Intersection	4873	3.1		1.104		119.9	LOS F	65.5	490.6				

Level of Service (LOS) Method: Delay (RTA NSW).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

1 Reduced capacity due to a short lane effect. Short lane queues may extend into the adjacent full-length lanes. Some upstream delays at entry to short lanes are not included.
6 Lane under-utilisation due to downstream effects

LANE SUMMARY

Site: Queen St x Phillip St - FU AM

Development Scenario
Giveway / Yield (Two-Way)

Lane Use and Performance

	Demand Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Queen Street													
Lane 1	418	1.0	1480	0.282	100	5.7	LOS A	1.6	11.0	Full	500	0.0	0.0
Approach	418	1.0		0.282		5.7	NA	1.6	11.0				
East: Phillip Street													
Lane 1	352	4.2	1328	0.265	100	6.4	LOS A	1.2	9.0	Full	500	0.0	0.0
Approach	352	4.2		0.265		6.4	LOS A	1.2	9.0				
North: Queen Street													
Lane 1	121	13.9	1310	0.092	100	5.1	LOS A	0.4	3.2	Full	500	0.0	0.0
Approach	121	13.9		0.092		5.1	NA	0.4	3.2				
Intersection	891	4.0		0.282		5.9	NA	1.6	11.0				

Level of Service (LOS) Method: Delay (RTA NSW).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

LANE SUMMARY

Site: Queen St x Phillip St - FU PM

Development Scenario
Giveway / Yield (Two-Way)

Lane Use and Performance

	Demand Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Queen Street													
Lane 1	565	3.7	1359	0.416	100	7.0	LOS A	2.8	20.6	Full	500	0.0	0.0
Approach	565	3.7		0.416		7.0	NA	2.8	20.6				
East: Phillip Street													
Lane 1	199	1.1	1146	0.174	100	6.9	LOS A	0.7	5.0	Full	500	0.0	0.0
Approach	199	1.1		0.174		6.9	LOS A	0.7	5.0				
North: Queen Street													
Lane 1	145	20.3	1398	0.104	100	3.6	LOS A	0.5	3.7	Full	500	0.0	0.0
Approach	145	20.3		0.104		3.6	NA	0.5	3.7				
Intersection	909	5.8		0.416		6.4	NA	2.8	20.6				

Level of Service (LOS) Method: Delay (RTA NSW).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

LANE SUMMARY

Site: Phillip St x Letherbridge St - FU AM

Development Scenario
Roundabout

Lane Use and Performance

	Demand Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Letherbridge St													
Lane 1[d]	43	0.0	824	0.052	100	9.1	LOS A	0.3	2.0	Full	330	0.0	0.0
Approach	43	0.0		0.052		9.1	LOS A	0.3	2.0				
East: Phillip St													
Lane 1[d]	434	3.2	1509	0.287	100	5.1	LOS A	1.1	7.6	Full	200	0.0	0.0
Approach	434	3.2		0.287		5.1	LOS A	1.1	7.6				
North: Letherbridge St													
Lane 1[d]	169	4.3	895	0.189	100	7.2	LOS A	0.9	6.7	Full	500	0.0	0.0
Approach	169	4.3		0.189		7.2	LOS A	0.9	6.7				
West: Phillip St													
Lane 1[d]	414	0.8	1341	0.309	100	5.1	LOS A	1.2	8.4	Full	350	0.0	0.0
Approach	414	0.8		0.309		5.1	LOS A	1.2	8.4				
Intersection	1060	2.3		0.309		5.6	LOS A	1.2	8.4				

Level of Service (LOS) Method: Delay (RTA NSW).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

d Dominant lane on roundabout approach

LANE SUMMARY

Site: Phillip St x Letherbridge St - FU PM

Development Scenario
Roundabout

Lane Use and Performance

	Demand Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Letherbridge St													
Lane 1[d]	54	0.0	795	0.068	100	9.1	LOS A	0.4	2.6	Full	330	0.0	0.0
Approach	54	0.0		0.068		9.1	LOS A	0.4	2.6				
East: Phillip St													
Lane 1[d]	472	3.1	1414	0.333	100	5.1	LOS A	1.3	9.6	Full	200	0.0	0.0
Approach	472	3.1		0.333		5.1	LOS A	1.3	9.6				
North: Letherbridge St													
Lane 1[d]	312	3.7	767	0.406	100	9.5	LOS A	2.5	17.8	Full	500	0.0	0.0
Approach	312	3.7		0.406		9.5	LOS A	2.5	17.8				
West: Phillip St													
Lane 1[d]	635	0.5	1404	0.452	100	5.2	LOS A	2.2	15.3	Full	350	0.0	0.0
Approach	635	0.5		0.452		5.2	LOS A	2.2	15.3				
Intersection	1472	2.0		0.452		6.2	LOS A	2.5	17.8				

Level of Service (LOS) Method: Delay (RTA NSW).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

d Dominant lane on roundabout approach

LANE SUMMARY

Site: Phillip St x Glossop St - FU AM

Development Scenario
Signals - Fixed Time Isolated Cycle Time = 60 seconds (Practical Cycle Time)

Lane Use and Performance

	Demand Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Glossop Street													
Lane 1	512	11.5	585	0.876	100	31.9	LOS C	18.1	139.0	Full	750	0.0	0.0
Lane 2	513	12.5	586	0.876	100	31.0	LOS C	18.1	140.4	Full	750	0.0	0.0
Approach	1025	12.0		0.876		31.4	LOS C	18.1	140.4				
North: Glossop Street													
Lane 1	466	17.2	1123	0.415	100	5.9	LOS A	6.8	54.8	Full	450	0.0	0.0
Lane 2	466	17.2	1123	0.415	100	5.9	LOS A	6.8	54.8	Full	450	0.0	0.0
Lane 3	371	2.8	413	0.897	100	42.1	LOS C	13.7	98.0	Short	100	0.0	NA
Approach	1303	13.1		0.897		16.2	LOS B	13.7	98.0				
West: Phillip Street													
Lane 1	335	2.5	886	0.378	100	15.2	LOS B	6.3	44.8	Full	180	0.0	0.0
Lane 2	109	3.8	303	0.362	100	29.7	LOS C	3.0	21.7	Full	180	0.0	0.0
Approach	444	2.8		0.378		18.8	LOS B	6.3	44.8				
Intersection	2773	11.0		0.897		22.3	LOS B	18.1	140.4				

Level of Service (LOS) Method: Delay (RTA NSW).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

LANE SUMMARY

Site: Phillip St x Glossop St - FU PM

Development Scenario
Signals - Fixed Time Isolated Cycle Time = 60 seconds (Practical Cycle Time)

Lane Use and Performance

	Demand Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Glossop Street													
Lane 1	575	9.9	682	0.843	100	26.9	LOS B	18.7	141.8	Full	750	0.0	0.0
Lane 2	578	10.8	686	0.843	100	25.7	LOS B	18.8	143.4	Full	750	0.0	0.0
Approach	1153	10.3		0.843		26.3	LOS B	18.8	143.4				
North: Glossop Street													
Lane 1	628	7.7	1282	0.490	100	4.9	LOS A	8.8	65.4	Full	450	0.0	0.0
Lane 2	628	7.7	1282	0.490	100	4.9	LOS A	8.8	65.4	Full	450	0.0	0.0
Lane 3	360	2.3	414	0.869	100	38.9	LOS C	12.6	89.7	Short	100	0.0	NA
Approach	1616	6.5		0.869		12.4	LOS A	12.6	89.7				
West: Phillip Street													
Lane 1	442	1.7	799	0.553	100	18.5	LOS B	9.8	69.7	Full	180	0.0	0.0
Lane 2	176	3.0	213	0.824	100	38.8	LOS C	5.9	42.5	Full	180	0.0	0.0
Approach	618	2.0		0.824		24.2	LOS B	9.8	69.7				
Intersection	3386	7.0		0.869		19.3	LOS B	18.8	143.4				

Level of Service (LOS) Method: Delay (RTA NSW).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Appendix A3

Existing + Development (with improvements)

LANE SUMMARY

Site: Mamre Rd x GWH - FU AM

Development Scenario
Queen Street No Stopping Extension
Signals - Fixed Time Isolated Cycle Time = 140 seconds (User-Given Cycle Time)
Variable Sequence Analysis applied. The results are given for the selected output sequence.

Lane Use and Performance

	Demand Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Mamre Road													
Lane 1	195	5.4	1225	0.159	100	11.7	LOS A	4.0	29.7	Short	60	0.0	NA
Lane 2	185	3.4	534	0.345	42[6]	45.9	LOS D	10.0	72.0	Full	350	0.0	0.0
Lane 3	394	11.5	478	0.825	100	61.0	LOS E	27.0	207.6	Full	350	0.0	0.0
Approach	774	8.0		0.825		45.0	LOS D	27.0	207.6				
East: Great Western Highway													
Lane 1	332	25.7	1095	0.303	100	11.4	LOS A	6.8	57.8	Short	60	0.0	NA
Lane 2	275	3.2	339[1]	0.812	100	57.1	LOS E	18.1	129.9	Full	550	0.0	0.0
Lane 3	360	3.2	443	0.812	100	58.7	LOS E	24.6	176.7	Full	550	0.0	0.0
Lane 4	323	3.2	397[1]	0.812	100	58.0	LOS E	21.7	155.8	Full	550	0.0	0.0
Lane 5	235	0.9	358	0.657	100	61.7	LOS E	14.9	105.2	Short	70	0.0	NA
Approach	1524	7.7		0.812		48.4	LOS D	24.6	176.7				
North: Queen Street													
Lane 1	179	4.7	228	0.785	100	67.9	LOS E	11.7	85.3	Short (P)	120	0.0	NA
Lane 2	161	6.6	205	0.785	100	72.0	LOS F	11.5	84.9	Full	450	0.0	0.0
Approach	340	5.6		0.785		69.8	LOS E	11.7	85.3				
West: Great Western Highway													
Lane 1	301	3.0	444	0.678	100	54.3	LOS D	18.8	134.7	Full	400	0.0	0.0
Lane 2	300	3.4	443	0.678	100	52.6	LOS D	18.7	134.8	Full	400	0.0	0.0
Lane 3	300	3.4	443	0.678	100	52.6	LOS D	18.7	134.8	Full	400	0.0	0.0
Lane 4	277	6.1	345	0.803	100	68.1	LOS E	19.2	141.6	Short	110	0.0	NA
Approach	1178	3.9		0.803		56.7	LOS E	19.2	141.6				
Intersection	3816	6.4		0.825		52.2	LOS D	27.0	207.6				

Level of Service (LOS) Method: Delay (RTA NSW).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

1 Reduced capacity due to a short lane effect. Short lane queues may extend into the adjacent full-length lanes. Some upstream delays at entry to short lanes are not included.
6 Lane under-utilisation due to downstream effects

LANE SUMMARY

Site: Mamre Rd x GWH - FU PM

Development Scenario
Queen Street No Stopping Extension
Signals - Fixed Time Isolated Cycle Time = 150 seconds (Practical Cycle Time)
Variable Sequence Analysis applied. The results are given for the selected output sequence.

Lane Use and Performance

	Demand Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	95% Back of Queue Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Mamre Road													
Lane 1	337	4.1	1085	0.310	100	18.7	LOS B	11.6	84.0	Short	60	0.0	NA
Lane 2	220	3.3	486	0.452	42[6]	53.4	LOS D	13.5	97.2	Full	350	0.0	0.0
Lane 3	478	8.4	443	1.079	100	170.7	LOS F	58.9	441.7	Full	350	0.0	26.1
Approach	1035	5.9		1.079		96.3	LOS F	58.9	441.7				
East: Great Western Highway													
Lane 1	541	6.6	919[1]	0.589	100	19.3	LOS B	19.4	143.8	Short	60	0.0	NA
Lane 2	326	1.5	300[1]	1.088	100	214.2	LOS F	41.5	294.1	Full	550	0.0	0.0
Lane 3	510	1.5	469	1.088	100	171.1	LOS F	63.5	450.2	Full	550	0.0	0.0
Lane 4	442	1.5	407[1]	1.088	100	182.6	LOS F	55.5	393.1	Full	550	0.0	0.0
Lane 5	154	0.0	324	0.475	100	65.4	LOS E	10.2	71.2	Short	70	0.0	NA
Approach	1974	2.8		1.088		131.0	LOS F	63.5	450.2				
North: Queen Street													
Lane 1	327	1.5	313	1.044	100	115.9	LOS F	28.0	198.7	Short (P)	120	0.0	NA
Lane 2	313	1.2	300	1.044	100	144.1	LOS F	34.7	245.2	Full	450	0.0	0.0
Approach	640	1.3		1.044		129.7	LOS F	34.7	245.2				
West: Great Western Highway													
Lane 1	294	1.9	471	0.625	100	55.1	LOS D	19.2	136.3	Full	400	0.0	0.0
Lane 2	292	1.9	468	0.625	100	54.1	LOS D	19.0	135.4	Full	400	0.0	0.0
Lane 3	292	1.9	468	0.625	100	54.1	LOS D	19.0	135.4	Full	400	0.0	0.0
Lane 4	345	2.4	318	1.085	100	178.7	LOS F	42.4	303.0	Short	110	0.0	NA
Approach	1224	2.1		1.085		89.5	LOS F	42.4	303.0				
Intersection	4873	3.1		1.088		113.0	LOS F	63.5	450.2				

Level of Service (LOS) Method: Delay (RTA NSW).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

1 Reduced capacity due to a short lane effect. Short lane queues may extend into the adjacent full-length lanes. Some upstream delays at entry to short lanes are not included.
6 Lane under-utilisation due to downstream effects