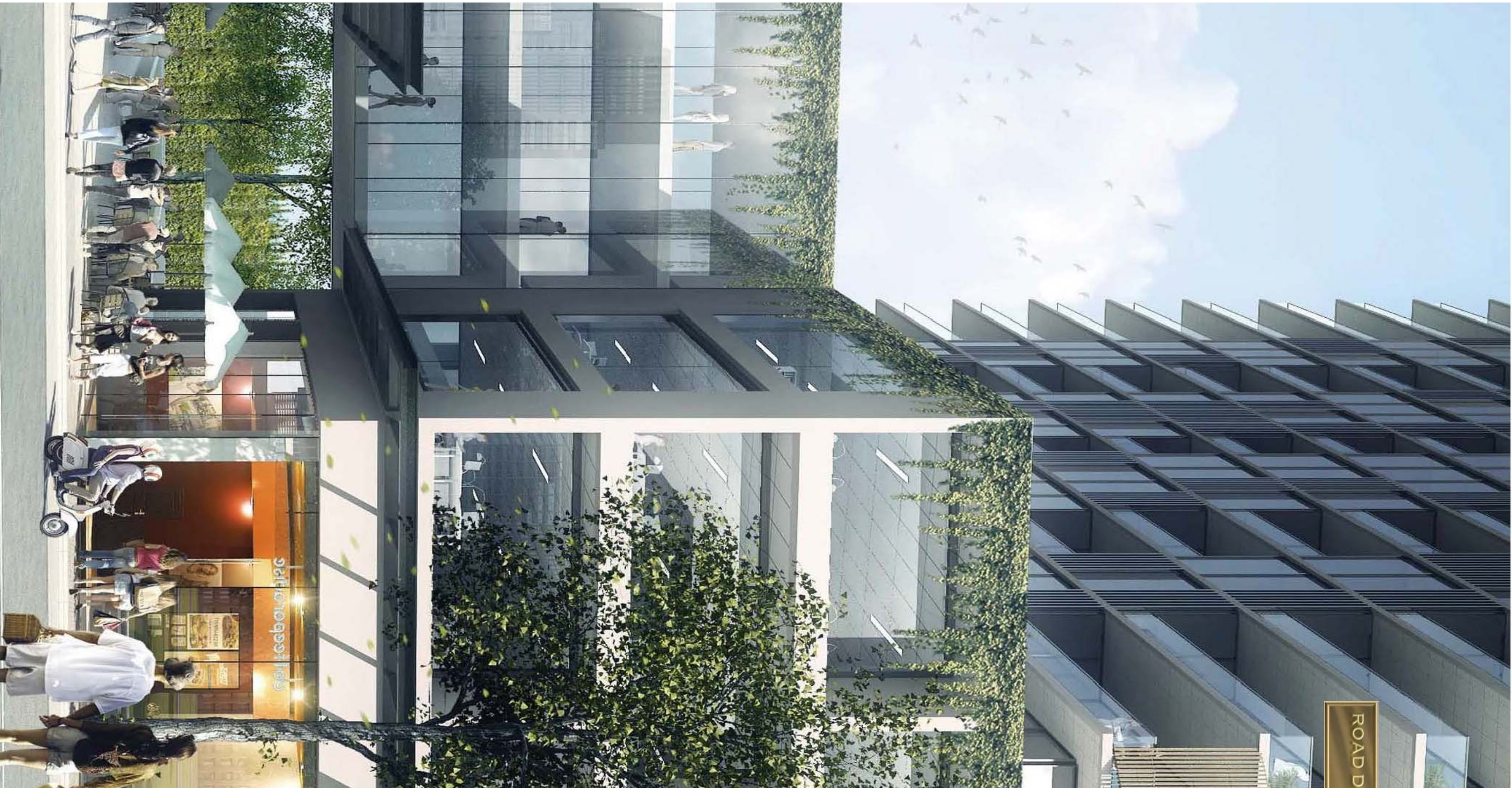

ROAD DELAY SOLUTIONS

28-34 Victoria Street &
23-27 George Street, Burwood

Planning Proposal for Mixed Use Development

Traffic Impact Assessment

ROAD DELAY SOLUTIONS

DOCUMENT STATUS

D:\Documents\28 34 Victoria St Burwood\Report\Draft Final.docx

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Date	22 October 2017...

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Reference: 20160267
October 2017

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FIGURES

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EXECUTIVE SUMMARY

Road Delay Solutions has been engaged by *VSD Developments Pty Ltd* to undertake the preparation of a Traffic Impact Assessment (TIA) in support of the Planning Proposal (PP) for a mixed use development at 28-34 Victoria Street and 23-27 George Street, Burwood.

This TIA has been prepared to determine and reflect the traffic needs and necessary mitigation treatments in support of the proposed development.

Road Delay Solutions has undertaken extensive consultation with Council officers to ensure the methodology and inputs used are in accordance with Council's exact requirements and expectations.

As a result of this consultation, this report has critically analysed and assessed the impacts of the Victoria Street & George Street development on the Burwood Town Centre road network. Extensive mesoscopic and operational modelling has focused n and analysed the following three future growth year traffic scenarios, namely…

- → *2026 Base Year Model ('Do Nothing'),*
- → *2026 Section 94 Infrastructure Model, and*
- → *2026 Victoria Street & George Street development Model.*

A number of measures (*additional to the infrastructure outlined in Council's S94 Plan*) have been identified and assessed in unison to sustain the movement of traffic within the town centre and support the planned level of growth anticipated with the Victoria Street & George Street development to year 2026.

These works include…

- → *Widening of the existing signalised foot crossings along Burwood Road, between Wilga Street and Belmore Street, to 5metres,*
- → *General retention of the current traffic signal operations at the Burwood Road intersections with Railway Parade (including retention of the right turn movement for all vehicles southbound turning into Railway Parade) and Belmore Street,*
- → *The introduction of a 'scramble' phase pedestrian crossing at the Burwood Road intersection with Railway Parade,*
- → *The introduction of traffic signal control at the intersections of…*
    - o *Shaftesbury Avenue and George Street, and*
    - o *Burwood Road and Victoria Street East.*

The assessment of these actions has concluded that, once the proposed infrastructure outlined in Council's Section 94 Contributions Plan has been implemented, in conjunction with the further identified upgrades, any impacts of traffic generation associated with the proposed development alone, both vehicular and pedestrian, will be benign on the town centre's road network.

It is considered that if the aforementioned measures are implemented, the impact of traffic generation associated with the Victoria Street & George Street development will be effectively and satisfactorily managed while reducing the impedence on pedestrian demands.

THE SITE

The subject site is located at 28-34 Victoria Street and 23-27 George Street, Burwood, and is situated within the City of Burwood Local Government Area (LGA). The site is segmented into two (2) major components and seamlessly integrates with the surrounding Burwood Town Centre commercial and retail activities.

The Burwood LGA is situated in the inner western suburbs of Sydney. Being some 7.26 km^2 in area, it is one of the smallest LGA's in the state and has a relatively high population density.

Situated and fronting both Victoria Street, to the north, and George Street, to the south, the site is only some 340m north of the Burwood Railway Station and 155m south from bus stops on Shaftesbury Avenue, adjacent to the Westfield Shopping Complex.

Figure ES 1 ***Victoria Street & George Street Site in Context***

Source *vimeo.com, 2017*

PROPOSED DEVELOPMENT

The planning proposal provides for a mixed use development including approximately…

- → *436 residential apartments,*
- → *4,447m² (3,202m² GLFA) of specialty reatail floor space, and*
- → *5,849m² (4,270m² GLFA) of commercial floor space.*

Figure ES 2 ***The Development Footprint***

Source *Architectus, 2017*

The development '*joins*' a current site at 23–27 George Sreet with the proposed development at 28-34 Victoria Street, forming a single development site and allowing for the introduction of a thouroughfare between Victoria Street and George Street. The resultant thouroughfare will facilitate improved access with the Burwood Railway station and Westfield Shopping Complex.

Vehicular access to the site is currently under consideration from two (2) locations on both Victoria Street and George Street, allowing residential, commercial, visitor and retail parking…

- → *Victoria Street servicing a maximum of 65% of development traffic (213vph), and*
- → *George Street servicing the remaing 35% of development traffic (115vph).*

The respective access destinations will be clearly defined on the surrounding road network via the use of signposting and on the internal ramp systems within the development's underground car park, connecting to the respective parking allocations.

The preliminary allocation of traffic generation by access location are shown in the above figure and have yet to be accurately determined. These allocations, by access location, have been applied to the year 2026 development vehicle generation model and represent a '*worst case'* scenario.

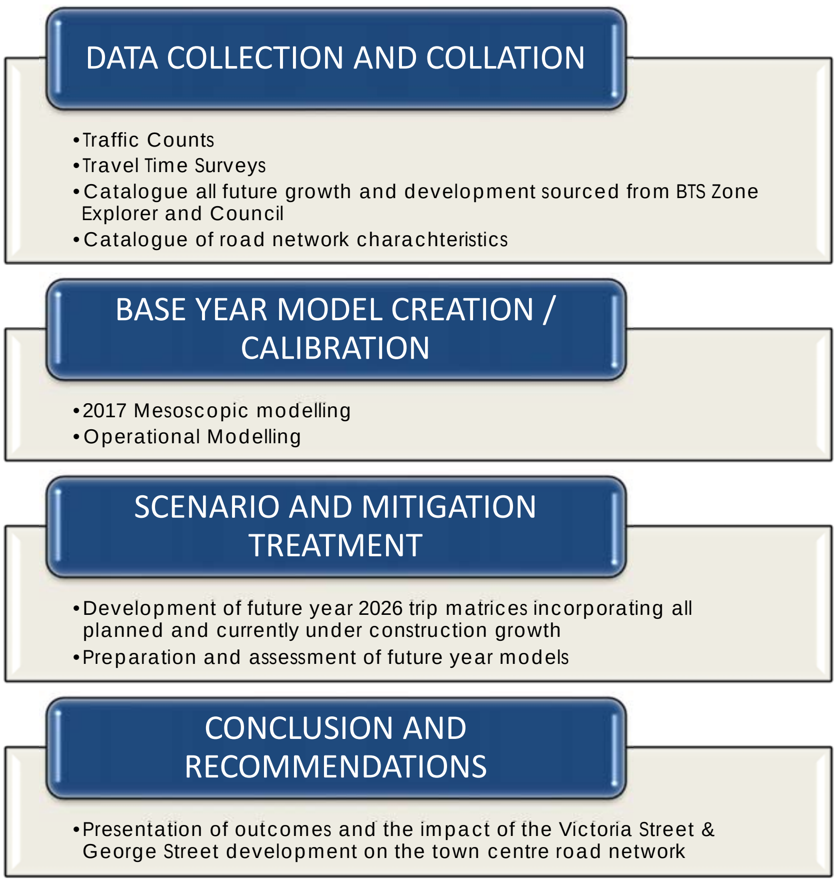
The layout and internal machinations of the car park provisions and access locations are yet to be finalised, subject to the preparation of architectural drawings for DA application.

THE ASSESSMENT PROCESS

This report has adopted a four (4) tier, systematic approach to assessment of the road network operation under both the existing and anticipated future growth conditions. The approach taken is graphically presented below, with the key tasks outlined for each tier.

Figure ES 3 The Assessment Process

Source Road Delay Solutions, 2017



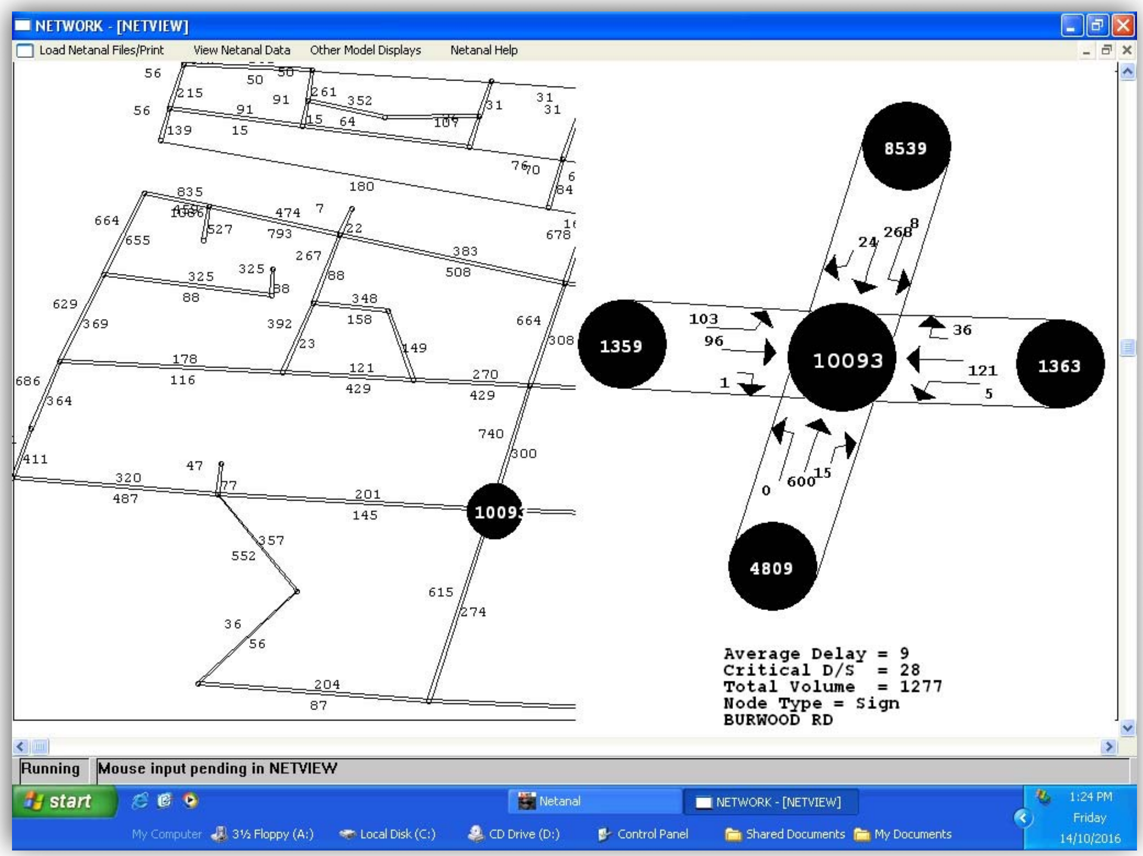
The Mesoscopic Model

The *Netanal* model utilises defined travel demand between zonal pairs, represented as assimilated traffic movements, throughout the Sydney Metropolitan Area. The program incrementally assigns vehicular traffic onto a computer based road network, developing link demand forecasts on each modelled section of road.

Netanal is a mesoscopic assignment model utilising intersection congestion levels and delays in the determination of a motorists' route choice.

Figure ES 4 ***The Typical Netanal Mesoscopic Model***

Source *Road Delay Solutions, 2017*



THE 2017 EXISTING SITUATION

Burwood Road

The mesoscopic and operational modelling indicates that the Burwood Road route, both northbound and southbound, during both the AM and PM comuter peak periods between Victoria Street and Belmore Street, currently operates at a satisfactory Level of Service (LoS) 'D'. Due to queuing implications there is currently little remaining capacity along this Road. This is further analysed below.

Occassional residual queues are reported from several sites back through preceding intersections, impeding the coordinated traffic signal operations and the through movements.

The pedestrian phases along Burwood Road are demanded each cycle and necessitate significant time to clear before allowing left and right turn vehicle movements to be performed.

This is particularly evident, southbound, at the Burwood Road intersection with Railway Parade. With a trailing and repeat right turn from the central shared through and right lane, in conjunction with the inherent delay imposed by pedestrians on the left turn movement, 'A' phase can '*trap*' southbound motorists if the right and left turn movements are held, concurrently.

The vehicle delays observed on Burwood Road, between George Street to the north and Clarence Street to the south, are the result of...

- → *The short distances between intersections, in close proximity to the railway station,*
- → *The incidence of pedestrian demand on cycle times and the occurance of the pedestrian 'walk' in each cycle,*
- → *Buses stopping,*
- → *The impacts of on street parking manouveres including drop off and pick up,*
- → *The single lane southbound approach prior to George Street, and*
- → *The lack of a dedicated right turn lane, southbound (existing shared through and right), at the Railway Parade intersection resulting in queueing back to the north through the preceding intersections.*

Operational analysis suggests that each intersection within the study area, in isolation, opearate within their respective vehicle capacities. However, congestion points, such as, the shared right turn and through movement southbound in Burwood Road from the centre lane at the Railway Parade intersection and the single lane, mid block, constraints imposed by on street parking, result in queueing both northbound and southbound along Burwood Road through the town centre.

These delays are typically inherent within built up town centre environments and are to be expected. Anecdotally, such vehicle congestion generally results in reduced vehicle speeds which may be conducive to improving pedestrian safety and reducing the severity of any occurring accidents while providing an unattractive route for through traffic.

The vehicle volumes on the competing parallel routes of Wentworth Road and Shaftesbury Road would appear to have increased more significantly than those on Burwood Road over the past years. Shaftesbury Road, in particular, reports a vehicle growth of approximately 10.3% over the past ten (10) years growing from some 1,652vph in 2000 to 1,825vph in 2016.

Shaftesbury Road

Shaftesbury Road is a major collector road with a four lane carriageway (two lanes in each direction) between Victoria Street and George Street.

On street parking is not permitted through this section and the sign posted, regulated, speed limit is 50km/hr.

Carrying a substantial traffic load, Shaftesbury Road serves as a dominant north south corridor providing access to the Westfield Shopping Complex and Burwood RSL. It is used by locals to avoid congestion on Burwood Road and as such, currently exhibits modest vehicle delays during the peak commuter periods at the signalised intersections between Railway Parade in the south and Wilga Street in the north.

The Wilga Street intersection provides only single through lanes both northbound and southbound through the intetrsection and capacity constraints are concerning with the introduction of traffic from both the Victoria Street & George Street and Burwood RSL developments.

Victoria Street

Victoria Street is a local road providing direct access to the Westfield Shopping Complex and facilitating access of some 65% of traffic generated by the proposed development. It serves as a bus layover along its northern kerb line.

At Burwood Road, Victoria Street forms a T-Junction permitting right turn, buses only, and left turn entry while at Shaftesbury Road all movements are permissible at a four way traffic signal conrtolled intersection.

George Street

George Street between Burwood Road and Shaftesbury Road is a local road with single lane midblock capacity allowing one-way traffic only, adjacent to the development site. The road is predominantly residential and experiences high pedestrian activity. On street parking is permitted on the southern side and is time restricted. The sign posted speed limit is 40km/hr.

The intersection with Shaftesbury Road, which is sign priority controlled (Giveway), allows for both left turn and right turn movements from George Sreet. The right turn movement from George Street currently reports a LoS 'C' but as congestion builds and gaps diminish in the traffic flows during the commuter peak periods on Shaftesbury Road, alternate options are utilised by motorists desiring to travel south. A number of motorists elect to utilise Marmaduke Street and either proceed to Waimea to perform a priority controlled (Giveway) right turn onto Shaftesbury Road or alternatively, turn right from Marmaduke Street onto Deane Street and proceed south via Burwood Road. The alternative routes via Marmaduke Street will be available to the proposed southbound development traffic.

Wentworth Road

Wentworth Road is primarily a residential collector road running north south, parallel to the Burwood Town Centre and with a regulated speed of 50km/hr.

The intersection of Wentworth Road, Railway Parade and Morwick Street serves as a western gateway to the town centre. While the intersection is currently operating at a satisfactory LoS 'D', no spare vehicle capacity is exhibited at the site, largely due to the single lane approach northbound and the shared through and right turn lane southbound in Wentworth Road. The traffic signal site also operates under split approach phasing, adding the burden of 'inter greens' to the cycle time.

Figure ES 5 2017 Existing Conditions Summary

Source Road Delay Solutions, 2017

GROWTH FORECASTS

Investigations into the traffic impacts associated with the Victoria Street & George Street Planning Proposal have required the preparation of a mesoscopic, computer based, model.

The Bureau of Transport Statistics (*BTS*) have set the areas defining the Burwood Town Centre as Travel Zones TZ 910, 913 and 915.

The future Year trip matrices, originally produced by the *BTS* in October 2014 (*Revised in October 2016 and supplemented by the BTS Zone Explorer*), have been developed from a 4 step travel model established on forecast population and employment projections throughout the Metropolitan Area and assigned to a computer based transport network.

These trip tables form the basis for the *Netanal* future year trip demands and have been applied from the 2011 *BTS* travel zone (TZ) system, through the employment of an equivalency table, prepared and provided by the *BTS*.

The interpreted population data employed in the modelled trip matrices were drawn from TZs 910, 913 and 915 in August 2017…

→ *A residential population of 8,374 persons in year 2016 is anticipated to reach 11,714 by year 2026, being an increase of 3,340 persons,*
→ *Dwellings (homes and/or apartments) are set to reach 6,069 by 2026, an increase of 1,730 with an adopted occupancy rate of 1.93 persons, and*
→ *The current workforce of 4,353 is expected to reach 6,051 by year 2026.*

The *BTS* data has been compared with Council's approved and known developments which lie within the *BTS* Zones 910, 913 and 915. After careful consideration and assessment it has been found that the *BTS* projections adequately encompass the approved and known development within the town centre and include the Parramatta Road Urban Renewal Corridor.

The analysis also determined that the *BTS* forecast dwellings of 6,069 is in fact marginally higher than Council's current anticipated growth level achieving only 5,565 dwellings by year 2026. The *BTS* and Council growth levels are presented in the following figures.

Figure ES 6 Adopted Forecast Growth Projections

Source BTS, August 2017

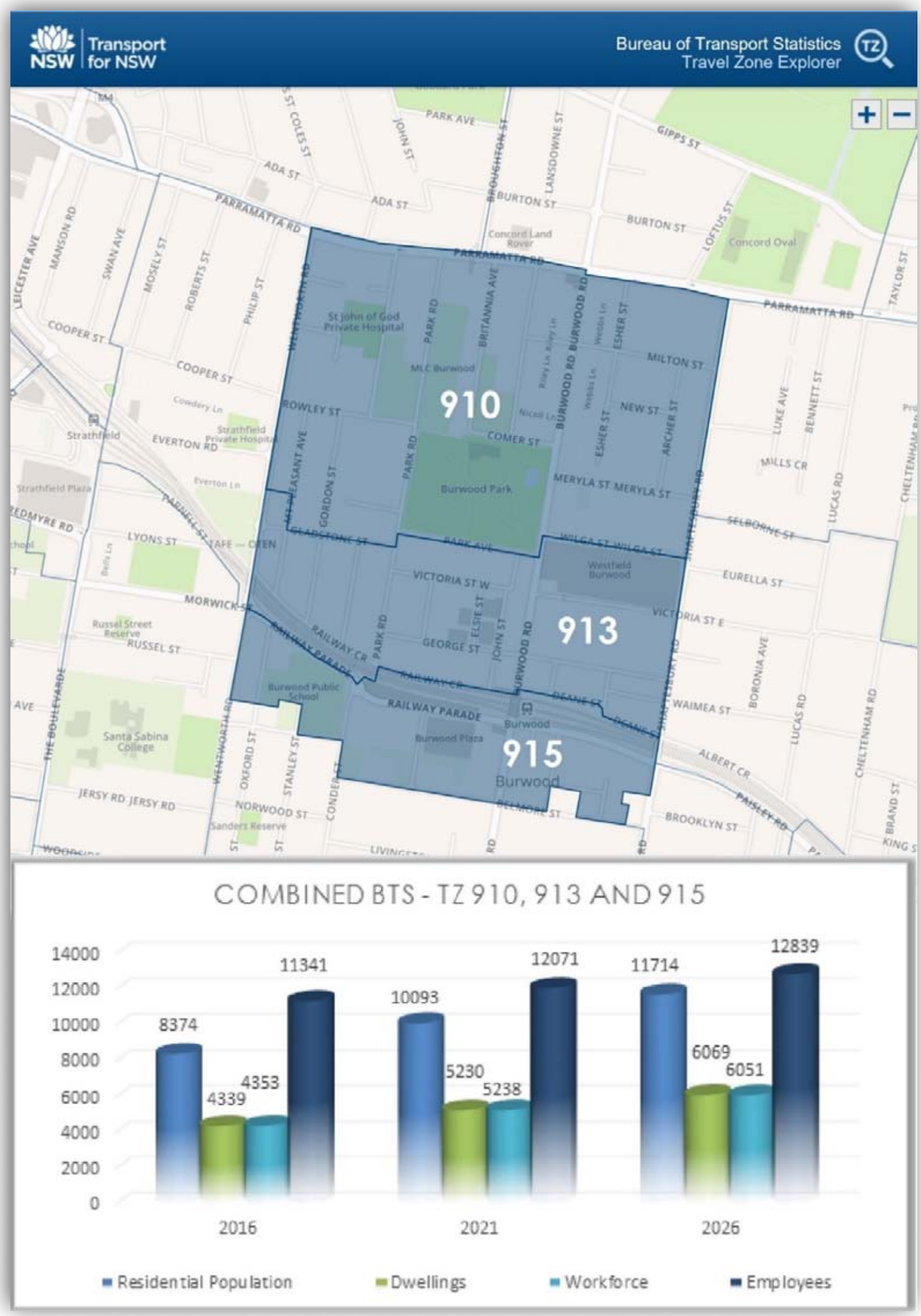


Figure ES 7 Burwood Council Approved and Planned Developments

Source Cardno, 2016

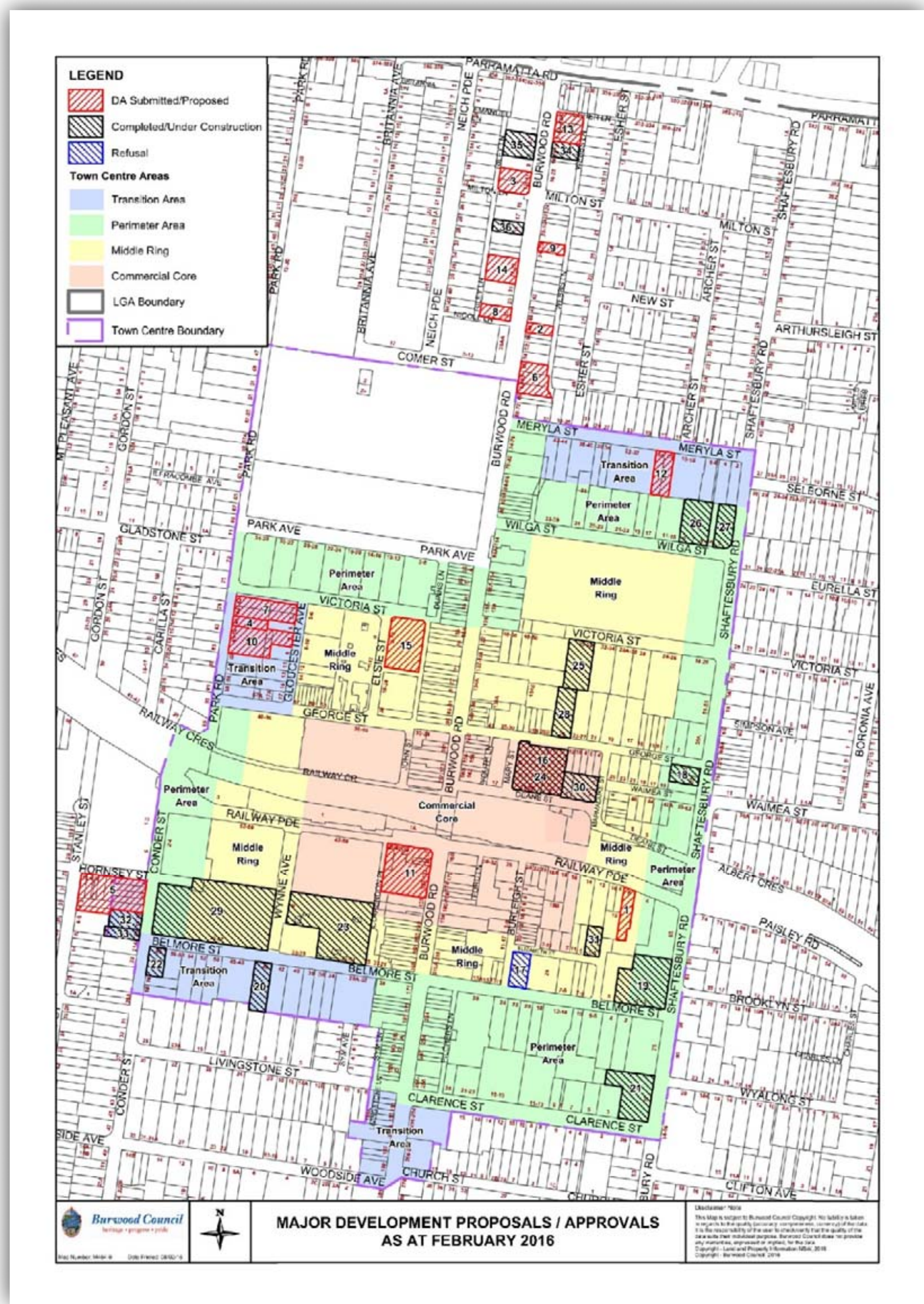
CALCULATED VEHICLE GROWTH WITHIN BTS TZ 913 and 915 PLANNED DEVELOPMENT

Identifier BTS Zone	Address	Proposed Development	Component				Generation Rate				Vehicle Generation	
			Residential Units	Retail GLFA (70% of Site Area)	Serviced Apartments	Commercial GLFA (70% of Site Area)	Residential	Retail	Serviced Apartments	Commercial	AM	PM
1 915	6 Railway Parade BURWOOD	Constructed 17 storey mixed residential flat building containing 47 residential units, 3 levels of commercial units, over 3 level of basement parking for 48 vehicles	BURWOOD CENTRAL EXISTING TRAFFIC GENERATION 2016									
2 910	48 Burwood Road BURWOOD	Construction of a 7 storey development comprising one ground floor commercial suite and twenty residential apartments over two levels of basement parking for 17 car parking spaces	20			252	0.19	0.125	0.4	0.016	8	8
3 910	11 - 13 Burwood Road BURWOOD	Construction of an 8 storey mixed use development containing commercial space, 37 residential apartments over 3 levels of basement parking for 53 vehicles	37			504	0.19	0.125	0.4	0.016	15	15
4 913	46 Park Road BURWOOD	Construction of a 5 storey residential flat building containing 14 units above basement parking	14				0.19	0.125	0.4	0.016	3	3
5 915	7 – 15 Conder Street, 2 – 10 Hornsey Street and 2 – 4 Stanley Street BURWOOD	Demolition and construction of Part 4 and 5 storey residential flat above basement parking	14				0.19	0.125	0.4	0.016	3	3
6 910	56 – 60 Burwood Road BURWOOD	Construction of 9 storey mixed use development containing 46 residential units and 1 ground floor retail suite above the basement parking	46	882			0.19	0.125	0.4	0.016	119	119
7 913	1 – 3 Gloucester Avenue and 42 – 44 Park Road BURWOOD	Construction of a 4 storey residential flat building comprising of 129 units with 2 levels of basement parking	129				0.19	0.125	0.4	0.016	25	25
8 910	35 Burwood Road BURWOOD	Construction of a 9 storey mixed use development containing ground floor commercial suites and 22 residential units above basement parking	22			420	0.19	0.125	0.4	0.016	11	11
9 910	32 Burwood Road BURWOOD	Construction of a 6 storey mixed use development containing ground floor commercial suites and 22 residential units above basement parking	22			252	0.19	0.125	0.4	0.016	8	8
10 913	7 Gloucester Avenue and 48 – 50 Park Road BURWOOD	Construction of a 5 storey residential flat building containing 42 units above basement parking	42			420	0.19	0.125	0.4	0.016	15	15
11 915	121 – 133 Burwood Road and 38 – 40 Railway Parade BURWOOD	Construction of a 20 storey mixed - use development consisting of 3 levels of retail suites, 1 level of restaurant, 7 levels containing 56 serviced apartments, 9 levels containing 68 residential apartments above basement parking	68	4200	56		0.19	0.125	0.4	0.016	560	560
12 910	18 – 20 Meryla Street BURWOOD	Construction of a 5 storey multi residential flat building containing 27 residential units, 3 commercial units and over 2 levels of basement parking for 33 vehicles	27			630	0.19	0.125	0.4	0.016	15	15
13 910	2A – 8 Burwood Road BURWOOD	Construction of a 9 storey residential flat building containing 50 residential units, over 2 level of basement parking for 67 vehicles	50				0.19	0.125	0.4	0.016	10	10
14 910	27 – 29 Burwood Road BURWOOD	Construction of a 9 storey mixed use development consisting of 46 residential units, 4 commercial premise units and 2 levels of basement car parking	46			525	0.19	0.125	0.4	0.016	17	17
15 913	2 -14 Elsie Street BURWOOD	Retention of 7 storeys commercial building and construction of 8 storey mixed use development containg 64 units and 2 reatil units above basement parking	64	945			0.19	0.125	0.4	0.016	130	130
16 913	9 - 15 Deane Street and 18 - 20 George Street BURWOOD	Construction of 3 storey residential flat building above basement parking	12				0.19	0.125	0.4	0.016	2	2
		TOTALS	**613**	**6027**	**56**	**3003**					**940**	**940**
		BYS TZ 910	**270**	**0**	**0**	**2583**					**1873**	**1873**
		BTS TZ 913	**261**	**945**	**0**	**420**					**150**	**150**
		BTS TZ 915	**82**	**4200**	**56**	**0**					**563**	**563**

1. *The above excludes the Burwood Plaza Redevelopment.*
2. *Retail and commercial GLFA has been calculated as 70% of the total site area.*

Figure ES 8 Burwood Town Centre Development Opportunity

Source Burwood Council, 2016



Traffic Generation

All projected traffic generation rates applied to the developments within the town centre were based on the industry standard *RMS Guide to Traffic Generating Developments*.

Based on the RMS's *Technical Direction TDT 2013/04a* entitled *'Guide to Traffic Generating Developments Updated Traffic Surveys'*, hereby referred to as the '*guide*', the Victoria Street & George Street development will generate 2,137 vehicle trips daily, with some 625 vehicle trips, including heavy vehicles, occurring during the morning and evening commuter peak periods, combined.

The applied annual growth rate is considered to be a conservatively high estimation within the study area given that the town centre is already well established, with Burwood Road operating near or at capacity during the commuter peak periods. Expectations are that with no change to the road network the reported growth on Burwood Road from the year 2026 '*Do Nothing*' model, vehicular growth within the study area will remain low, with vehicles utilising the spare capacity on competing parallel routes.

Traffic Distribution

The traffic distribution through the town centre has been drawn from numerous sources.

Commuter, residential and commercial land use distribution has been based on the applied year 2026 *BTS* trip matrices, published in 2014 and revised by the *BTS* in October 2016, while the retail traffic distribution has been determined by a catchment analysis of simillar mixed use operations.

Figure ES 9 Proposed Vehicle Generation

Source Road Delay Solutions, 2017

VICTORIA TOWERS VEHICLE GENERATION TABLE

Development Component	Area (Units &/or GLFA m^2)	Area (Units &/or GFA m^2)	Daily RMS Trip Rate	AM Peak Hour GLFA RMS Trip Rate/m^2	PM Peak Hour GLFA RMS Trip Rate/m^2	PM Peak Hour GLFA RMS Trip Rate/m^2	AM Peak Hour Generation (vph)	PM Peak Hour Generation (vph)	WE Peak Hour Generation (vph)	AM Outbound Trips (vph)	AM Inbound Trips (vph)	PM Outbound Trips (vph)	PM Inbound Trips (vph)	WE Outbound Trips (vph)	WE Inbound Trips (vph)
Residential Apartments	436		1.52	0.19	0.15	0.1	83	65	44	66	17	13	52	24	20
1 Bed Apartments	103														
2 Bed Apartments	280														
3 Bed Apartments	53														
Retail Specialty Shops*	3,202	4,447	0.3403	0.059	0.059	0.075	189	189	240	85	104	104	85	132	108
Commercial	4,270	5,849	0.11	0.016	0.012	0.001	68	51	4	10	58	44	8	3	2
TOTAL			**2,222**				**340**	**306**	**288**	**162**	**179**	**161**	**145**	**159**	**129**

**The Specialty Shops Generation rate is based on RMS Technical Direction TDT 2013/04a for the highest weekday generation - 5.9vph/100m2 of GLFA.*

The retail GLFA excludes common areas such as walkways, garbage holding room(s), unoccupied lobby areas and the shared stock storage provisions.

THE FUTURE YEAR MODELS

The future year 2026 models were run against three differing infrastructure scenarios to appreciate and compare the impacts associated with the Victoria Street & George Street development site and Council's proposed Section 94 infrastructure. These include…

- → *2026 'Do Nothing' - The future growth run on the current 2016 road network,*
- → *2026 Section 94 Model – The developed 2026 road network including the Section 94 infrastructure improvements with the future year 2026 traffic demands, excluding the Victoria Street & George Street development traffic, and*
- → *2026 Development Model – The 2026 Section 94 road network including proposed infrastructure and traffic generation from the Victoria Street & George Street development.*

2026 Base Year 'Do Nothing' Model

Year 2026 was nominated as the future assessment year which is conventional practice for this form of mixed use development. The year represents a practical timeframe within which some confidence in the understanding of likely development levels and prevailing traffic patterns can be made.

The future year 2026 model was run on the current 2017 road network to develop an understanding of the likely traffic impacts the general metropolitan growth, and the planned Burwood town centre developments (*excluding Victoria Street & George Street*), would have on the traffic network.

The Metropolitan arterial road network screen lines, including Parramatta Road and the Hume Highway, report an average growth in vehicular traffic of some 13.8% to year 2026.

Figure ES 10 Model Projected 10 Year Vehicle Growth

Source Road Delay Solutions, 2017

AVERAGE PROJECTED VEHICLE GROWTH TO YEAR 2026			
Road	AM PEAK	PM PEAK	WEEKEND PEAK
Burwood Road	7.8%	7.6%	8.7%
Shaftesbury Avenue	15.3%	12.6%	9.2%

The reported growth on Shaftesbury Road is greater than that on Burwood Road and suggests that the congested state of Burwood Road will be unattractive to motorists until such time as capacity constraints are reduced or eliminated.

It is apparent that with the anticipated metropolitan growth, Burwood Road will operate, at a LoS ‘E’. Anecdotally, it can be supposed that Burwood Road is operating at or near its theoretical capacity and will allow for no further growth in vehichular traffic while the competing parallel route of Shaftesbury Road remains a viable option for motorists.

It is considered that the level of congestion reported on Burwood Road is acceptable as it reduces the speed of vehicles within a highly pedestrianised town centre while reducing the attractiveness of the route to through traffic.

2026 Section 94 Infrastructure Model

The second scenario model of the Year 2026 was prepared inclusive of...

- → *The BTS growth rates,*
- → *Stage 1 of the West Connex project (M4 East – Homebush Bay Drive to Pomeroy Street/Tunnelled Pomeroy Street to City West Link Road), which is scheduled for opening in 2019, and*
- → *Burwood Council’s Section 94 Infrastructure Plan.*

Figure ES 11 Westconnex Stage 1 M4 East – M4 to City West Link Road

Source http://www.westconnex.com.au, 2017

The Section 94 infrastructure plan and anticipated implementation dates include...

- → *Future signalised right turn movement from Burwood Road, southbound, into Belmore Street, westbound, (2016-2018),*
- → *Upgrade to the signalised intersection at Burwood Road and Railway Parade, (2016-2018),*

- → *New traffic signals at the intersection of Railway Parade and Conder Street, (2016-2018),*
- → *Widening of Railway Parade east of Burwood Road (2024-2027),*
- → *New mid-block traffic signals in Wynne Avenue (2012-2015),*
- → *New traffic signals at Belmore Street and Wynne Avenue (2012-2015),*
- → *New traffic signals at Belmore Street and Conder Street (2012-2015),*
- → *Widening of Railway Parade adjacent to Victoria Street & George Street (after 2035),*
- → *Streetscape upgrades in Belmore Street, Conder Street, Wynne Avenue (2012 - after 2020), and*
- → *Shared zones in Conder Street and Clarendon Place (2016-2018).*

The intention of this model is to adopt the Section 94 infrastructure measures, as proposed by Council, and report the road network operation under the demands of year 2026 growth.

The Section 94 Infrastructure Plan outlines provision for modification to the Burwood Road intersection with Railway Parade. After dicussions with Council it is intended to retain the current movement conditions including the right turn from Burwood Road, southbound, into Railway Parade under the plan.

It has been reported from the modelling that with the introduction of the Section 94 improvements, the operational performance of Burwood Road, both northbound and southbound will operate at a LoS ‘E’, further consolidating the view that Burwood Road is operating at capacity and the competing parallel route of Shaftesbury Road remains a viable alternative path into and out of the town centre, with motorists utilising side street entry to the centre (Burwood Road) and access to the available parking provisions.

Under the Section 94 Infrastructure Plan the introduction of traffic signals in Shaftesbury Road at George Street will provide for improved access onto Shaftesbury Road, particularly right turn vehicles from George Street. The introduction of signalised pedestrian crossings at the proposed signal site will improve community mobility and safety while facilitating access to the retail and commercial activity on Burwood Road.

Modelling supports Council’s view that the Burwood Road intersection with Railway Parade and also with Belmore Street, should be retained in their current form as no significant improvement is reported with the relocation of the right turn movement, southbound, in Burwood Road from Railway Parade to Belmore Street, as reported in the body of this document.

2026 Victoria Street & George Street development Model

The third scenario model of the Year 2026 includes the impacts of the Victoria Street & George Street development.

The Victoria Street & George Street development model was specifically constructed to shape the necessary mitigation treatments to sustain the planned growth levels within the immediate Burwood town centre and surrounds. The model addresses the following objectives...

→ *The minimisation of impacts from development generated traffic on Burwood Road, Shaftesbury Road and local streets,*

→ *The optimisation of traffic operations on Burwood Road during the commuter peak periods within the current road reserve constraints,*

→ *To maintain and/or improve pedestrian mobility and safety within the study area, and*

→ *Realise a traffic management outcome which retains a level of amenity while allowing further development necessary for economic growth within the retail and commercial sectors of the town centre.*

The major input parameters incorporated in the 2026 Victoria Street & George Street development model, comprise...

→ *The introduction of committed road network infrastructure improvements outlined in Burwood Council's Section 94 Plan,*

→ *Trip matrices for the AM, PM and WE peak periods encapsulating the planned growth levels to year 2026, as defined by the BTS, within the Metropolitan Area, and the BTS TZ 910, 913 and 915 for the town centre,*

→ *The introduction of traffic generation associated with the Victoria Street & George Street development, via the proposed access locations on Victoria Street and George Street, and*

→ *A general 3% increase in pedestrian traffic associated with the population growth within the Burwood town centre.*

To achieve the objectives of this assessment, it was necessary to consider a number of treatments, including several from the Section 94 Infrastructure Plan, which will meet the amenity and capacity objectives associated with the Victoria Street & George Street development.

Figure ES 12 2026 Victoria Street & George Street Development Model – Road Network Treatment Options

Source Road Delay Solutions, 2017

Identifier	Proposed Road Network Component	Priority in Relation to Burwood Towers Development	Reasoning
1	Widening of pedestrian crossings to 5m at select locations.	Medium	To increase the pedestrian capacity and attempt to reduce the incidence of demand for the pedestrian 'WALK' during each cycle.
2	Retention of right turn for all vehicles, SB on Burwood Road at Railway Parade.	High	Afford buses access to the stops in Railway Parade on the northern side of Burwood Plaza.
3	Introduction of a pedestrian 'scramble' phase.	High	A pedestrian 'scramble' phase will reduce the impacts of pedestrian movements on the SB left turn movement in Burwood Road.
4	Introduction of traffic signals at Shaftesbury Road and George Street.	High	Right turn delays from George Street onto Shaftesbury Road require the signalisation of the site. Improved pedestrian access to the proposed retail component of the development by local patrons.
5	Signalisation of Burwood Road intersection at Victoria Street East. Buses Only RT movement from Burwood Road NB (Interim measure).	Low	Necessary to formalise both bus and pedestrian movements. Intended to reduce the incidence of 'J' walking across Burwood Road.
6	`Increased capacity at the intersection of Shaftesbury Road and Wilga Street by developing and introducing... ** A shared through and left turn lane NB in Shaftesbury Road,* ** A corresponding 80m kerbside departure lane, and* ** An 80m long RT bay SB in Shafesbury Road.*	High	The Wilga Street intersection currently has capacity constraints with only a single lane NB on Shaftesbury Road limiting the potential growth of traffic with development. Widening is necessary to sustain the Towers and Burwood RSL developments.

The development vehicle generation has been applied to the year 2026 trip matrices. The operational modelling reports a LoS 'E' for the morning, evening and weekend peak periods.

Detailed assessment of each key intersection and the town centre route was undertaken to determine the impact on average vehicle delay, level of service and the resultant queue lengths.

The mesoscopic modelling and select link analysis indicates that with the addition of the Victoria Street & George Street and Burwood RSL traffic generation, Burwood Road southbound traffic volumes increase by some100vph during the commuter peak periods while Shaftesbury Road reported increased flow of some 250-300vph.

PROPOSED MITIGATION TREATMENTS

Widening of Pedestrian Crossings

Consideration has been given to widening of the marked foot crossings on Burwood Road at…

- → *Victoria Road East,*
- → *Deane Street,*
- → *Wilga Street,*
- → *Park Avenue,*
- → *Railway Parade, and*
- → *Belmore Street.*

The measure will increase pedestrian '*throughput*', reduce pedestrian delays and may reduce the incidence of the pedestrian '*walk phase*' being called each cycle of the traffic signals throughout the day. It is considered that the pedestrian phases at the above sites will be in heavy demand during the commuter peak periods.

Widening of the crossings will also improve pedestrian mobility within the confines of the signalised crossings and may reduce the incidence of 'J' walking.

Modelling of the widened crossings was undertaken and found to reduce pedestrian delays by up to 20 seconds per person per cycle of the traffic lights.

This action may be undertaken when each signal site undergoes reconstruction.

Burwood Road and Railway Parade

A number of options have been considered and modelled for this site. The signalised intersection is currently operating a dedicated right turn phase, from the central shared lane, on Burwood Road northbound into Railway Parade, modelling indicated no significant improvement in the network operation would result from banning the movement ot all vehicles, with the exception of buses.

Reloction of the right turn phase from Railway Parade to Belmore Street yielded no significant benefit. The action reported significant increases in vehicle delay and queues for southbound motorists.

The pedestrian demand at the intersection is high and causes delay to turn movements. To eliminate this delay a '*scramble*' pedestrian phase has been analysed. By introducing the signle walk phase all left turn movements are no longer held by the movement of pedestrians.

The '*scramble'* phase is introduced as the last phase of the cycle and has been timed to coincide with the longest perpendicular walk through the intersection.

With the Burwood railway station only 170m from the Victoria Street & George Street site, the scramble walk will afford pedestrians improved connectivity and a shorter walk times with the need to perform a single crossing.

The retention of the right turn movement for all vehicles and the introduction of the scramble walk phase, the intersection reports a LoS 'D' during the week day commuter peaks and 'C' during the weekend peak.

Traffic Signals at Shaftesbury Road and George Street

The introduction of traffic signal control at the site is proposed to...

- *Facilitate safe turn movements from George Street onto Shaftesbury Road with the increase in traffic,*
- *Improve pedestrian mobility between the residential catchment to the east of Shaftesbury Road and the Burwood Railway station and retail operations at the proposed development, and*
- *Reduce the potential intrusion of traffic onto Marmaduke Street and Waimea Street.*

The proposed traffic signal operation reports a LoS 'B' during each of the modelled peak hour periods.

Traffic Signals at Burwood Road and Victoria Street East

The traffic signalisation of the Burwood Road intersection with Victoria Street East to facilitate the right turn movement northbound for buses only (Interim measure)to enable access to bus layover provisions in Victoria Street East, adjacent to the Westfield Shopping Complex.

Bus priority and a 'B' signal lantern display is proposed at the Burwood Road intersection with Victoria Street East. The bus movement is proposed to occur during the intergreen period prior to 'A' phase. The site reports a LoS 'B' during the peak periods with the linked signal offsets from Wilga Street and Park Avenue.

The area around the site has been identified as a known 'J' walking location, and with the introduction of traffic signals and the incorporation of controlled pedestrian crossings, improved pedestrian safety provisions are envisaged.

Capacity Increase on Shaftesbury Road at Wilga Street

With only single through traffic lanes on Shaftesbury Road at Wilga Street, the capacity of the traffic signal controlled intersection northbound becomes a pinch point requiring increased capacity to sustain development growth of some 300vph in the peak flow directions during the commuter peaks.

As the Victoria Street & George Street development has access from both Victoria Street and George Street, with the latter being one way, the southbound increase is not significant enough to require widening of the southbound carriageway. However, egress from the proposed development is entirely onto Shaftesbury Road and with the directional flow towards the Sydney CBD during the morning peak, the intersection reports unsatisfactory service.

The volume of through traffic, under full development of the town centre, will require the widening of Shaftesbury Road to accommodate two (2) trafficable lanes northbound and lengthening of the southbound right turn bay into Wilga Street.

CONCLUSION

Road Delay Solutions has been engaged by *VSD Developments Pty Ltd* to undertake the preparation of a Traffic Impact Assessment (TIA) in support of the Planning Proposal (PP) for a mixed use development at 28-34 Victoria Street and 23-27 George Street, Burwood, to be commonly known as '*Victoria Street & George Street*'.

Burwood is a dynamic LGA with the town centre constantly growing with planned residential, retail and commercial developments, some well into their construction phases. The Victoria Street & George Street development is just one of these.

Extensive mesoscopic and operational modelling has reported that vehicular growth, particularly along Burwood Road is relatively static and any further growth is shared with the competing routes of Shaftesbury Road and Wentworth Road. Shaftesbury Road in particular, provides a viable through traffic alternative between the Hume Highway to the south and Great Western Highway to the north, which removes pressure from Burwood Road.

This assessment has concluded that, once the proposed infrastructure outlined in Council's Section 94 Contributions Plan has been implemented, any impacts of traffic generation, both vehicular and pedestrian, is relatively benign on the town centre's road network.

A number of measures (in conjunction and additional to the infrastructure outlined in Council's S94 Plan) have been identified and assessed in unison, to sustain the movement of traffic within the town centre and support the planned level of growth anticipated with the Victoria Street & George Street development to year 2026. These works include…

- → *Widening of existing signalised foot crossings along Burwood Road between Wilga Street and Belmore Street to 5m,*
- → *General retention of the current traffic signal operations at the Burwood Road intersections with Railway Parade (including retention of the right turn movement for all vehicles southbound turning into Railway Parade) and Belmore Street,*
- → *The introduction of a 'scramble' phase pedestrian crossing at the Burwood Road intersection with Railway Parade,*
- → *The introduction of site specific access from Victoria Street and George Street,*
- → *Widening of Shaftesbury Road to accommodate two (2) through lanes northbound at Wilga Street and lengthening of the right turn bay into Wilga Street, and*
- → *The introduction of traffic signal control at the intersections of…*
  - *Shaftesbury Road and George Street, and*
  - *Burwood Road and Victoria Street East.*

In conclusion, with the introduction of the aforementioned measures, the impact of traffic generation associated with the Victoria Street & George Street development will be effectively managed while reducing the impedence to pedestrian movement.

It is recommended that the traffic measures outlined be implemented over the coming five (5) years to retain the current service and amenity levels as development occurs with the anticipated growth within the Burwood Town Centre.

The specific details and mechanism(s) by which the aforementioned infrastructure is to be implemented, shall be determined in consultation with Council and the respective stakeholders during preparation and prior to submission of any Development Application documentation.

Figure ES 13 Burwood Town Centre Intersection Operational Performance

Source Road Delay Solutions, 2017

BURWOOD TOWN CENTRE SIDRA NETWORK INTERSECTION PERFORMANCE												
	2017 Existing			2026 'Do Nothing' Base			2026 'With Section 94'			2026 Full Development		
	AM	PM	WE	AM	PM	WE	AM	PM	WE	AM	PM	WE
Burwood Road and Victoria Street East												
DS	0.156	0.182	0.165	0.158	0.275	0.231	0.171	0.206	0.186	0.44	0.752	0.525
AVD *(sec)*	1.2	1.6	1.5	1.1	1.9	1.7	1.2	1.5	1.3	11.4	15.7	11.8
LOS	A	A	A	A	A	A	A	A	A	A	B	A
Burwood Road, Deane Street and Railway Crescent												
DS	0.881	0.711	0.723	0.288	0.772	0.755	0.671	0.72	0.819	0.871	0.731	0.883
AVD *(sec)*	19.6	14	13.9	2.4	14.7	14.1	14.2	14.3	16.3	14.2	14.1	19.8
LOS	B	A	A	A	B	B	A	B	B	A	B	B
Burwood Road and Railway Parade												
DS	0.861	0.798	0.798	0.855	0.882	0.869	0.772	0.831	0.71	0.924	0.986	0.896
AVD *(sec)*	36.3	25.5	25.5	27.4	36.3	31.2	20.8	24.9	20.3	34.2	54.6	33.3
LOS	C	B	B	B	C	C	B	B	B	C	D	C
Burwood Road and Belmore Street												
DS	1.177	0.666	0.856	0.799	0.791	0.73	1.07	0.709	0.895	0.918	0.824	0.692
AVD *(sec)*	72.3	16.4	21.1	18.9	21.5	20.4	45.7	19.9	36.1	25.5	21.9	20.8
LOS	F	B	B	B	B	B	D	B	C	B	B	B
Shaftesbury Road and Wilga Avenue												
DS	0.639	0.871	0.794	1.157	0.857	0.898	0.981	0.864	0.878	1.039	0.945	0.995
AVD *(sec)*	16.5	21.3	19.6	123	21.4	32	44.2	24.7	29.7	55.8	44.5	43.7
LOS	B	B	B	F	B	C	D	B	C	D	D	D
Shaftesbury Road and Victoria Street												
DS	0.892	0.763	0.728	0.824	0.791	0.842	0.873	0.845	0.845	0.907	0.903	0.867
AVD *(sec)*	45.2	22.4	48.8	26.4	22.1	44.2	31.9	40.8	41.9	48.7	46.4	32.5
LOS	B	B	D	B	B	D	C	C	C	D	D	C
Shaftesbury Road and George Street												
DS	0.182	0.28	0.415	0.196	0.84	0.793	0.623	1.008	1.689	0.668	0.838	0.736
AVD *(sec)*	1	1.3	1.9	0.4	3.8	3.7	2.1	6.8	28	8.8	13.4	10.5
LOS	A	A	A	A	A	A	A	A	B	A	A	A
Shaftesbury Road, Railway Parade and Paisley Street												
DS	0.91	0.84	0.84	0.829	0.856	0.762	0.853	0.854	0.854	0.925	0.876	0.852
AVD *(sec)*	44.4	41.9	37.7	34.1	45.5	26.6	29.2	39.8	31.6	49.1	41.6	41.6
LOS	D	C	C	C	D	B	C	C	C	D	C	C
Wentworth Road, Railway Parade and Morwick Street												
DS	0.879	0.975	0.84	0.796	0.975	0.807	0.911	1.121	1.129	0.911	1.174	0.919
AVD *(sec)*	43.9	61.4	37.7	33	61.4	37.8	49.8	139.1	127.7	49.8	172.2	57.8
LOS	D	E	C	C	E	C	D	F	F	D	F	D
Burwood Road and George Street												
DS	0.196	0.164	0.17	0.196	0.194	0.19	0.167	0.172	0.208	0.167	0.18	0.208
AVD *(sec)*	0.7	0.7	1	0.4	0.7	0.9	1.3	1.1	1.3	1.3	1.1	1.3
LOS	A	A	A	A	A	A	A	A	A	A	A	A

Figure ES 14 Modelled Vehicle Projections

Source *Road Delay Solutions, 2017*

MESOSCOPIC MODEL HOURLY TRAFFIC VOLUME PROJECTIONS																					
	Model																				
Road Link	17AM4	26AMBTB	Variance 2026 Base Model minus Existing	26AMS94B	Variance 2026 S94 Model minus Existing	26AMBTD	Variance 2026 Towers Model minus Existing	17PM3	26PMBTB	Variance 2026 Base Model minus Existing	26PMS94B	Variance 2026 S94 Model minus Existing	26PMBTD	Variance 2026 Towers Model minus Existing	17AMWE6	26AMWEB	Variance 2026 Base Model minus Existing	26AMWESB	Variance 2026 S94 Model minus Existing	26AMWED	Variance 2026 Towers Model minus Existing
BURWOOD RD SB N WILGA ST	562	655	93	717	62	557	-5	452	609	157	442	-10	580	128	371	627	256	429	58	429	58
WILGA ST EB	386	327	-59	404	77	352	-34	541	474	-67	516	-25	549	8	581	646	65	567	-14	520	-61
WILGA ST WB	501	479	-22	583	104	544	43	472	564	92	509	37	560	88	489	511	22	564	75	550	61
PARK AVE EB	460	482	22	411	-71	388	-72	507	507	0	490	-17	586	79	536	604	68	403	-133	432	-104
PARK AVE WB	359	415	56	398	-17	367	8	349	297	-52	343	-6	269	-80	298	264	-34	311	13	266	-32
BURWOOD RD NB S PARK AVE	487	519	32	419	-100	514	27	486	602	116	464	-22	584	98	423	497	74	550	127	531	108
BURWOOD RD SB S PARK AVE	540	613	73	529	-84	518	-22	502	762	260	457	-45	797	295	496	778	282	515	19	592	96
BURWOOD RD SB N GEORGE ST	471	538	67	482	-56	461	-10	389	575	186	335	-54	629	240	346	651	305	417	71	463	117
GEORGE ST EB	84	244	160	212	-32	332	248	58	592	534	488	430	639	581	71	611	540	461	390	649	578
GEORGE ST WB W BURWOOD RD	140	98	-42	68	-30	41	-99	179	53	-126	43	-136	19	-160	106	58	-48	71	-35	37	-69
RAILWAY CRES WB	93	132	39	54	-78	135	42	56	193	137	42	-14	139	83	73	165	92	51	-22	108	35
DEANE ST WB	173	77	-96	67	-10	47	-126	216	106	-110	72	-144	109	-107	137	71	-66	86	-51	91	-46
BURWOOD RD NB N RAILWAY PDE	588	692	104	513	-179	670	82	569	826	257	545	-24	764	195	523	697	174	644	121	682	159
RAILWAY PDE EB W BURWOOD RD	428	469	41	408	-61	389	-39	395	596	201	282	-113	635	240	334	623	289	326	-8	437	103
RAILWAY PDE WB E BURWOOD RD	415	334	-81	379	45	377	-38	416	299	-117	474	58	531	115	448	313	-135	343	-105	360	-88
RAILWAY PDE EB E BURWOOD RD	341	390	49	291	-99	254	-87	411	451	40	566	155	479	68	400	435	35	362	-38	558	158
BURWOOD RD NB S RAILWAY PDE	509	511	2	382	-129	437	-72	446	555	109	362	-84	445	-1	484	585	101	354	-130	420	-64
BURWOOD RD SB S RAILWAY PDE	311	308	-3	261	-47	299	-12	312	414	102	194	-118	323	11	274	404	130	241	-33	285	11
BURWOOD CENTRAL NB	11	10	-1	11	1	11	0	12	11	-1	13	1	13	1	11	10	-1	12	1	12	1
BURWOOD CENTRAL SB	12	12	0	12	0	12	0	22	24	2	24	2	24	2	13	14	1	14	1	14	1
RAILWAY PDE EB W WYNNE AVE	369	397	28	352	-45	407	38	472	476	4	831	359	805	333	473	434	-39	584	111	660	187
RAILWAY PDE WB W WYNNE AVE	480	388	-92	870	482	605	125	607	496	-111	910	303	956	349	463	455	-8	549	86	610	147
RAILWAY PDE EB W CONDER ST	507	689	182	361	-328	959	452	516	1188	672	638	122	1149	633	573	855	282	657	84	1208	635
RAILWAY PDE WB W CONDER ST	476	997	521	986	-11	971	495	584	699	115	1041	457	1082	498	436	606	170	528	92	809	373
CONDER ST NB	239	299	60	502	203	292	53	217	221	4	376	159	220	3	202	221	19	227	25	208	6
CONDER ST SB	212	213	1	223	10	410	198	102	294	192	353	251	576	474	183	207	24	249	66	511	328
BELMORE ST EB W BURWOOD RD	231	171	-60	162	-9	180	-51	333	464	131	498	165	408	75	403	466	63	382	-21	490	87
BELMORE ST WB W BURWOOD RD	178	331	153	718	387	515	337	206	317	111	477	271	1055	849	181	308	127	466	285	870	689
BELMORE ST WB E BURWOOD RD	138	218	80	286	68	388	250	183	241	58	326	143	873	690	144	212	68	265	121	740	596
BELMORE ST EB E BURWOOD RD	132	140	8	138	-2	153	21	160	190	30	117	-43	261	101	201	196	-5	239	38	249	48
WYNNE AVE NB N BELMORE RD	128	401	273	777	376	322	194	132	485	353	712	580	533	401	117	259	142	359	242	478	361
WYNNE AVE SB N BELMORE RD	182	337	155	364	27	105	-77	168	238	70	457	289	438	270	147	227	80	171	24	222	75
CONDER ST NB S BELMORE ST	338	356	18	518	162	298	-40	193	339	146	378	185	260	67	259	326	67	237	-22	313	54
CONDER ST SB N BELMORE ST	159	297	138	190	-107	290	131	228	221	-7	162	-66	302	74	231	295	64	222	-9	359	128
BELMORE ST WB E CONDER ST	90	93	3	111	18	115	25	228	299	71	273	45	283	55	171	245	74	232	61	182	11
BELMORE ST EB E CONDER ST	197	122	-75	94	-28	123	-74	146	259	113	115	-31	226	80	245	257	12	159	-86	228	-17
WENTWORTH NB S RAILWAY	223	781	558	339	-442	157	-66	376	444	68	319	-57	256	-120	228	220	-8	415	187	212	-16
WENTWORTH SB S RAILWAY	337	513	176	467	-46	254	-83	529	853	324	662	133	403	-126	516	390	-126	576	60	398	-118
RAILWAY WB E WENTWORTH	478	1511	1033	986	-525	971	493	598	1032	434	1041	443	1082	484	440	610	170	528	88	809	369
RAILWAY EB E WENTWORTH	516	1288	772	361	-927	959	443	517	1367	850	638	121	1149	632	581	863	282	657	76	1208	627
WENTWORTH SB N RAILWAY	643	793	150	747	-46	913	270	1002	1315	313	1066	64	1275	273	851	1056	205	1075	224	1247	396
MORWICK EB W WENTWORTH	596	515	-81	257	-258	391	-205	517	687	170	548	31	454	-63	640	618	-22	396	-244	498	-142
SHAFTESBURY NB S RAILWAY	635	656	21	729	73	774	139	613	629	16	597	-16	657	44	689	674	-15	848	159	882	193
SHAFTESBURY SB S RAILWAY	541	546	5	603	57	814	273	593	700	107	758	165	1109	516	612	688	76	787	175	1285	673
PAISLEY EB E SHAFTESBURY	380	355	-25	137	-218	190	-190	443	758	315	180	-263	282	-161	346	370	24	85	-261	219	-127
PAISLEY WB E SHAFTESBURY	564	104	-460	295	191	489	-75	432	74	-358	301	-131	376	-56	440	89	-351	208	-232	422	-18
SHAFTESBURY NB N RAILWAY	797	766	-31	889	123	964	167	766	738	-28	851	85	696	-70	829	831	2	1094	265	1225	396
SHAFTESBURY SB N RAILWAY	521	820	299	662	-158	782	261	769	1294	525	801	32	1070	301	641	956	315	862	221	1173	532
RAILWAY WB W SHAFTESBURY	327	250	-77	305	55	296	-31	342	183	-159	343	1	394	52	313	197	-116	206	-107	231	-82
SHAFTESBURY SB N WILGA	682	703	21	798	95	920	238	906	846	-60	963	57	1166	260	569	492	-77	690	121	1001	432
WILGA EB W SHAFTESBURY	146	68	-78	130	62	114	-32	146	109	-37	140	-6	115	-31	119	87	-32	115	-4	125	6
SHAFTESBURY NB S WILGA	917	920	3	1071	151	1296	379	638	753	115	784	146	789	151	718	801	83	918	200	1261	543
SHAFTESBURY SB N VICTORIA	464	445	-19	622	177	669	205	917	777	-140	943	26	1116	199	536	440	-96	633	97	844	308
VICTORIA WB E SHAFTESBURY	540	668	128	624	-44	764	224	324	465	141	405	81	513	189	324	494	170	518	194	584	260
SHAFTESBURY NB S VICTORIA	831	924	93	1010	86	993	162	594	714	120	742	148	638	44	757	888	131	895	138	1155	398
VICTORIA EB W SHAFTESBURY	241	244	3	212	-32	332	91	524	592	68	488	-36	639	115	528	611	83	461	-67	649	121

TRAFFIC IMPACT ASSESSMENT

1. INTRODUCTION

1.1 Currently

Road Delay Solutions has been engaged by *VSD Developments Pty Ltd* to undertake the preparation of a Traffic Impact Assessment (TIA) in support of the Planning Proposal (PP) for a mixed use development at 28-34 Victoria Street and 23-27 George Street, Burwood, to be known as '*Victoria Street & George Street*'.

The City of Burwood Local Government Area (LGA) is situated in the inner wester suburbs of Sydney. Being some 7.26 km^2 in area, it is one of the smallest local government areas in the state and has a relatively high population density.

Bordered by Concord Council (*Parramatta Road*) to the north, Canterbury Council (*Cooks River*) to the south, Strathfield Council (*The Boulevarde*) to the the west and Ashfield Council to the east, Burwood Town Centre is approximately 12km west of the Sydney CBD.

The Town Centre consists of a dense mix of residential, retail and commercial activities. With considerable development interest and current planning proposals, there is potential for a significant increase in traffic during the already heavily congested commuter peak periods. Burwood Road, in particular, exhibits high congestion levels resulting in the increasing use of parallel routes such as Shaftesbury Road and Wentworth Road and further filtering through to the lower order east west roads such as, but not limited to, Victoria Street East, George Street, Wilga Street and Park Street.

Plans for further development under the potential in the LEP, including Victoria Street & George Street, need to address the concerns of the local community with regard to traffic and parking impacts. Measures may be required to manage traffic volumes in residential streets but also on the higher order road network whilst maintaining amenity for residents, businesses, pedestrians, cyclist and buses.

The Burwood Town Centre is identified by the Bureau for Transport Statistics (BTS) as Travel Zones (TZ) 910, 913 and 915.

Figure 1 ***BTS Travel Zones – Burwood Town Centre***

Source *Transport For NSW - BTS, 2017*

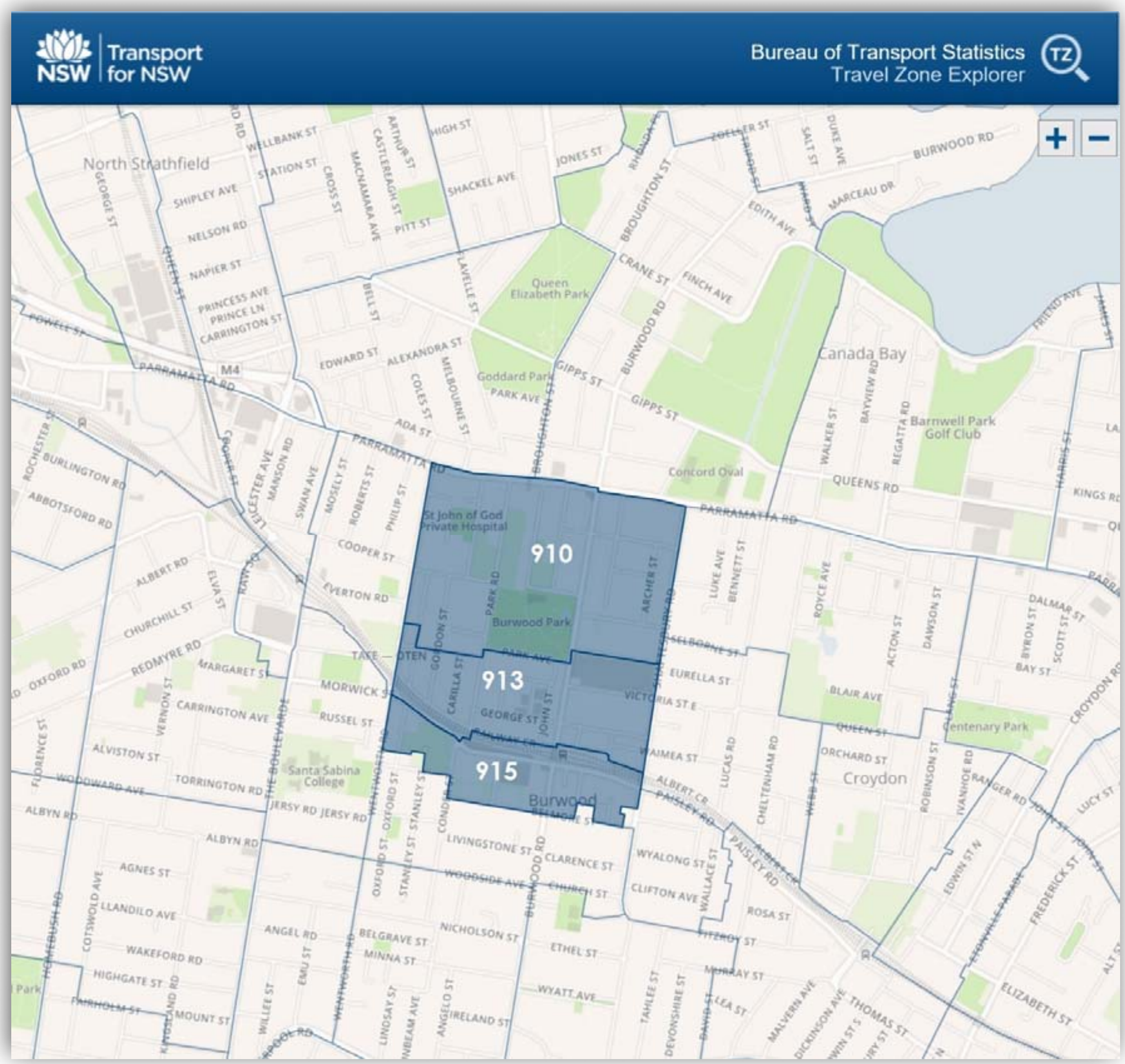


Figure 2 Looking West on Victoria Street

Source Google Street View, 2017

1.2 The Site

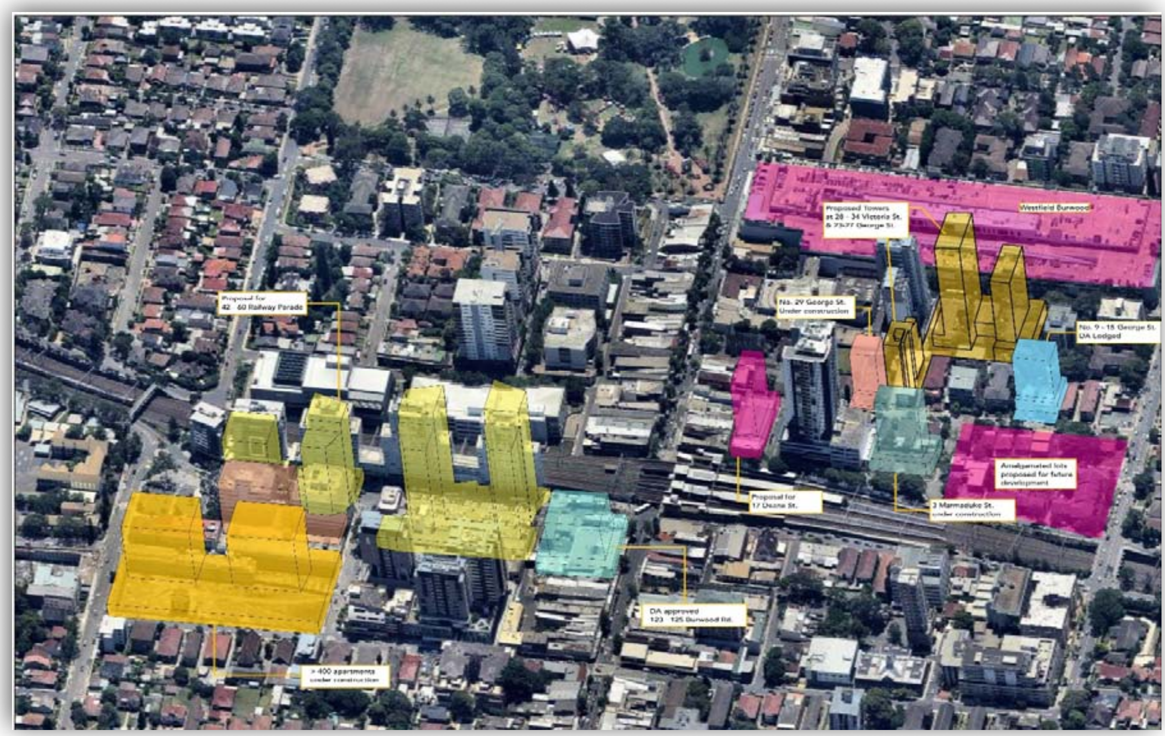
The subject site is located at 28-34 Victoria Street and 23-27 George Street,Burwood, and is situated within the City of Burwood Local Government Area (LGA). The site is segmented into two (2) major components and seamlessly integrates with the surrounding Burwood Town Centre commercial and retail activities.

The Burwood LGA is situated in the inner western suburbs of Sydney. Being some 7.26 km^2 in area, it is one of the smallest LGA's in the state and has a relatively high population density.

Situated and fronting both Victoria Street, to the north, and George Street, to the south, the site is only some 340m north of the Burwood Railway Station and 155m south from bus stops on Shaftesbury Avenue, adjacent to the Westfield Shopping Complex.

Figure 3 ***Victoria Street & George Street Site in Context***

Source *vimeo.com, 2016*



The planning proposal provides for a mixed use development including approximately…

- → *436 residential apartments,*
- → *4,447m² (3,202m² GLFA) of specialty reatail floor space, and*
- → *5,849m² (4,270m² GLFA) of commercial floor space.*

1.3 Study Purpose

The purpose of this report is to qualify the impacts and recommend the necessary traffic infrastructure and parking strategy to adequately manage the performance of the Burwood Town Centre road network under the projected cumulative demands of the proposed development and anticipated future background growth in vehicular and pedestrian traffic to the horizon year 2026.

The year 2026 is commonly utilised in the assessment of developments for which planning and growth data is readily available from various government sources.

This assessment has been predicated on a computer based mesoscopic model and Sidra operational modelling by intersection control method, focusing on the Burwood Town Centre and the operation of the road network under both existing and future conditions.

1.4 The Assessment Process

This report has adopted a four (4) tier, systematic approach to assessment of the road network operation under both the existing and anticipated future conditions. The approach taken is graphically presented below, with the key tasks outlined for each tier.

Figure 4 The Assessment Process

Source Road Delay Solutions, 2017

DATA COLLECTION AND COLLATION

- Traffic counts collected via video surveillance
- Travel time surveys
- Public transport route and frequency
- Pedestrian and cyclist demand and desire lines
- Road network feature catalogue
- Scats data
- Traffic signal design layouts
- Catalogue all future growth and development sourced from BTS Zone Explorer and Council
- Determine historic vehicle growth levels to 2016
- Catalogue of Section 96 infrastructure improvements
- Present results within the report

BASE YEAR MODEL CREATION / CALIBRATION

- Road network preparation
- Model parameter determination
- Development of year 2016 trip matices and zone allocations
- Base year 2016 model calibration and assessment
- Present results within the report

SCENARIO AND MITIGATION TREATMENT

- Development of future year 2026 trip matrices
- Future year 2026 '*Do Nothing*' mesoscopic model
- Future 2026 *Section 94* mesoscopic model
- Future year 2026 '*With Development*' mesoscopic model
- Operational Sidra assessment of intersection operation
- Determination of infrastructure requirements with development
- Pedestrian mobility strategy
- Loading dock management strategy
- Present results within the report

CONCLUSION AND RECOMMENDATIONS

- Reiterate the proposed level of development under the Planning Proposal
- Outline the impacts of the development on the road network and transport system
- Recommend a framework of infrastructure necessary to sustain the planned growth and development

2 EXISTING CONDITIONS

2.1 Road Network

The study area is generally bounded by Parramatta Road (GWH) to the north, Shatesbury Road to the east, Nicholson Parade to the south and Wentworth Road to the west.

The Burwood Town Centre is dominated by a grid like network of varying order roads. The following figure presents the current Road Hierachy as defined in Burwood City Council's (BCC) Development Control Plan (DCP).

This study focuses on a number of principle road corridors within the Burwood Town Centre, being…

- → *Burwood Road,*
- → *Shaftesbury Road,*
- → *Victoria Street, and*
- → *George Street.*

Burwood Road

Burwood Road is the primary road corridor through the Burwood Town Centre, connecting Parramatta Road in the north to the Hume Highway and Georges River Road in the south. The road generally provides a four (4) lane undivided carriageway catering for a single through lane and on street parking lane in each direction, clear of intersections.

Key intersections on Burwood Road are signalised, including Wilga Street, Park Street, Railway Parade and Belmore Street with a 40km/hr speed limit through the town centre.

Shaftesbury Road

Shaftesbury Road is a major collector road with a four lane carriageway (two lanes in each direction) between Victoria Street and George Street.

On street parking is not permitted through this section and the sign posted, regulated, speed limit is 50km/hr.

Carrying a significant traffic load, Shaftesbury Road serves as a significant north south corridor providing access to the Westfield Shopping Complex and Burwood RSL. It is used by locals to avoid congestion on Burwood Road and as such, currently exhibits modest vehicle delays of some 55 seconds during the peak commuter periods at the signalised intersections between Railway Parade in the south to Wilga Street in the north.

Victoria Street

Railway Parade runs parallel to and south of the railway line, through the town centre. It forms part of a connection between Croydon and Ashfield in the east and Strathfield in the west. Providing a four lane carriageway, with two traffic lanes in each direction, Railway Parade accommodates bus stops on both sides of the carriageway, including indented bus bays on the northern side in close proximity to Burwood Central.

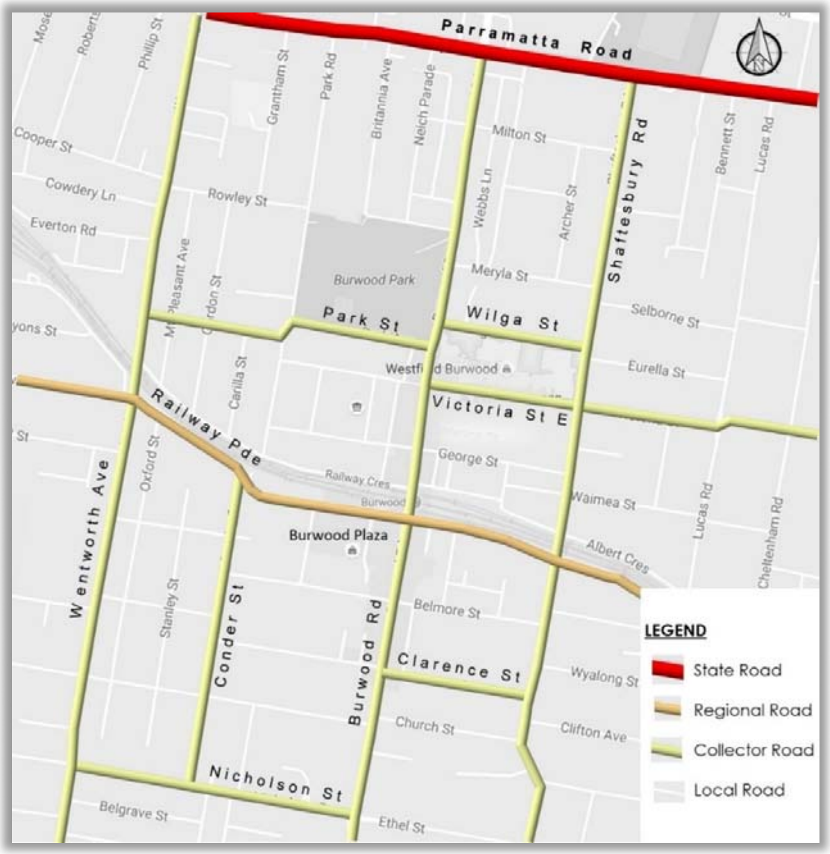
George Street

George Street between Burwood Road and Shaftesbury Road is a local road with single lane midblock capacity allowing one-way traffic only, adjacent to the development site. The road is predominantly residential and experiences high pedestrian activity. On street parking is permitted on the southern side and is time restricted. The sign posted speed limit is 40km/hr.

The intersection with Shaftesbury Road, which is sign priority controlled (Giveway), allows for both left turn and right turn movements from George Sreet. The right turn movement from George Street currently reports a LoS ‘C’ but as congestion builds and gaps diminish in the traffic flows during the commuter peak periods on Shaftesbury Road, alternate options are utilised by motorists desiring to travel south. A number of motorists elect to utilise Marmaduke Street and either proceed to Waimea to perform a priority controlled (Giveway) right turn onto Shaftesbury Road or alternatively, turn right from Marmaduke Street onto Deane Street and proceed south via Burwood Road. The alternative routes via Marmaduke Street will be available to the proposed southbound development traffic.

Figure 5 ***Road Hierarchy***

Source *BCC DCP, Amended 2015*



Observations made during the peak periods indicate that a number of intersections in the town centre are operating near capacity during the commuter peak periods, particularly along Burwood Road.

The vehicle delays observed on Burwood Road, between Victoria Street to the north and Clarence Street to the south, are the result of…

- *The short distances between intersections, in close proximity to the railway station,*
- *The incidence of pedestrian demand on cycle times and the occurance of the pedestrian 'walk' in each cycle,*
- *Buses stopping,*
- *The impacts of on street parking manouveres including drop off and pick up,*
- *The single lane southbound approach prior to George Street, and*
- *The lack of a dedicated right turn lane, southbound (existing shared through and right), at the Railway Parade intersection resulting in queueing back to the north through the preceding intersections.*

Sidra analysis suggests that each intersection, in isolation opearate within their respective vehicle capacities. However, with the shared right turn and through movement from the centre lane at the Railway Parade intersection and the single lane mid block constraints imposed by on street parking, queueing has been observed both northbound and southbound along Burwood Road through the town centre.

In conjunction with the capacity constraints, pedestrian demands have an impact on the timing offsets between subsequent signal sites.

These delays are typically inherent within built up town centres and are to be expected. Anecdotally, such vehicle congestion generally results in reduced vehicle speeds which may be conducive to improving pedestrian safety and reducing the severity of any occurring accidents while providing an unattractive route for through traffic.

The vehicle volumes on the competing parallel routes of Wentworth Road and Shaftesbury Road would appear to have increased more significantly than those on Burwood Road over the past years. Shaftesbury Road, in particular, reports a vehicle growth of approximately 10.3% over the past ten (10) years growing from some 1,652vph in 2000 to 1,825vph in 2016.

Site observation indicates that the Westfield Burwood is one of the largest attractors within the town centre and that some 80% of vehicles arriving at the shopping complex do so from Shaftesbury Road. Conversely, 78% of vehicles were recorded leaving the complex via Shaftesbury Road.

2.2 Public Transport Provisions

Rail

Burwood Town Centre delivers significant public transport choice with the Burwood Railway Station located centrally within the centre and numerous bus services to the Sydney CBD and regional centres.

Sydney Trains offer services from Burwood Railway Station to the Sydney CBD operate at 9-10 minute intervals, daily, with a trip duration of some 12 minutes.

The station services the following rail lines…

- → *T1 North Shore Line (Berowra to Parramatta via the Sydney CBD)*
- → *T1 Northern Line Hornsby and Epping to Sydney CBD via Strathfield),*
- → *T1 Western Line Emu Plains and Richmond to the Sydney CBD), and*
- → *T2 Inner West and South Line Campbelltown to the Sydney CBD via Granville).*

Council have outlined desired upgrades to the Burood Railway Station which is to focus on functional Urban design and capabilities. It is envisaged these changes, combined with the State Government's commitment to increase the capacity of the rail network by some 60% under the Long Term Master Plan to 2021 should ensure the station's capacity to manage the anticipated Burwood Town centre growth levels to year 2026.

Bus

Local bus services are provided by Sydney Buses. These services link Burwood with surrounding areas. There are major bus stops on Railway Parade adjacent to the site, at Burwood station, as well as other stops on Burwood Road. Bus services provide links to surrounding areas and include…

- → *Route 407: Burwood – Strathfield,*
- → *Route 408: Burwood – Rookwood Cemetery,*
- → *Route 415: Campsie, Strathfield, Burwood, Chiswick,*
- → *Route 458: Burwood, Strathfield, Rhodes, Ryde,*
- → *Route 461: Burwood, Parramatta Road, city, Domain,*
- → *Route 463: Burwood, Bayview Park,*
- → *Route 466: Cabarita, Burwood, Strathfield, Ashfield,*
- → *Route 490: Drummoyne, Burwood, Kingsgrove, Hurstville,*
- → *Route 492: Drummoyne, Burwood, Kingsgrove, Rockdale,*
- → *Route 525: Parramatta, Newington, Burwood, and*
- → *Route 526: Sydney Olympic Park Wharf, Newington, Strathfield.*

A bus layover can be defined as a holding location for terminating bus services where buses may park before commencing a scheduled run. While Burwood Town Centre generally provides informal bus layover areas, currently Sydney Buses utilise on street, kerb side, availability in Victoria Street East, Shaftesbury Road, Railway Parade and Victoria Street.

Figure 6 ***Extract from Council Media Release Burwood Railway Station***

Source *Burwood City Council, 2005*

MEDIA RELEASE **30 November, 2005**

BURWOOD COUNCIL

heritage ■ progress ■ pride

Burwood Station upgrade plan provides direction for city renewal

Council plans for the much-needed upgrade of Burwood Railway Station, with a strong focus on functional urban design, will set the benchmark for future development in the Town Centre.

In a briefing to the Burwood Chamber of Commerce today, Burwood Mayor John Faker outlined proposed concept development plans for the Railway Station which would contribute to the existing and future built form of the Town Centre.

The plans maximise opportunities for public space and public domain improvements, as well as improve the accessibility and safety of commuters.

Highlights of the Railway Station development plan commissioned by Council include:

- Relocation of the major east-west pedestrian crossing of Burwood Road from Railway Parade corner to align with station concourse;
- Opening up existing concourse area to general north-south pedestrian movement;
- Creation of a new public open space to the north of the station;
- Relocation of the main station entry to the northern side;
- Creation of new space under tracks for retail and ticketing facilities;
- Doubling the access points to platforms via stairs and lifts;
- Creation of a new public open space north of the Post Office to a landscaped area with café;
- New pedestrian underpass lined with retail outlets under Railway Parade and Burwood Road linking Station with Post Office area and Burwood Hotel;

Further Highlights of public domain plans also include proposed conversion of Deane Street (on the northern boundary of the Station) into a pedestrian mall, and the creation of a bus/taxi interchange nearby.

Cr Faker said Council commissioned the plans in 2004 to illustrate the integration of a preferred upgrade option for the Burwood Town Centre.

"Council has done all the hard work in planning for this vital upgrade. All that's needed now is for the State Government to approve them and agree on a funding mechanism to make it happen.

2.3 Pedestrians and Cyclists

The Burwood Town Centre typically accommodates high pedestrian activity with the railway station being one of the main focal points. Just over 50% of residents within the town centre utilise rail as their transport mode for journey to work (JTW).

With a residential workforce of some 4,238 persons[1], 4% travel by bus to work. Combined with retail, commercial and recreational activities, pedestrian demand within the town centre is high and is catered for by generally 3.7m wide footways, unsignalised, marked, foot crossings, and signalised crossings.

Site inspections have revealed a significant level of J-walking and mid block crossing of Burwood Road between George Street and Park Avenue, signifying a potential requirement for an additional, controlled, crossing point. There are plans to signalise the intersection of Burwood Road with Victoria Street East. This will provide the needed pedestrian crossing point and reduce the incidence of J-walking.

Select location pedestrian fencing on Burwood Road and Railway Parade direct pedestrians to the correct signalised crossings.

The DCP requires all future developments within the town centre must maintain pedestrian safety, scale and amenity.

[1] *BTS Travel Zone Explorer (based on the 2011 Census Data) Bureau of Transport Statistics, 2016*

Figure 7 Burwood Road J-Walking

Source Road Delay Solutions, 2017

Figure 8 ***City Rail Network***

Source *Transport Sydney Trains, 2017*

Figure 9 ***Intercity Rail Network***

Source *Transport Sydney Trains, 2017*

Figure 10 ***Bus Network Routes 407 and 408***

Source *Transport Sydney Trains, 2017*

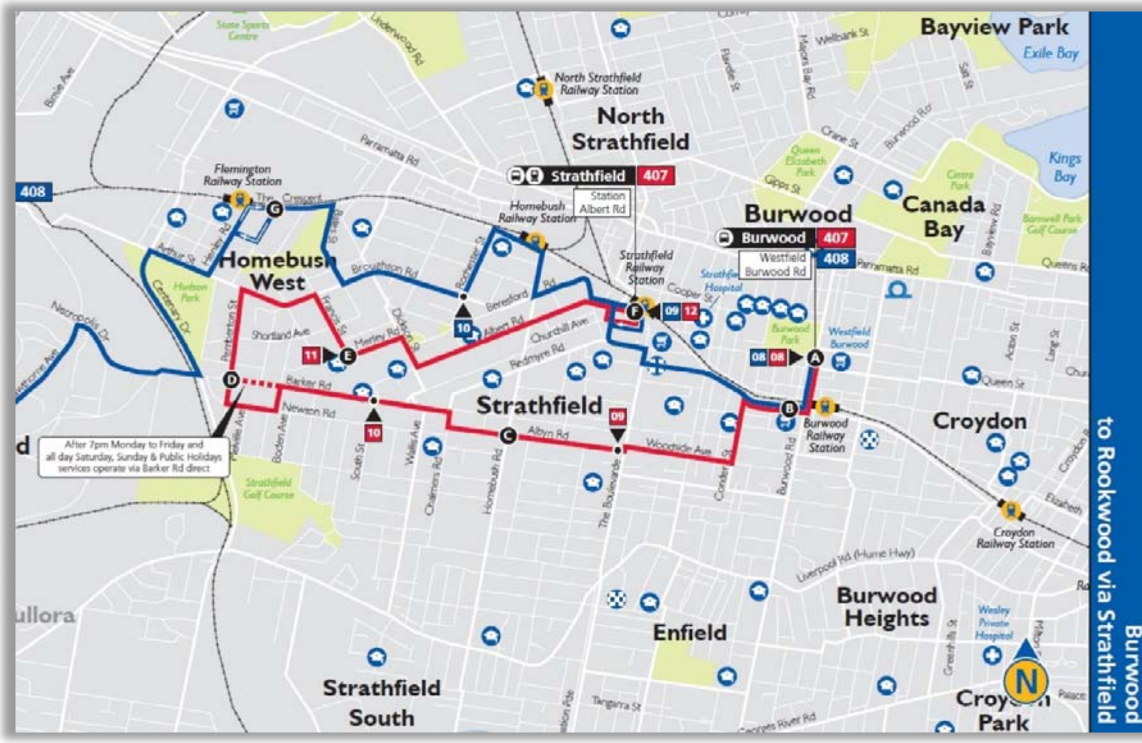


Figure 11 ***Bus Network Route 461***

Source *Transport Sydney Trains, 2017*

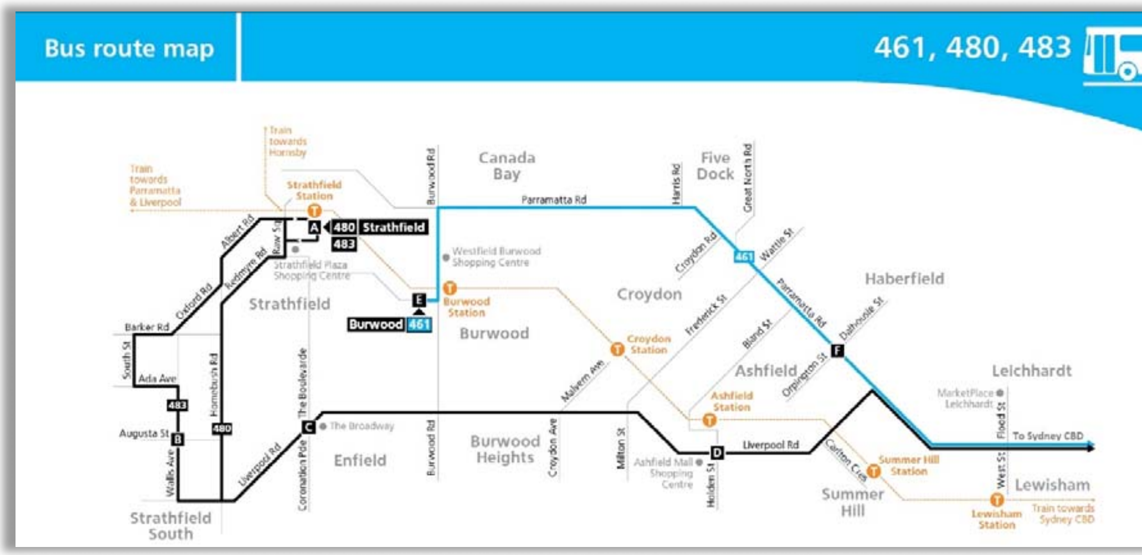


Figure 12 ***Bus Network Route 415***

Source *Transport Sydney Trains, 2017*

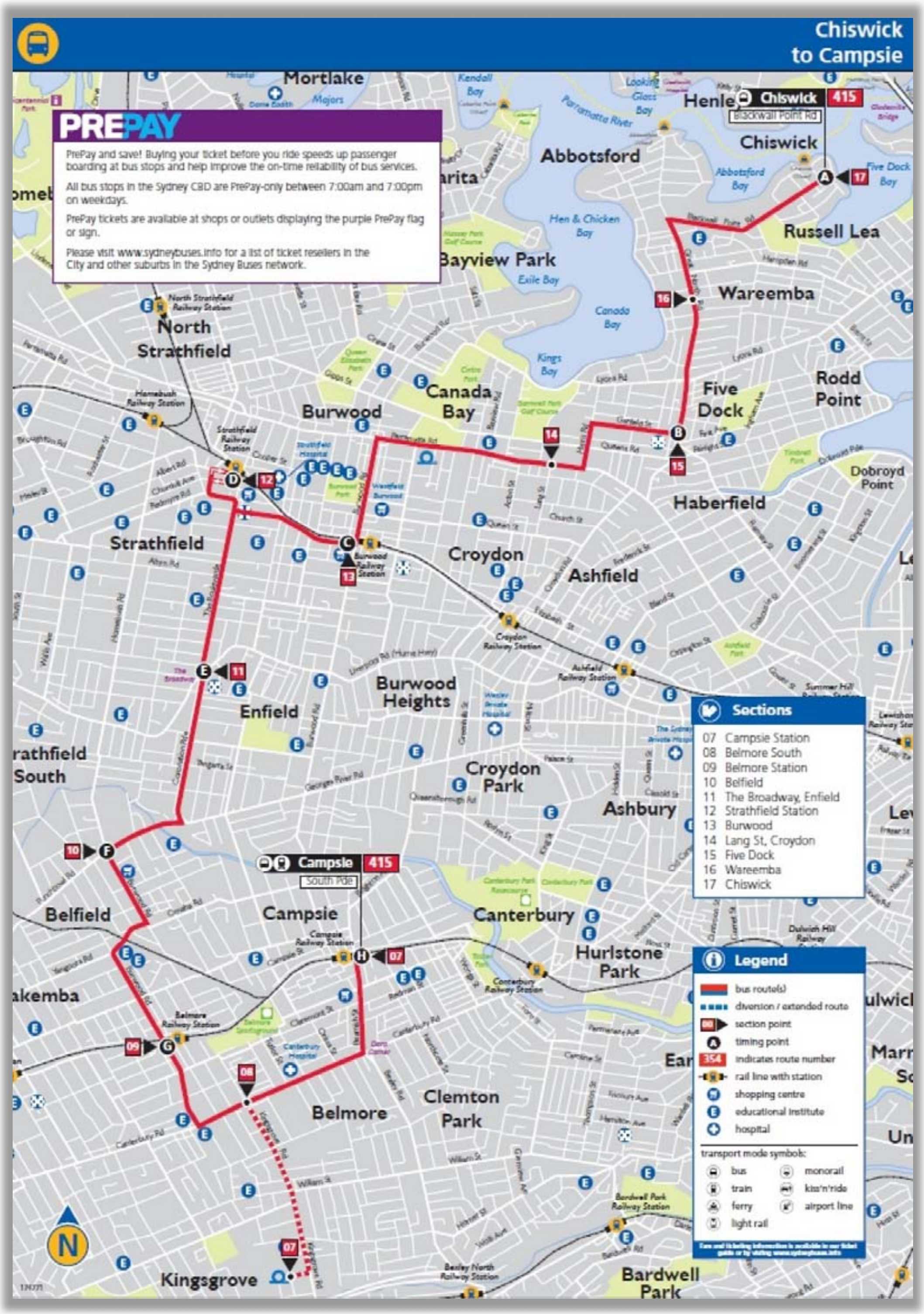
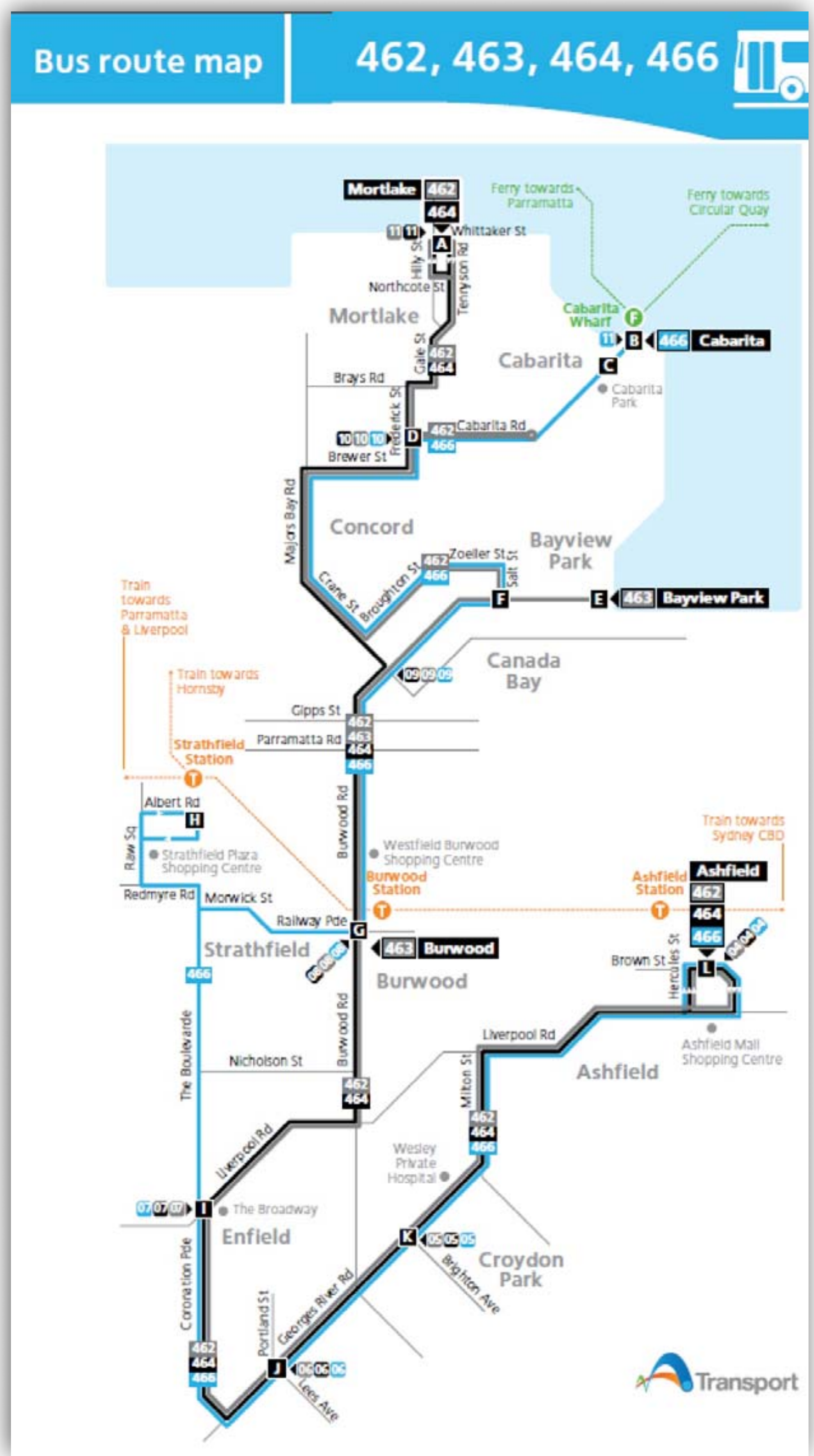


Figure 13 ***Bus Network Route 458***

Source *Transport Sydney Trains, 2017*

Figure 14 Bus Network Route 463 and 466

Source Transport Sydney Trains, 2017



2.4 Parking

Parking activities has a significant impact on the movement of traffic within the Burwood Town Centre.

Burwood Council undertook a parking survey in December 2011[2] to better understand the impacts of a newly implemented parking strategy. From the survey computer based models were developed to understand the different factors influencing parking choice in Burwood Town Centre. This study has drawn from the fore mentioned survey in appreciating the behaviour of motorists and their impacts in utilising the available town centre parking provisions.

Parking choice is provided and catered for by Council in various forms such as…

- → *The use of formalised controlled parking stations,*
- → *Free, timed on street parking,*
- → *Metered on street parking,*
- → *Metered off street car parking, and*
- → *Private property parking.*

The pursuit of parking and the associated parking manoeuvres by motorists, given the available on street parking along Burwood Road and within the side streets, impedes the movement of through traffic and increases travel times.

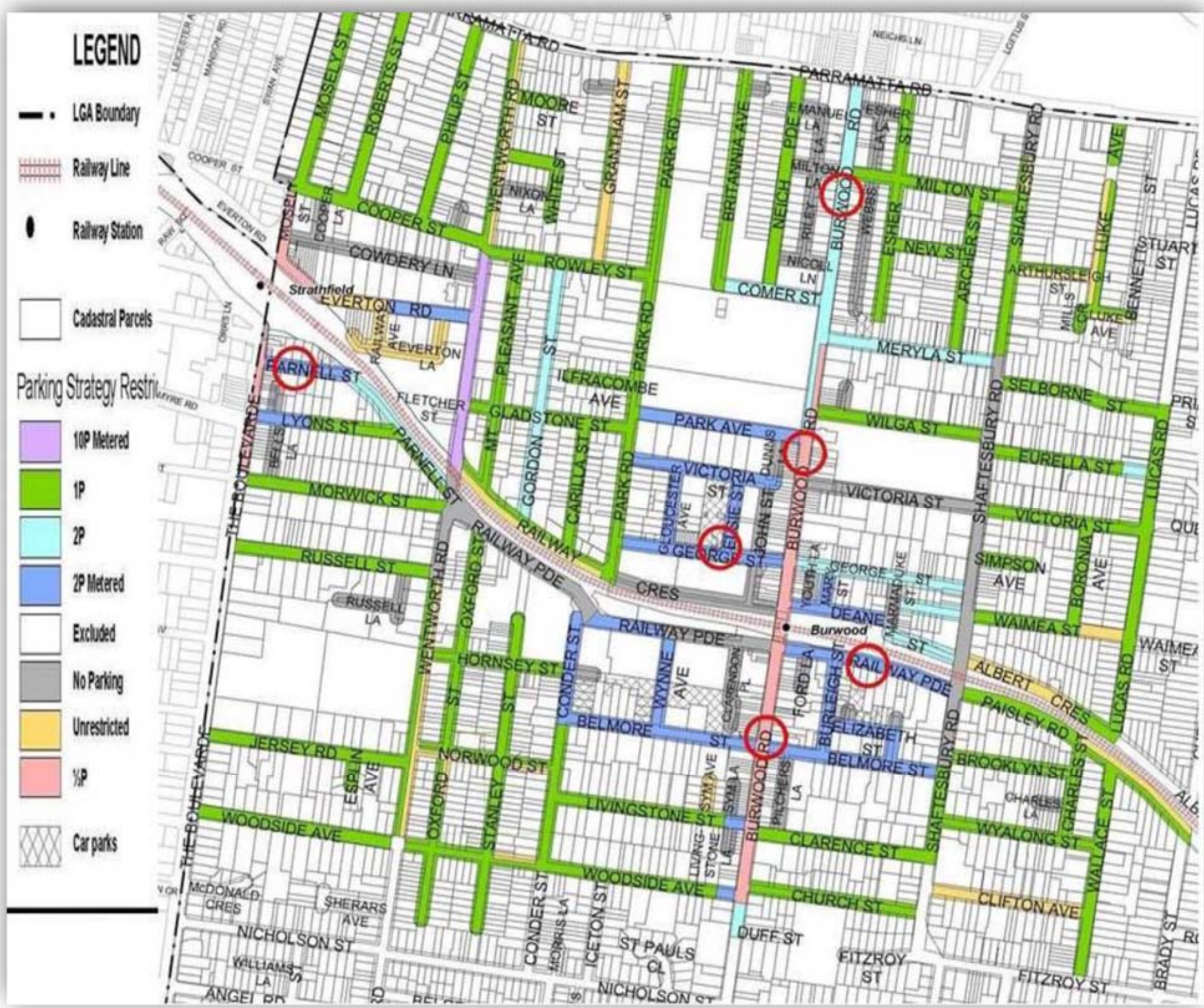
Parking cost and the proximity to rail, bus, retail and commercial services heavily influence the attractiveness of parking choice. The free on street parking in Burwood Road is consistently full and desired by motorists accessing the adjacent retail, commercial and service operations.

[2] *'Parking Behaviour of Burwood Town Centre', Alex Karki, 2015*

A catalogue of the available parking choice is presented in the following figure.

Figure 15 Burwood Town Centre Parking

Source ‘Parking Behaviour of Burwood Town Centre’, Alex Karki, 2015



DATA COLLECTION

3.1 Data Sources

A broad range of data has been collected in preparing this assessment...

- → *Traffic counts at key intersections (Austraffic, 2016),*
- → *Traffic Counts at key intersections on Shaftesbury Road ROAR Data 2017),(*
- → *Origin and destination to confirm traffic patterns (Road Delay Solutions, 2017),*
- → *Travel time surveys along Burwood Road (Road Delay Solutions, 2017),*
- → *Parking occupancy rates (Road Delay Solutions, 2017),*
- → *Bus routes and frequency (State Buses, 2017),*
- → *Train routes and frequency (Sydney Trains, 2017),*
- → *Road network catalogue (Road Delay Solutions, 2017), and*
- → *Traffic signal operation SCATS data (RMS, 2000, 2005, 2017).*

Traffic data from previous studies and papers have been utilised to derive historical growth and variations in traffic patterns within the Burwood Town Centre...

- → *'Parking Behaviour of Burwood Town Centre', Alex Karki, 2015,*
- → *'Burwood Town Centre Proposed Bus Strategy, URS, 2007,*
- → *'Burwood Town Centre Bus Strategy - Review and Analysis', Parsons Brinkerhoff, 2006,*
- → *'Burwood Town Centre Growth', Transport and Traffic Planning Associates, 2005, and*
- → *'Burwood Town Centre & Environs – Preparation of Traffic Model', Parsons Brinkerhoff, 2004.*

3.2 Traffic Counts

The existing morning (AM), evening (PM) and Saturday (WE) traffic data has been collected and collated by *Austraffic on Thursday 9 June, 2016, and Saturday 11 June, 2016*, and *ROAR Data* on Thursday 20 July 2017 and Saturday 22 July 2017, for...

- → *The weekday AM commuter peak 8:00am till 9:00am,*
- → *The weekday PM commuter peak 4:00pm till 6:00pm, and*
- → *The weekend Saturday AMWE peak 12.00 till 1:00pm.*

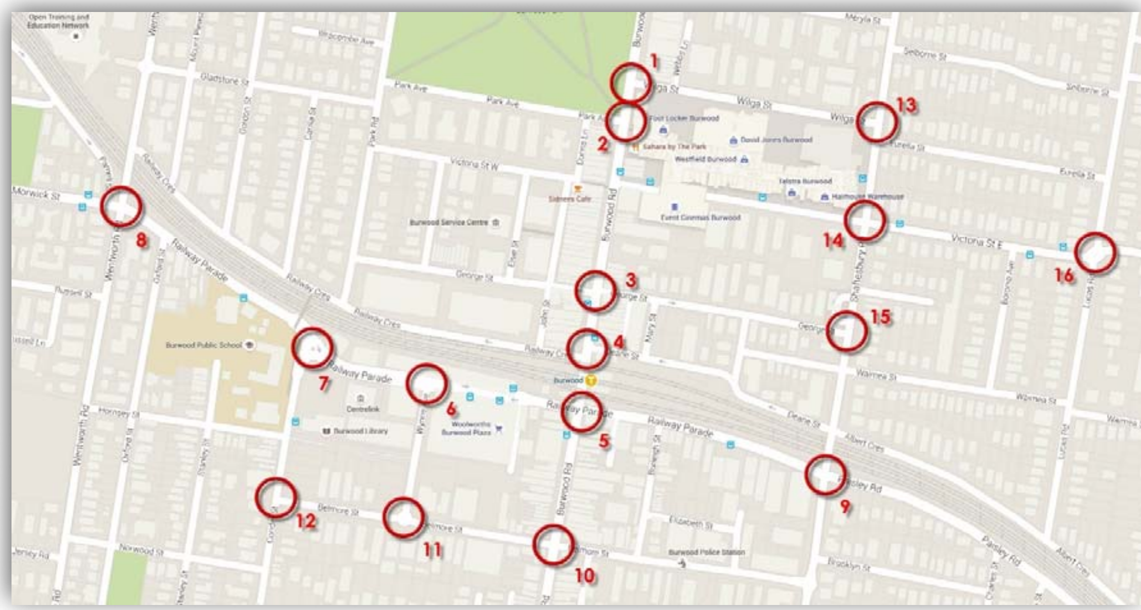
Traffic surveys were conducted over 2 hours during each peak at the following intersections...

1. *Burwood Road and Wilga Street,*
2. *Burwood Road and Park Avenue,*
3. *Burwood Road and George Street,*
4. *Burwood Road, Deane Street and Railway Crescent,*
5. *Burwood Road and Railway Parade,*

6. *Railway Parade and Wynne Avenue,*
7. *Railway Parade and Conder Street,*
8. *Railway Parade, Wentworth Road, and Morwick Street,*
9. *Shaftesbury Road, Railway Parade and Paisley Street,*
10. *Burwood Road and Belmore Street,*
11. *Belmore Street and Wynne Avenue,*
12. *Belmore Street and Conder Street,*
13. *Shaftesbury Road and Wilga Street,*
14. *Shaftesbury Road and Victoria Street,*
15. *Shaftesbury Road and George Street, and*
16. *Victoria Street, Lucas Road and Queen Street.*

Figure 16 ***Traffic Count Locations***

Source *Road Delay Solutions, 2017*



Appendix A presents the traffic survey data utilised in the coding and calibration of the base year 2017 model.

Given the nature of the trip matrix development process and traffic zone placement, the collected traffic flows had to be '*balanced*'. Typically, this consisted of minor adjustments to specific turn movements to ensure that adjacent intersections had consistent upstream and downstream volumes. These 'gains and losses' occur when vehicles leave the carriageway into individual driveways, park on street or turn into intermediate side streets between the counted intersections. This fine level of detail is, typically, not accommodated in computer based mesoscopic traffic models.

3.3 Travel Time Surveys

Travel time data was collected along Burwood Road, between Wilga Street in the north to Belmore Street in the south, on Thursday 9 June, 2016 during the morning and evening commuter peak periods and Saturday 11 June, 2016 between 11am and 1pm.

Travel time data was collected along Shaftesbury Road, between Wilga Street in the north and Clarence Street in the south, on Thursday 20 July, 2017 during the morning and evening commuter peak periods and Saturday 22 July, 2017 between 11am and 1pm.

Travel times were collected every 15 minutes over a two (2) hour period in each of the peak periods, averaged, and then compared against the modelled travel time outputs for the routes assessed…

ROUTE 1 – Burwood Road Northbound

- → *Belmore Street northbound to Wilga Street.*
- →

ROUTE 2 – Burwood Road Southbound

- → *Wilga Street southbound to Belmore Street.*
- →

ROUTE 3 – Shaftesbury Road Northbound

- → *Clarence Street northbound to Wilga Street.*
- →

ROUTE 4 – Shaftesbury Road Southbound

- → *Wilga Street southbound to Clarence Street.*

Figure 17 Travel Time Corridors

Source Google Maps, 2017

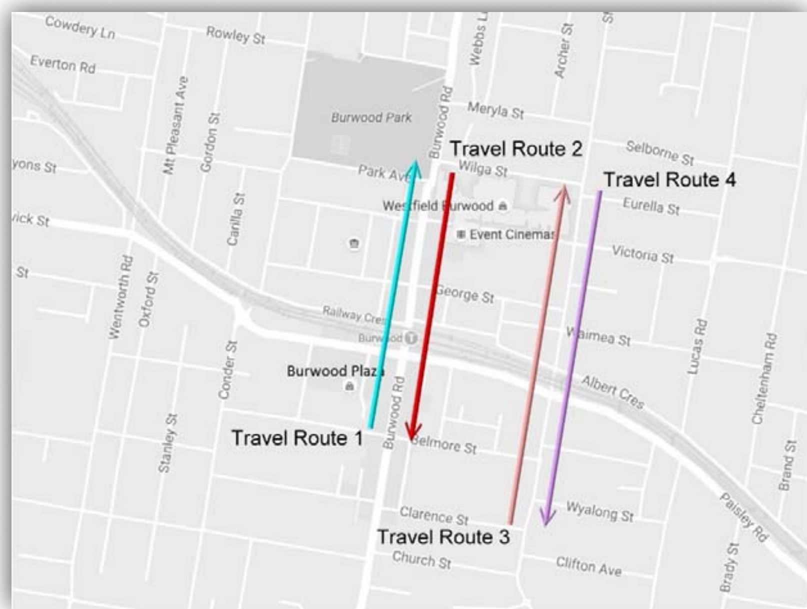


Table 1 ***2017 Calibrated Travel Route 1***

Source *Road Delay Solutions, 2017*

ROUTE 1	AVG SURVEYED TIME (minutes)	AVG SURVEYED SPEED km/hr	MODEL 16AM28 TIME (minutes)	MODEL 16AM28 SPEED km/hr	Distance km	TIME Diff %
Start Node = 8539 BELMORE STREET						
RAILWAY PARADE	0.9	10.00	0.78	11.25	0.15	-13.33%
RAILWAY CRESCENT	1.1	13.64	1.08	13.67	0.25	-1.82%
GEORGE STREET	1.3	14.77	1.17	16.29	0.32	-10.00%
VICTORIA STREET EAST	1.4	18.00	1.27	19.82	0.42	-9.29%
PARK AVENUE	1.9	16.11	1.72	17.94	0.51	-9.47%
WILGA STREET	2.0	16.80	1.77	18.94	0.56	-11.50%
TOTALS	2.0	14.89	1.77	16.32	0.56	-11.50%

ROUTE 1	AVG SURVEYED TIME (minutes)	AVG SURVEYED SPEED km/hr	MODEL 16PM23 TIME (minutes)	MODEL 16PM23 SPEED km/hr	Distance km	TIME Diff %
Start Node = 8539 BELMORE STREET						
RAILWAY PARADE	0.76	11.84	0.71	12.50	0.15	-6.58%
RAILWAY CRESCENT	1.04	14.42	0.99	15.00	0.25	-4.81%
GEORGE STREET	1.8	10.67	1.08	17.74	0.32	-40.00%
VICTORIA STREET EAST	1.2	21.00	1.18	21.44	0.42	-1.67%
PARK AVENUE	1.71	17.89	1.62	19.00	0.51	-5.26%
WILGA STREET	1.78	18.88	1.68	20.03	0.56	-5.62%
TOTALS	1.78	15.78	1.68	17.62		-5.62%

ROUTE 1	AVG SURVEYED TIME (minutes)	AVG SURVEYED SPEED km/hr	MODEL 16AMWE17 TIME (minutes)	MODEL 16AMWE17 SPEED km/hr	Distance km	TIME Diff %
Start Node = 8539 BELMORE STREET						
RAILWAY PARADE	0.77	11.69	0.71	12.50	0.15	-7.79%
RAILWAY CRESCENT	1.04	14.42	0.96	15.47	0.25	-7.69%
GEORGE STREET	1.07	17.94	1.05	18.25	0.32	-1.87%
VICTORIA STREET EAST	1.18	21.36	1.15	21.99	0.42	-2.54%
PARK AVENUE	1.71	17.89	1.59	19.36	0.51	-7.02%
WILGA STREET	1.78	18.88	1.65	20.39	0.56	-7.30%
TOTALS	1.78	17.03	1.65	17.99		-7.30%

Note The Modelled travel speeds are corrected to reflect mid block and downstream intersection vehicle delay(s) and congestion.

Table 2 ***2017 Calibrated Travel Times Route 2***

Source *Road Delay Solutions, 2017*

ROUTE 2	AVG SURVEYED		MODEL 16AM28		Distance km	TIME Diff %
	TIME (minutes)	SPEED km/hr	TIME (minutes)	SPEED km/hr		
Start Node = 10096 WILGA STREET						
PARK AVENUE	0.28	10.71	0.28	10.00	0.05	0.00%
VICTORIA STREET EAST	0.48	17.50	0.4	21.10	0.14	-16.67%
GEORGE STREET	0.54	26.67	0.5	29.14	0.24	-7.41%
RAILWAY CRESCENT	0.71	26.20	0.73	25.89	0.31	2.82%
RAILWAY PARADE	1.5	16.40	1.41	17.56	0.41	-6.00%
BELMORE STREET	1.9	17.78	1.75	19.23	0.56	-7.41%
TOTALS	1.9	19.21	1.75	20.49	0.56	-7.41%

ROUTE 2	AVG SURVEYED		MODEL 16PM23		Distance km	TIME Diff %
	TIME (minutes)	SPEED km/hr	TIME (minutes)	SPEED km/hr		
Start Node = 10096 WILGA STREET						
PARK AVENUE	0.31	9.68	0.28	12.50	0.05	-9.68%
VICTORIA STREET EAST	0.39	21.54	0.4	15.00	0.14	2.56%
GEORGE STREET	0.61	23.61	0.5	17.74	0.24	-18.03%
RAILWAY CRESCENT	0.85	21.88	0.7	21.44	0.31	-17.65%
RAILWAY PARADE	1.52	16.18	1.38	19.00	0.41	-9.21%
BELMORE STREET	1.87	17.97	1.74	20.03	0.56	-6.95%
TOTALS	1.87	18.48	1.74	17.62		-6.95%

ROUTE 2	AVG SURVEYED		MODEL 16WE17		Distance km	TIME Diff %
	TIME (minutes)	SPEED km/hr	TIME (minutes)	SPEED km/hr		
Start Node = 10096 WILGA STREET						
PARK AVENUE	0.27	11.11	0.28	10.00	0.05	3.70%
VICTORIA STREET EAST	0.43	19.53	0.4	21.10	0.14	-6.98%
GEORGE STREET	0.62	23.23	0.5	29.14	0.24	-19.35%
RAILWAY CRESCENT	0.8	23.25	0.73	26.88	0.31	-8.75%
RAILWAY PARADE	1.48	16.62	1.41	17.90	0.41	-4.73%
BELMORE STREET	1.74	19.31	1.76	19.34	0.56	1.15%
TOTALS	1.74	18.84	1.76	20.73		1.15%

Note The Modelled travel speeds are corrected to reflect mid block and downstream intersection vehicle delay(s) and congestion.

Table 3 **2017 Calibrated Travel Times Route 3**

Source *Road Delay Solutions, 2017*

ROUTE 3	AVG SURVEYED		MODEL 16AM28		Distance km	TIME Diff %
	TIME *(minutes)*	SPEED *km/hr*	TIME *(minutes)*	SPEED *km/hr*		
Start Node = 10092 CLARENCE ST						
BELMORE ST	0.27	37.78	0.25	49	0.17	-7.41%
RAILWAY PDE	0.58	26.90	0.54	28.34	0.26	-6.90%
DEANE ST	0.62	34.84	0.64	33.36	0.36	3.23%
WAIMEA ST	0.78	35.38	0.75	37.03	0.46	-3.85%
GEORGE STREET	0.81	37.04	0.79	38.3	0.5	-2.47%
VICTORIA ST EAST	1.27	28.82	1.24	29.33	0.61	-2.36%
WILGA STREET	1.4	31.08	1.35	31.92	0.72	-2.88%
TOTALS	**1.4**	**33.12**	**1.35**	**35.33**	**0.72**	**-2.88%**
ROUTE 3	AVG SURVEYED		MODEL 16PM23		Distance km	TIME Diff %
	TIME *(minutes)*	SPEED *km/hr*	TIME *(minutes)*	SPEED *km/hr*		
Start Node = 10092 CLARENCE ST						
BELMORE ST	0.21	48.57	0.2	50.00	0.17	-4.76%
RAILWAY PDE	0.64	24.38	0.62	24.60	0.26	-3.13%
DEANE ST	0.74	29.19	0.73	29.57	0.36	-1.35%
WAIMEA ST	0.82	33.66	0.83	33.35	0.46	1.22%
GEORGE STREET	0.89	33.71	0.87	34.67	0.5	-2.25%
VICTORIA ST EAST	1.32	27.73	1.29	28.31	0.61	-2.27%
WILGA STREET	1.51	28.61	1.4	30.90	0.72	-7.28%
TOTALS	**1.51**	**32.26**	**1.4**	**33.06**		**-7.28%**
ROUTE 3	AVG SURVEYED		MODEL 16AMWE17		Distance km	TIME Diff %
	TIME *(minutes)*	SPEED *km/hr*	TIME *(minutes)*	SPEED *km/hr*		
Start Node = 10092 CLARENCE ST						
BELMORE ST	0.21	48.57	0.22	50.00	0.17	4.76%
RAILWAY PDE	0.54	28.89	0.51	30.06	0.26	-5.56%
DEANE ST	0.65	33.23	0.61	35.04	0.36	-6.15%
WAIMEA ST	0.78	35.38	0.72	38.61	0.46	-7.69%
GEORGE STREET	0.8	37.50	0.76	39.86	0.5	-5.00%
VICTORIA ST EAST	1.3	28.15	1.26	28.99	0.61	-3.08%
WILGA STREET	1.48	29.19	1.37	31.58	0.72	-7.43%
TOTALS	**1.48**	**34.42**	**1.37**	**36.31**		**-7.43%**

Note The Modelled travel speeds are corrected to reflect mid block and downstream intersection vehicle delay(s) and congestion.

Table 4 ***2017 Calibrated Travel Times Route 4***

Source *Road Delay Solutions, 2017*

ROUTE 4	AVG SURVEYED		MODEL 16AM28		Distance km	TIME Diff %
	TIME (minutes)	SPEED km/hr	TIME (minutes)	SPEED km/hr		
Start Node = 4798 WILGA ST						
VICTORIA STREET EAST	0.48	13.75	0.49	13.75	0.11	2.08%
GEORGE STREET	0.61	21.64	0.59	21.87	0.22	-3.28%
WAIMEA ST	0.65	24.00	0.63	24.42	0.26	-3.08%
DEANE ST	0.79	27.34	0.74	29.39	0.36	-6.33%
RAILWAY PDE	1.18	23.39	1.14	24.26	0.46	-3.39%
BELMORE ST	1.31	25.19	1.23	26.73	0.55	-6.11%
CLARENCE ST	1.5	28.42	1.4	30.8	0.72	-7.89%
TOTALS	1.5	23.39	1.4	24.46	0.72	-7.89%

ROUTE 4	AVG SURVEYED		MODEL 16PM23		Distance km	TIME Diff %
	TIME (minutes)	SPEED km/hr	TIME (minutes)	SPEED km/hr		
Start Node = 4798 WILGA ST						
VICTORIA STREET EAST	0.44	15.00	0.45	15.00	0.11	2.27%
GEORGE STREET	0.54	24.44	0.55	23.48	0.22	1.85%
WAIMEA ST	0.68	22.94	0.64	24.34	0.26	-5.88%
DEANE ST	0.8	27.00	0.74	29.31	0.36	-7.50%
RAILWAY PDE	1.27	21.73	1.23	22.61	0.46	-3.15%
BELMORE ST	1.4	23.57	1.31	25.03	0.55	-6.43%
CLARENCE ST	1.58	27.34	1.48	29.06	0.72	-6.33%
TOTALS	1.58	23.15	1.48	24.12	0.72	-6.33%

ROUTE 4	AVG SURVEYED		MODEL 16AMWE17		Distance km	TIME Diff %
	TIME (minutes)	SPEED km/hr	TIME (minutes)	SPEED km/hr		
Start Node = 4798 WILGA ST						
VICTORIA STREET EAST	0.51	12.94	0.54	12.50	0.11	5.88%
GEORGE STREET	0.63	20.95	0.64	20.20	0.22	1.59%
WAIMEA ST	0.76	20.53	0.68	22.67	0.26	-10.53%
DEANE ST	0.84	25.71	0.79	27.57	0.36	-5.95%
RAILWAY PDE	1.21	22.81	1.16	23.90	0.46	-4.13%
BELMORE ST	1.35	24.44	1.25	26.36	0.55	-7.41%
CLARENCE ST	1.58	27.34	1.42	30.42	0.72	-10.13%
TOTALS	1.58	22.10	1.42	23.37	0.72	-10.13%

Note The Modelled travel speeds are corrected to reflect mid block and downstream intersection vehicle delay(s) and congestion.

Results indicate a maximum difference of <10.5% between the collated field data and modelled travel times. *RMS* guidelines require average modelled travel times to have a differential not greater than 15% or one (1) minute from the observed travel times for the entire route collected.

3.4 Origin and Destination Survey

A simple number plate survey was undertaken to determine the travel patterns of motorists travelling along Burwood Road.

The data was used for comparison and calibration with select link data from the base year 2016 model. The model, once calibrated, reported a maximum route difference, compared with the collected field data, of some 16.6%, being the northbound route (D to A) on Burwood Road during the morning peak. Generally, all other routes yielded an absolute average difference less than 7.5%.

Figure 18 O/D Survey Boundary and Locations

Source Road Delay Solutions, 2017

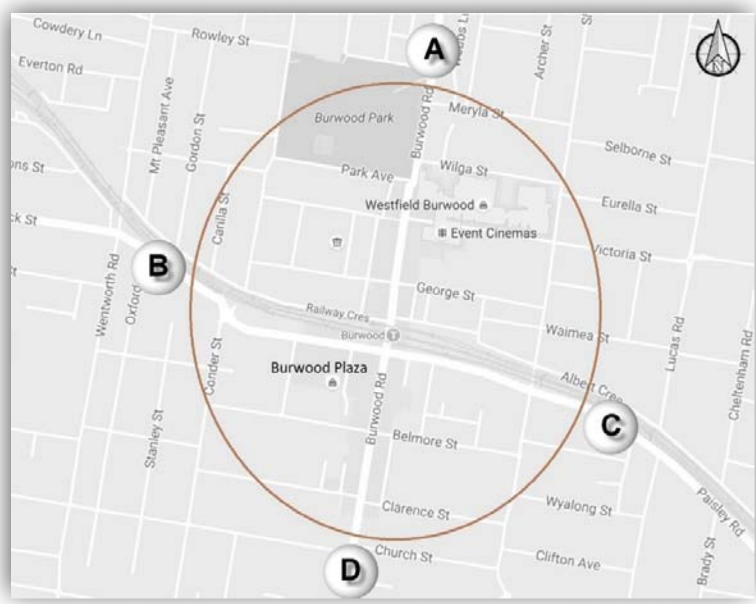
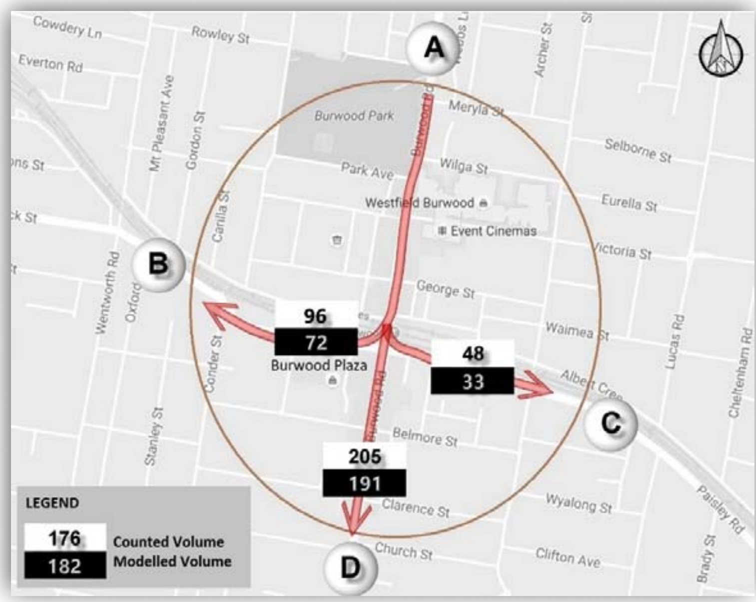


Figure 19 ***Northbound O/D Survey***

Source *Road Delay Solutions, July 2016*

Figure 20 ***Southbound O/D Survey***

Source *Road Delay Solutions, July 2016*



3.5 Vehicle Growth to 2017

To determine the historic vehicle growth on Burwood Road, data has been drawn from previous studies and compared with the volumes presented in the collected traffic counts at select intersections.

Figure 21 AM Vehicle Growth

Source Road Delay Solutions, 2017

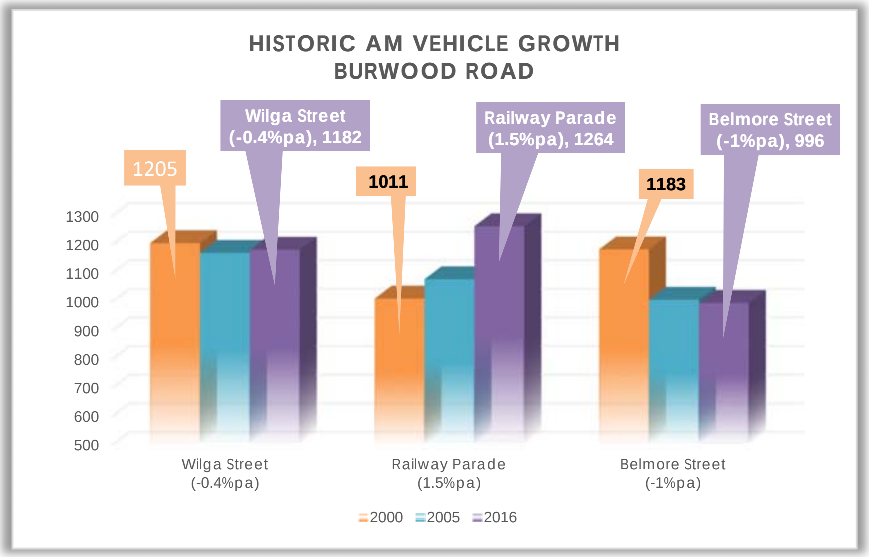
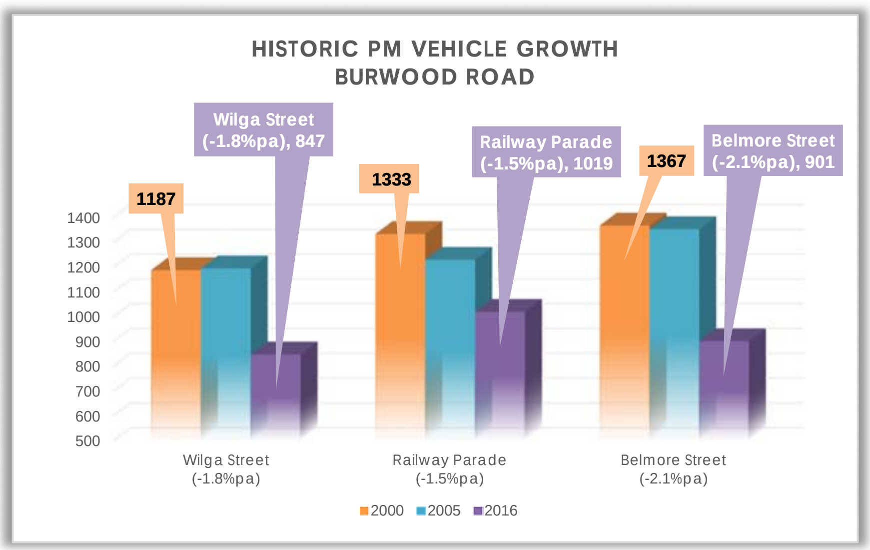


Figure 22 PM Vehicle Growth

Source Road Delay Solutions, 2017



All indicators suggest that there has been a negative vehicle growth on Burwood Road over the past 17 years between year 2000 and 2017.

3.6 Mode Share

Residents within the Burwood Town Centre have a significant mode choice and rely heavily on the available rail and bus services during the commuter peaks.

The current predominant available transport mode choices for JTW have been catalogued from those available within, or adjacent to, the town centre, and as defined within the *BTS* TZs 913 and 915.

The latest Household Travel Survey (HTS) data indicates that the average weekday trips have grown by 1.0% between 2009/10 and 2010/11, which was slower than the 1.6% rate of population growth in the Sydney Statistical Division (SSD).

The private motor vehicle remains the dominant mode of transport embraced by the wider Sydney community. However, the *BTS* reports the town centre exhibits a significant public transport share, with a higher than metropolitan average of 56% of JTW trips attributed to the available train and bus modes.

In line with NSW 2021 targets, growth in public transport trips has been higher than growth in private vehicle passenger trips. Vehicle driver trips have increased by 1.5%, while train and bus trips increased by 2.6% and 2.3%, respectively. These inherent increases can be attributed to increased traffic congestion on the arterial road system, greater frequency of public transport services and improved intermodal/interchange provisions. This is clearly evident within the Burwood Town Centre, and in particular on Burwood Road, with the reported average reduction in vehicle growth since year 2000.

With a walking distance of only 340m between the Victoria Street & George Street site and Burwood Railway Station, combined with the convenience of available bus provisions, public transport remains the dominant mode choice for JTW by residents within, and in close proximity to, the town centre.

Planners invariably work on the basis that commuter bus users will walk no more than 400 metres from home to the nearest stop. Data suggests travellers will walk further to catch a train.

Travel surveys have shown the median walk distance to a bus in heavily built up areas of Sydney and Melbourne is some 500 metres, with only 25% walking more than 800 metres.

The data, anecdotally, suggests that train travellers infrequently elect to walk more than 800 metres if the prevailing pedestrian environment is condusive.

Therefore, the maximum walk distance to a station has been adopted as 800 metres within the model.

Bicycle to train is an ever growing opportunity for both efficiency and health choices. This may offer some relief from commuter traffic generation but it is considered negliable in this instance as no significant cycle provisions are currently provided at the railway station.

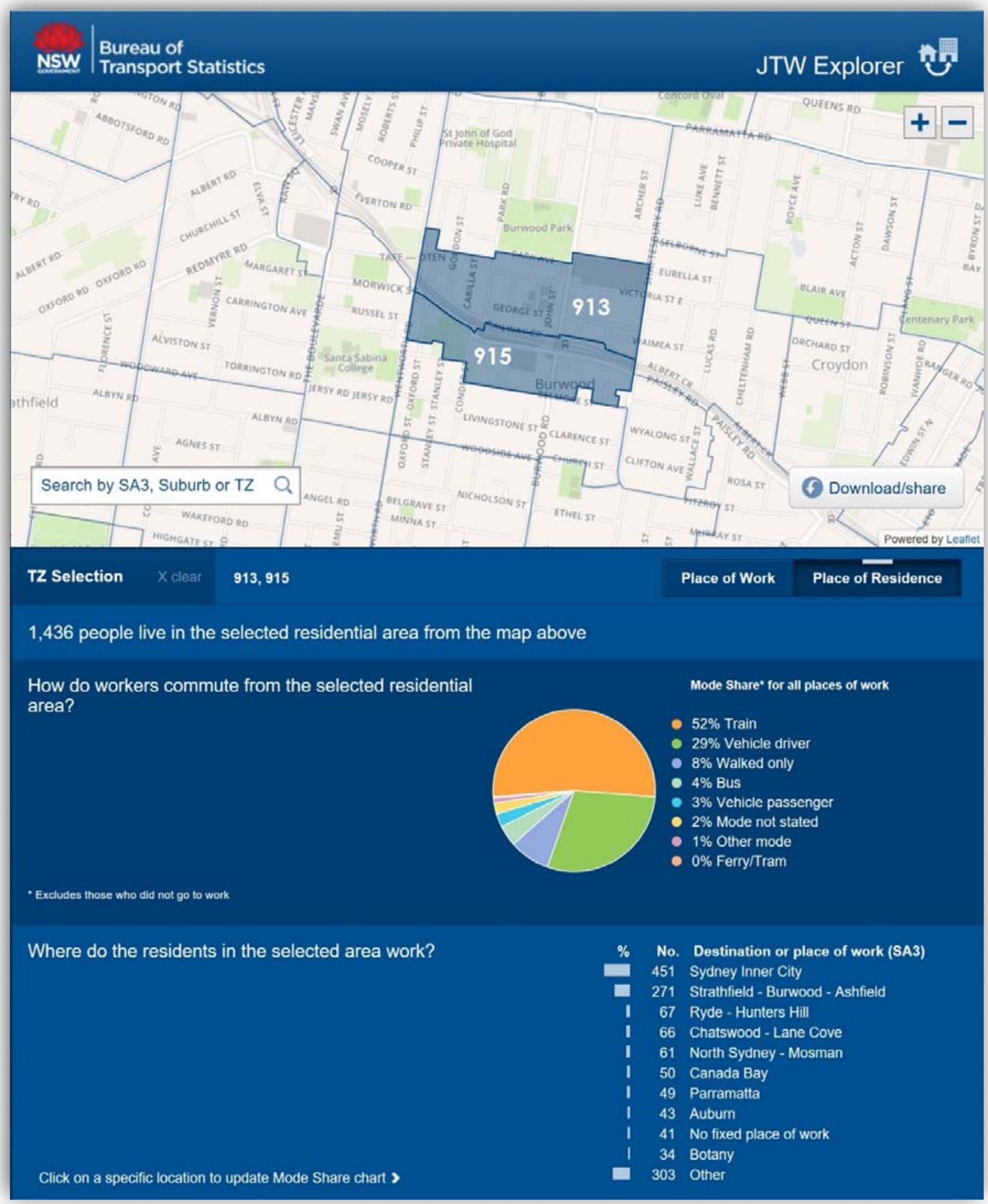
It can therefore be concluded that...

- → *The distance between the Victoria Street & George Street site and Burwood Railway Station will promote public transport mode choice with future population growth within the town centre,*
- → *The public transport network provides significant opportunity for a reduction in the dependence in private vehicle usage, and*
- → *Retail and commercial patrons also have significant opportunity to employ public transport modes.*

While all indicators would suggest that the current public transport services within the town centre provide significant opportunity for mode shift, none has been adopted in the mesoscopic modelling for the Victoria Street & George Street development. The full traffic generation of 328vph during the AM commuter peak and 297vph during the PM has been incorporated into the model trip matrices to provide a conservative '*worst case*' assessment.

Figure 23 ***Burwood Town Centre JTW Mode Share***

Source *BTS JTW Exporer, 2017*



THE MESOSCOPIC MODEL

The *Netanal* model utilises defined travel demand between zonal pairs, represented as assimilated traffic movements, throughout the Sydney Metropolitan Area. The program incrementally assigns vehicular traffic onto a computer based road network, developing link demand forecasts on each modelled section of road.

Netanal is a mesoscopic assignment model utilising intersection congestion levels and delays in the determination of a motorists' route choice.

4.1 Route Selection

Route selection between zonal pairs is determined on the basis of the shortest travel cost ('*time is money*'), considering the inherent intersection delays, and associated parameters, incurred along possible routes, the road hierarchy, various behavioural characteristics and a number of empirical social economic considerations. Parameters such as link capacity, speed, gap acceptance, phase timings at signalised intersections, toll charges and distance are coded into the model, by the user, from which the program determines the relative vehicular delays on each competing route, selecting, after undertaking a prescribed number of iterations, the route with the shortest travel time and/or least delay. Costs and travel time are relative within the Netanal model. Time penalties are applied to turn movements, stops and delays, etc… which in turn have a corresponding travel cost.

In the most general form, this 'cost' represents a combination of factors which the program takes into account when choosing routes through the road network. The most important of these factors are time and distance. Also where tolls are charged for the use of a specific section of road, these costs are included in the driver's route choice and are based on a driver's willingness to pay the toll based upon published data from the *RMS* and *BTS*.

The process which *Netanal* employs to determine the 'cost' of travel on competing paths, equates heavily to travel time. Time penalties for turning manoeuvres, vehicle delays, and tolls each increase the cost and time of travel on competing routes.

Toll value, on a specific link, is included indirectly by converting the monetary toll value to time (in minutes) based on the driver's perceived value of time and socio economic proclivity to pay the toll. This 'time value of the toll' is applied as a 'penalty' to the link and is known as the Toll Diversion Penalty (TDP).

The premise on which the future year modelling has been based, specifically the route selection process, is the current value of time. Toll values, toll diversion penalties and socio economic decision making defaults, have not been increased with CPI or standard of living projections beyond the current year.

4.2 Incremental Assignment

In order to reflect the impact of intersection congestion on route selection, *Netanal* assigns the traffic from the trip table as a series of equal increments. This process is outlined below…

- → *The process commences by identifying competing routes with the shortest travel times, for each origin-destination zone pair, with no traffic using the roads (ie based on sign-posted speed limits, green lights, etc). Known colloquially as increment 0 (zero), the link and intersection delays, accumulated over the modelled one hour period, are tabulated for later reference.*
- → *The first incremental run of the model imposes the time delays recorded during Increment 0 and adds the delays to the travel time of each route. During the increment, routes yielding the lowest travel time between zonal pairs are chosen. Again the resultant delays on each route, inclusive of intersections, are recorded by the program.*
- → *Each subsequent increment performs ongoing route selection based on recorded delays and the resultant route travel times. As delays stabilise, so too does the route selection within the model, until the optimum number of increments are run.*

At the completion of the nominated number of incremental runs, the optimum routes and vehicle demands, on each link, are reported.

Incremental convergence is employed to determine the projective stability and optimum number of increments to be adopted for a model run. The process of incremental convergence involves the running of sensitivity models reflecting a differing number of increments, with the projected volumes on a select number of key links, reported.

Once the differential change between the projected volumes, on each reported link, minimises, the model is considered stable and the resultant number of increments are utilised in the project model runs.

For this project, 20 increments were found to provide stability in link demand.

4.3 Assignment Calculations

Netanal calculates travel time on the basis of the capacity related, geometric and operational characteristics of roads and intersections defining the road network. The following are specifically incorporated in the calculation of road network and route operations for the mid-block section of each link.

→ ***Speed-flow relationships***. *As traffic volume increases, speeds on roads decrease and the relationships within Netanal take this into account. The speed is based on the ratio of the traffic flow to the nominated road capacity. Netanal assumes free flow conditions on links up to a set value of degree of saturation (DS). This value is set to equal 90%. When traffic flows on a particular link exceeds the DS set value, the speed drops according to a speed flow relationship, to the power of four.*

→ ***Transit lanes***. *The proportion of traffic using the transit and non-transit lanes on a section of road is based on RTA surveys of Epping Road, Military Road and Victoria Road. This survey reported that the transit lanes operated to a maximum of 50% of the adjacent trafficable lane. Illegal use was reported as 25% while the DS of the adjacent lane was below 0.75.*

With an increase above 0.75 in the adjacent lane, a proportionate increase in the illegal use of the transit lane results. Netanal applies this principle on all transit lanes, within the model.

The program assumes a 40% maximum usage of T3 transit lanes while the DS of the adjacent lane remains below 0.75. The program assumes the illegal usage of a T3 lane is the same as that of a T2.

Bus lanes, and bus stops are incorporated into the network. Netanal reports on travel time changes on these routes.

→ ***On-street parking.*** *The occupancy rate, timed parking allowance and space egress are converted to a time delay penalty of some 50 seconds/parking instance/vph and and added to the travel time along the link.*

→ ***Speed limits.*** *Vehicles within the model are restricted to the permissible speed limit. Illegal travel speeds and the percentage above the signposted limit must be adjusted manually, per link, as site inspections and/or survey(s) dictate.*

→ ***LATM devices*** *Such as speed humps, raised thresholds, road narrowings, etc…*

- ***Pedestrian crossings.*** *Pedestrian crossings incur a delay to travel times. Any significant delay is added to the link travel time manually, as site inspections and/or survey(s) dictate.*

- ***Toll Plazas*** *A delay of seven seconds per vehicle is applied at toll plazas that have manual payment collection. This delay is reduced as some manual collection is retained and the proportion of electronic tolling increases. Electonic tolling invokes no toll plaza delay.*

- ***Toll fees*** *Tolls are collected in dollars but have the effect of making a route less attractive. Therefore the toll has to be converted to a time value that can be attributed to the relevant link in Netanal to reflect additional travel time in the route selection process. This conversion factor is the TDP, and is expressed in minutes per dollar.*

4.4 Speed-flow relationships

As traffic volume increases, speeds on roads decrease and the relationships within the *Netanal* software take this into account. The speed is based on the ratio of the traffic flow to the nominated road capacity. *Netanal* assumes free flow conditions on links up to a set value for the degree of saturation (DS). This value is set to equal 90%. When traffic flows on a particular link exceeds the DS set value, the speed drops according to a speed flow relationship, to the power of four.

4.5 Transit Lanes

The proportion of traffic using the transit and non-transit lanes on a section of road is based on *RMS* surveys of Epping Road, Military Road and Victoria Road. This surveys reported that the transit lanes operated to a maximum of 50% of the adjacent trafficable lane. Illegal use was reported as 25% while the DS of the adjacent lane was below 0.75.

With an increase above 0.75 in the adjacent lane, a proportionate increase in the illegal use of the transit lane results. *Netanal* applies this principle on all transit lanes, within the model.

The program assumes a 40% maximum usage of T3 transit lanes while the DS of the adjacent lane remains below 0.75. The program further assumes the illegal usage of a T3 lane is the same as that of a T2.

Bus lanes, and bus stops can be included as part of the network. *Netanal* can report on travel time changes on these routes.

4.6 Ancillary Effects on Road Network Operation

On-street parking, speed limits, LATM devices (eg speed humps, raised thresholds, road narrowings, etc…), pedestrian crossings and toll plazas all add time/cost penalties during the route selection choice.

4.7 Tollways

A delay of seven seconds per vehicle is applied at toll plazas that have manual or automatic payment collection at the toll plaza. Manual and automatic toll collection has ceased in Sydney. Replaced by electronic tolling, no toll plaza delay is invoked within the model. Consideration must be given to any reduced speeds at a specified toll location, where signposted. This is done by specifying the regulated speed on the link through toll point within the model so as to accurately model the vehicle travel time.

Tolls are collected in dollars but have the effect of making a route less attractive by an invoked time penalty. Therefore, the toll cost must be converted to a time value that can be attributed to the relevant route within *Netanal* to reflect additional travel time in the route selection choice. This conversion factor is the TDP, and is expressed in minutes per dollar.

Those network characteristics which may vary across a 24hr time of day operation, such as transit lanes, bus lanes, parking restrictions, toll fees, turn prohibitions, etc… are included in the network definition and further impact on the assignment route selection.

Intersection delay, calculated within the model, employs the *Austroad's* and *AARB* established formulae for the control of intersections operating as give way or stop sign, roundabout or traffic signals. For the latter the benefits of Sydney's coordinated signal control system, SCATS, on improved traffic flow, is incorporated. *SCATES* are run to dynamically emulate the SCATS operation at all signalised intersections, so designated, within the model. A '*cost*' penalty is added to the travel time to represent the delay that is associated with any pedestrian conflict at a marked crossing and/or any left turns and/or opposing traffic for right turns.

Netanal specifically calculates both the mid-block capacity and intersection performance. The model is therefore able to calculate queue lengths based on lane availability by time of day when traffic demand exceeds capacity and incorporate this queuing delay in the calculation of travel time during route choice.

If the travel time remains lower on a particular route with queues, *Netanal* will continue to assign traffic to that route until such time as the queue results in a time delay that makes an alternative route more attractive.

4.8 Projected Intersection Turn Movements

Netanal produces the hourly intersection turn movement demands at each node (intersection) within the mesoscopic model. These specific outputs have been employed in this project to provide the critical projected turn movements, within the study area, to enable the operational micro analysis, utilising the *Sidra* program, at key intersections.

Inherently, the predictive nature of mesoscopic modelling and the location of zone generators is one of the primary factors impacting on the volume of traffic reported at each intersection. Zones harbour vehicle generation based on land use within a precinct boundary, generally representing several hectares. Zones are often located within the model based upon, but not limited to…

- → *Their context within the precinct in relation to the primary direction of traffic flow to and from the zone,*
- → *Generally, central within a zone boundary (subject to finer disaggregation as land use dictates),*
- → *Representation of a major vehicle generator within the precinct, such as school, large apartment block, shopping centre, car park, significant commercial operation, recreational grounds, etc… , and*
- → *To allow the even distributiuon of traffic onto the arterial road network while limiting the intrusion of through traffic within local communities, unless identified from field observations.*

In some instances, the zone location may propagate errors at some intersections, in close proximity to high vehicle generation. A zone may be located so as to avoid the unwanted or unkikely trip diversion or '*rat runs*' within a local precinct attempting to access the arterial road network.

Significant effort is placed on locating the zones within the model to effectively assign vehicles onto the road network.

4.9 The SIDRA Model

SIDRA is utilised in this report to verify the mesoscopic model outputs and enable the assessment of lane based vehicle operation within the road network. The affects of oversaturation, upstream and down stream lane blockages at multiple intersections by differing intersection control methods are assessed diligently and without bias.

SIDRA provides the means by which to assess and report the **Network**, **Route** and **Intersection** operations concurrently. The results presented in this report reflect the findings reported from the *SIDRA* models following exportation of the projected turn volumes and residual queue lengths from the *Netanal* model.

5 2017 MODEL CALIBRATION

5.1 General

This section provides a concise framework for the verification, validation and calibration of the base year 2017 traffic model, assimilating the current study area road network and it's operational conditions.

Mesoscopic modelling lies between large strategic macro modelling and detailed microsimulation modelling, and is used to model relatively large areas (e.g. at the suburb level) while capturing detailed intersection operation effects on congestion and driver route choice. A mesoscopic traffic model has been created as part of this study using the *Netanal* software, which allows for the capacity and queuing effects of each intersection within the network to be assessed, as well as the cumulative effects of this congestion on adjacent intersections and route choice throughout the network.

The model utilises land use information and its traffic generation as inputs, along with road network details such as intersection geometry and road link speeds, number of lanes and capacity limitations. The model then calculates delays for the available routes through the network from each origin "zone" to each destination "zone" and assigns the generated traffic to the network based on comparable travel times. This allows intersection performance outputs (delays, levels of capacity usage, turning volumes etc.) and network travel times to be extracted, along with a range of other statistics valuable for option comparison.

A detailed outline of the software operation is provided earlier in this report.

5.2 Input Data

Appendix A presents the current traffic volumes collected by *Austraffic* in vehicles per hour, travelling on the surrounding road network. This data has been utilised in the calibration procedure of the mesoscopic model to align the projected model volumes with the current traffic flow and distribution, within the study area.

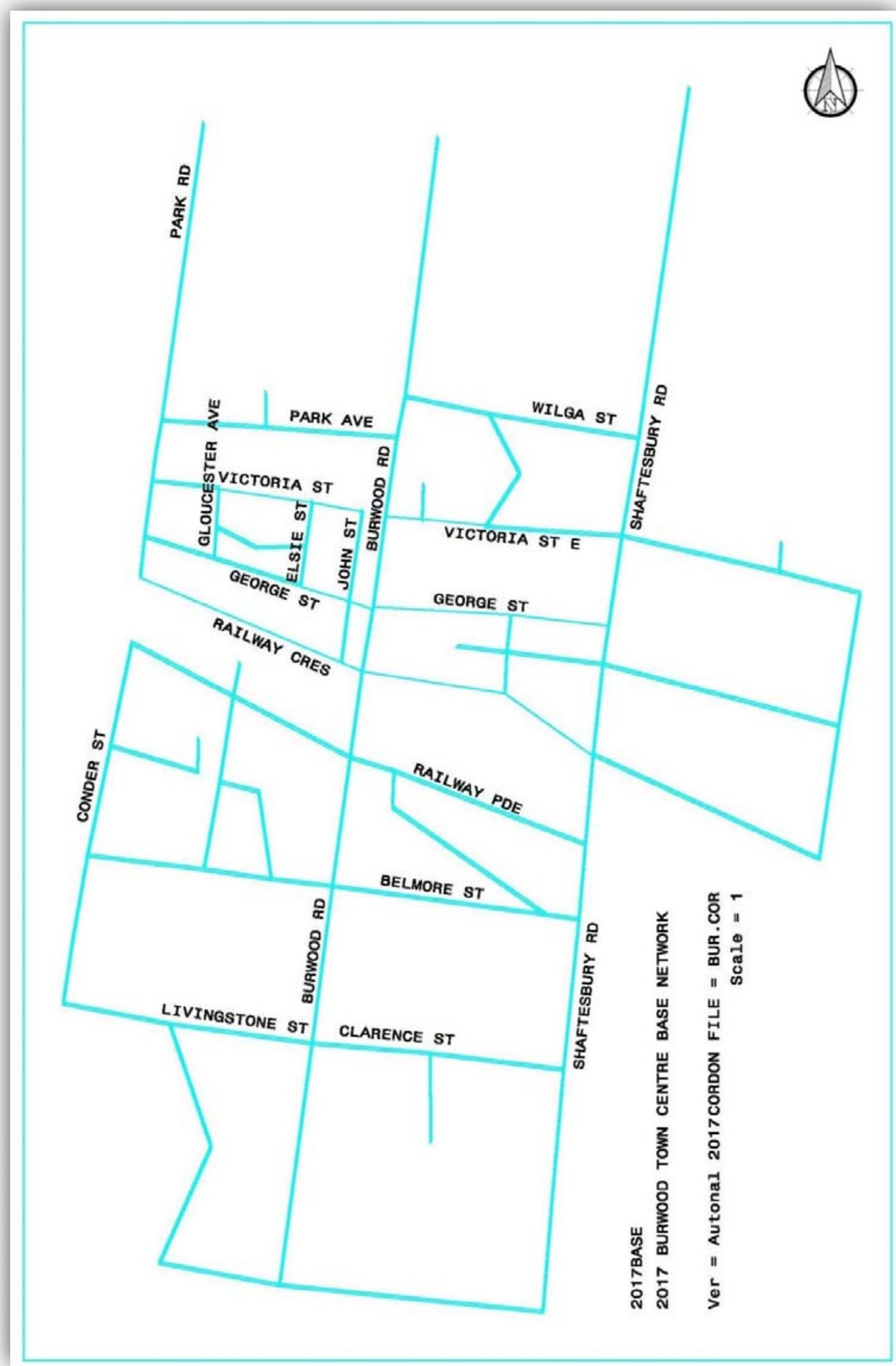
A detailed audit and catalogue of the town centre road network, and surrounds, has been undertaken ensuring the accuracy of the network platform onto which the developed morning, evening and Saturday peak trip matrices have been assigned.

Generally, the network characteristics catalogued were…

- *Road hierarchy,*
- *Road alignment,*
- *Number of lanes by peak period,*
- *Transit corridors,*
- *Regulated link speeds,*
- *Intersection control modes,*
- *Traffic signal timing offsets,*
- *Gap acceptance timing,*
- *Turn penalties pertaining to intersection geometries, and*
- *Lane capacities.*

Figure 24 ***Mesoscopic Road Network Cordon***

Source *Road Delay Solutions, 2017*



5.3 2017 Base Year Model

The geographic region modelled (*Sydney Statistical Division or Sydney SD*) is represented by a trip matrix (*trip table*), that details the individual travel demands between origin and destination pairs. Each distinct area representing a trip origin or end is called a '*Zone*'. The Sydney *Netanal* model contains some 998 zones, following disaggregation. These elements define areas of homogenous land use (eg. residential, industrial, retail, commercial, education, airports, hospitals), enclosed and linked, by physical features such as major roads, railways and rivers, which is known as the network.

The trip table specifies the number of car and truck trips travelling between zones, within the modelled area. The boundaries of these zones for the Sydney Metropolitan Area were originally defined in 1996, by the *NSW Department of Transport's Transport Data Centre* (TDC), and have been generic across all traffic and transport modelling activities undertaken in Sydney. New boundaries were defined by *TDC* in 2006 and again in 2011, with an equivalency table, prepared by the *TDC*, employed to rationalise the current projected land use and trip distribution patterns with the *Netanal* zonal structure.

The current trip matrices employed in the *Netanal* models have been imported from those prepared by *TDC* but have had been subjected to extensive disaggregation to better define land use and vehicle generation patterns.

The assignment process, described above, essentially determines the anticipated route selection made by motorists between the '*origin*' and '*destination*' zones during a designated time period. The total number of trips between all the zonal pairs produces the projected traffic volumes reported by the model. *Netanal* model's the road network assignment over a 1hour period.

The current and future year trip matrices, originally produced by the *BTS* in October 2014 (*Revised in October 2016 and supplemented by the BTS Zone Explorer*), have been developed from a 4 step travel model established on forecast population and employment projections throughout the Metropolitan Area and assigned to a computer based transport network.

Extensive disagregation of the vehicle distribution and trip demands between zonal pairs has been undertaken by *Road Delay Solutions* for the one (1) hour morning and evening peak travel trip tables to accurately reflect and assimilate the operation of the Sydney Metropolitan road network.

The land use assumptions adopted in the year 2017 trip matrices, conform with those published by *TDC* and have been further advanced through numerous calibration processes throughout the Sydney Metropolitan area.

5.4 Verification

Verification is the process of determining if the computer code, that implements the modelling logic, produces the desired output for a given set of input data and/or parameters.

A model is considered successful if the outputs are consistent, in terms of both magnitude and direction, with results from the direct application of the logic on which the code within the software is based.

The *Netanal* software package produces travel forecasts generally based upon travel time and cost rather than shortest distance and/or 'gravity' principles.

Netanal determines the invoked link and intersection delays predicated upon capacity and intersection control method, during a model assignment run, to effectively produce travel times between origins and destinations.

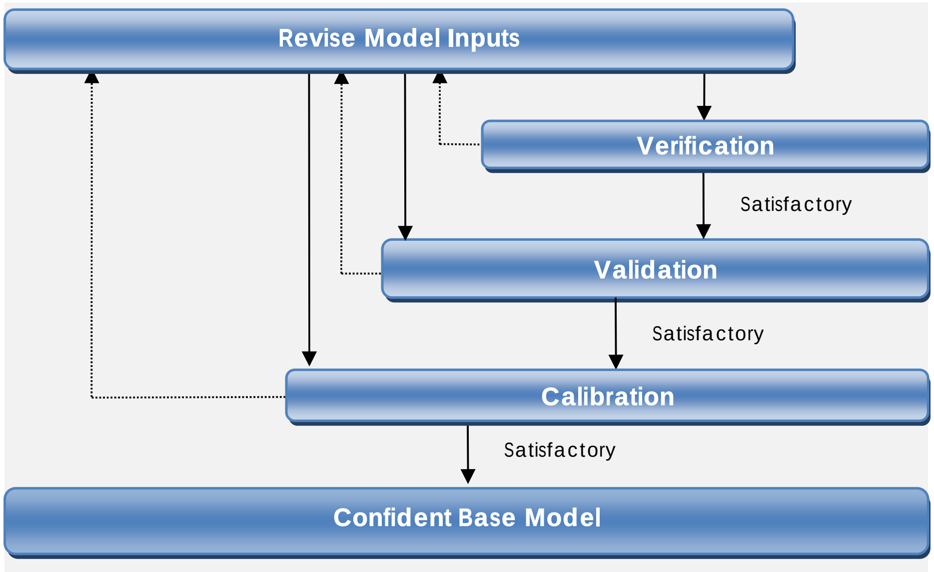
Based on these times, route selection within the model is influenced by the determined travel times on each modelled or alternate route. Preferred travel routes will be those yielding the lowest travel times, with a direct correlation to the vehicle operating costs.

Each intersection within the model is run at the operational level to determine the respective vehicle delays through the intersection and these are in turn added to the link delays.

The *Netanal* model has been verified by the former *RTA*, with reference found in *Part 2* of the '*Economic Analysis Manual*'.

Figure 25 ***The Correctness Procedure***

Source *Road Delay Solutions, 2017*



5.5 Validation

The term applied to the fundamental method of assessing the effectiveness of the calibration procedure and its underlying principles in achieving an acceptable level of calibration.

To assess the model calibration, a formula known as the '*GEH Statistic*'[3] has been employed to rationalise the differential between the modelled and actual counted traffic volumes, on selected turn movements and links.

Turns and links with low volumes and a higher differential between the modelled and counted volumes, while possibly exhibiting a high percentage of inaccuracy, are considered less critical than links accommodating higher volumes. The GEH Statistic balances the relative priority of each link based on the counted volume, during the model calibration process. The GEH statistic is computed by the *Netanal* program.

[3] The GEH Statistic named after Geoffrey E. Havers, who invented it in the 1970s while working as a transport planner in London, England. In a mathematical form it is similar to a chi-squared test, but is not considered a true statistical test. Rather, it is an empirical formula that proves useful for a variety of traffic analysis purposes.

Figure 26 **The GEH Statistic**

Source *Road Delay Solutions, 2017*

$$GEH = \sqrt{\frac{(E-V)^2}{(E+V)/2}}$$

where… E = Predicted model volume *V = Actual field counted volume*

Four criteria were used to ensure the model was adequately calibrated (as per the RMS guidelines)…

- → *A minimum of 85% of turn volumes with a GEH < 5,*
- → *A minimum of 95% of link volumes with a GEH < 5,*
- → *No volumes yielding a GEH > 10, and*
- → *A minimum R-squared value of 0.9 for both link and turn volumes.*

A range of GEH targets have been realistically set to achieve the prescribed Level of Accuracy (LoA), noted in the calibration synopsis. The targets highlight the percentage and weighted degree of difference between modelled volumes and the collected field data. For link volumes, a GEH value of 5 or less was adopted for the model and is presented in the report.

The figure below describes the components of the GEH Statistic and the typical targets employed in the calibration of the base year models.

Figure 27 ***A Typical GEH Output***

Source *Road Delay Solutions, 2017*

A target 60% of the modelled volumes in the calibration summary should have a GEH of 5 or less

68 of the 89 count locations report a GEH of 5 or less

The 68 modelled volumes, with a GEH of 5 or less, equate to 76% of the total 89 count locations

	Counts	%
GEH <= 5 Target = > 60	68	76
GEH <= 7 Target = > 80	78	88
GEH <= 10 Target = > 95	86	97
GEH <= 12 Target = 100	89	100
GEH > 12 Target = 0	0	0
Total Counts		89

Note: The above figure is indicative only. It presents a representation of the typical turn volume results for a hyperthetical model. The actual GEH results for this project are presented in the following section.

5.6 Calibration

Defined as the process of model parameter and input manipulation to achieve a prescribed differential between actual local traffic volumes and those modelled.

Calibration is, fundamentally, the transparent production of output, controlled by the value of input parameters on the basis of available field data. The success or failure of the calibration process, is determined by the accurate and logical evaluation of the collected and available field data employed in the selected input parameters.

From the collected intersection counts, all turn movements at the counted intersection and links at the mid block count locations have been calibrated, individually, to ensure the integrity of the trip distribution and volume flows within the study area and surrounds.

Table 5 2017 GEH Calibrated Link and Turn Results

Source Road Delay Solutions, 2017

Accuracy	AM Peak Turns	PM Peak Turns	WE Peak Turns
GEH >= 10	0%	0%	0%
GEH >= 5 <= 10	5%	8%	11%
GEH < 5	95%	92%	89%
An R-squared value, in excess of 0.961 was achieved for the AM, PM and WE modelled peak periods			
Accuracy	**AM Peal Links**	**PM Peak Links**	**WE Peak Links**
GEH >= 10	0%	0%	0%
GEH >= 5 <= 10	0%	0%	0%
GEH < 5	100%	100%	100%

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The calibration synopsis of traffic flows, on key routes, was output from the base 2016 AM, PM and WE peak models for the purpose of brevity. The *Calibration Synopsis* clearly shows that the link volumes achieved the required level of accuracy, in accordance with *RMS* guidelines.

The zonal information, contained within the matrices, has been disaggregated in accordance with data collated during various studies conducted by *Road Delay Solutions Pty Ltd*, generally yielding a mean absolute screen line calibration Level of Accuracy (LoA) of some 15-20%.

The traffic volume calibration process for this project has adopted a standard deviation of 15% of the absolute mean, constituting an accepted LoA within the study area, while a deviation of 25% defines the LoA through the Sydney SD.

It should be noted that the *Netanal* program is a mesoscopic demand model, which reflects the total volume of traffic on a link, including residual traffic queues at the end of the modelled one-hour time period. This is in contrast to the counted volume, collected in the field data, which only records those vehicles passing a given point during the same period.

Unless the residual queue is added to the count volume, it is safe to assume, that a count location will frequently report a lower traffic volume than those projected within the model, where significant vehicle queues exist at a site.

Discrepancies between adjacent intersection counts (known as gains and losses) are to be expected and an error in the order of some 3-4% was exhibited by the collected field data on Burwood Road and Shaftesbury Road.

5.7 2017 AM Peak Calibration Synopsis

Calibration Summary for Model 17AM4
Network = 2017BASE Trip Table = 17AM4
2017 AM Peak CALIBRATED BASE MODEL
Observed Counts versus Modelled Volumes

Location..........	Node	Node	Count	Model	Diff	Diff%	GEH
BURWOOD RD SB N WILGA	1348	10096	493	562	69	14	3
WILGA ST EB	10096	4020	365	386	21	6	1
WILGA ST WB	4020	10096	506	501	-5	-1	0
PARK AVE EB	8542	10097	449	460	11	2	1
PARK AVE WB	10097	8542	409	359	-50	-12	3
BURWOOD RD NB S PARK A	4800	10097	508	487	-21	-4	1
BURWOOD RD SB S PARK A	10097	4800	493	540	47	10	2
BURWOOD RD SB N GEORGE	4800	8541	420	471	51	12	2
GEORGE ST EB	8541	1356	63	84	21	33	2
GEORGE ST WB W BURWOOD	8541	8506	153	140	-13	-8	1
RAILWAY CRES WB	8544	1365	144	93	-51	-35	5
DEANE ST WB	8543	8544	133	173	40	30	3
BURWOOD RD NB N RAILWA	10094	8544	679	588	-91	-13	4
RAILWAY PDE EB W BURWO	8544	10094	473	428	-45	-10	2
RAILWAY PDE WB E BURWO	8522	10094	409	415	6	1	0
RAILWAY PDE EB E BURWO	10094	8522	334	341	7	2	0
BURWOOD RD NB S RAILWA	8539	10094	636	509	-127	-20	5
BURWOOD RD SB S RAILWA	10094	8539	368	311	-57	-15	3
BURWOOD CENTRAL NB	8533	848	7	11	4	57	1
BURWOOD CENTRAL SB	848	8533	9	12	3	33	1
RAILWAY PDE EB W WYNNE	8554	8533	423	369	-54	-13	3
RAILWAY PDE WB W WYNNW	8533	8554	452	480	28	6	1
RAILWAY PDE EB W CONDE	1361	8554	564	507	-57	-10	2
RAILWAY PDE WB W CONDE	8554	1361	592	476	-116	-20	5
CONDER ST NB	8557	8525	267	239	-28	-10	2
CONDER ST SB	8554	8525	218	212	-6	-3	0
BELMORE ST EB W BURWOO	8523	8539	164	231	67	41	5
BELMORE ST WB W BURWOO	8539	8523	196	178	-18	-9	1
BELMORE ST WB E BURWOO	8228	8539	162	138	-24	-15	2
BELMORE ST EB E BURWOO	8539	8228	111	132	21	19	2
WYNNE AVE NB N BELMORE	8555	8524	100	128	28	28	3
WYNNE AVE SB N BELMORE	8533	8524	184	182	-2	-1	0
CONDER ST NB S BELMORE	8559	8557	396	338	-58	-15	3
CONDER ST SB N BELMORE	8525	8557	199	159	-40	-20	3
BELMORE ST WB E CONDER	8555	8557	142	90	-52	-37	5
BELMORE ST EB E CONDER	8557	8555	236	197	-39	-17	3
WENTWORTH NB S RAILWAY	1367	4820	252	223	-29	-12	2
WENTWORTH SB S RAILWAY	4820	1367	374	337	-37	-10	2
RAILWAY WB E WENTWORTH	1361	4820	517	478	-39	-8	2
RAILWAY EB E WENTWORTH	4820	1361	590	516	-74	-13	3
WENTWORTH SB N RAILWAY	8536	4820	644	643	-1	-0	0
MORWICK EB W WENTWORTH	4813	4820	599	596	-3	-1	0
SHAFTESBURY NB S RAILW	8556	4803	726	635	-91	-13	3
SHAFTESBURY SB S RAILW	4803	8556	623	541	-82	-13	3
PAISLEY EB E SHAFTESBU	4803	4804	402	380	-22	-5	1
PAISLEY WB E SHAFTESBU	4804	4803	490	564	74	15	3
SHAFTESBURY NB N RAILW	4803	8537	886	797	-89	-10	3
SHAFTESBURY SB N RAILW	8537	4803	636	521	-115	-18	5
RAILWAY WB W SHAFTESBU	4803	8522	434	327	-107	-25	5
SHAFTESBURY SB N WILGA	10089	4798	557	682	125	22	5
WILGA EB W SHAFTESBURY	4020	4798	180	146	-34	-19	3
SHAFTESBURY NB S WILGA	10095	4798	809	917	108	13	4

SHAFTESBURY SB N VICTO	4798	10095	390	464	74	19	4
VICTORIA WB E SHAFTESB	8528	10095	502	540	38	8	2
SHAFTESBURY NB S VICTO	8552	10095	779	831	52	7	2
VICTORIA EB W SHAFTESB	4036	10095	222	241	19	9	1

Summary of GEH Calibration Validation

	Counts	%
GEH <= 5 Target = > 60%	56	100
GEH <= 7 Target = > 80%	56	100
GEH <= 10 Target = > 95%	56	100
GEH <= 12 Target = 100%	56	100
GEH > 12 Target = 0%	0	0
Total Counts	56	

Mean, Mean Absolute Difference (MAD) & +/- 10% MAD Analysis - Model 17AM4

Note.... A Mean, a Mean Absolute Difference (MAD) & a MAD +/- 10% Count Variability Analysis is calculated and the results given below. The 10% MAD count variation endeavours to cater for the known 20% variation in daily traffic volumes, errors and discrepancies in SCATS and other count methods.

Observed Count Range	Mean %	MAD ABS %	MAD +-10% %	Counts
0001 to 0500	1.63	12.66	2.66	38
0501 to 1000	5.18	10.87	0.87	18
1001 to 1500	0.00	0.00	0.00	0
1501 to 2000	0.00	0.00	0.00	0
2001 to 2500	0.00	0.00	0.00	0
2501 to 3000	0.00	0.00	0.00	0
3001 to 3500	0.00	0.00	0.00	0
3501 to 4000	0.00	0.00	0.00	0
4001 to 5000	0.00	0.00	0.00	0
5001 to Maximum	0.00	0.00	0.00	0
Total of Counts 0001 to Maximum Range	3.46	11.74	1.74	56
Total of Counts 0501 to Maximum Range	5.18	10.87	0.87	18

5.8 2017 PM Peak Calibration Synopsis

Calibration Summary for Model 17PM3
Network = 2017BASE Trip Table = 17PM3
2017 PM Peak CALIBRATED BASE MODEL
Observed Counts versus Modelled Volumes

Location..........	Node	Node	Count	Model	Diff	Diff%	GEH
BURWOOD RD SB N WILGA	1348	10096	439	452	13	3	1
WILGA ST EB	10096	4020	480	541	61	13	3
WILGA ST WB	4020	10096	565	472	-93	-16	4
PARK AVE EB	8542	10097	499	507	8	2	0
PARK AVE WB	10097	8542	365	349	-16	-4	1
BURWOOD RD NB S PARK A	4800	10097	415	486	71	17	3
BURWOOD RD SB S PARK A	10097	4800	485	502	17	4	1
BURWOOD RD SB N GEORGE	4800	8541	475	389	-86	-18	4
GEORGE ST EB	8540	8552	22	12	-10	-45	2
GEORGE ST WB W BURWOOD	8541	8506	178	179	1	1	0
RAILWAY CRES WB	8544	1365	41	56	15	37	2
DEANE ST WB	8543	8544	210	216	6	3	0
BURWOOD RD NB N RAILWA	10094	8544	532	569	37	7	2
RAILWAY PDE EB W BURWO	8544	10094	474	395	-79	-17	4
RAILWAY PDE WB E BURWO	8522	10094	417	416	-1	-0	0
RAILWAY PDE EB E BURWO	10094	8522	374	411	37	10	2
BURWOOD RD NB S RAILWA	8539	10094	479	446	-33	-7	2
BURWOOD RD SB S RAILWA	10094	8539	325	312	-13	-4	1
BURWOOD CENTRAL NB	8533	848	16	12	-4	-25	1
BURWOOD CENTRAL SB	848	8533	18	22	4	22	1
RAILWAY PDE EB W WYNNE	8554	8533	523	472	-51	-10	2
RAILWAY PDE WB W WYNNE	8533	8554	624	607	-17	-3	1
RAILWAY PDE EB W CONDE	1361	8554	586	516	-70	-12	3
RAILWAY PDE WB W CONDE	8554	1361	607	584	-23	-4	1
CONDER ST NB	8557	8525	301	217	-84	-28	5
CONDER ST SB	8525	8557	255	228	-27	-11	2
BELMORE ST EB W BURWOO	8523	8539	327	333	6	2	0
BELMORE ST WB W BURWOO	8539	8523	178	206	28	16	2
BELMORE ST WB E BURWOO	8228	8539	265	183	-82	-31	5
BELMORE ST EB E BURWOO	8539	8228	210	160	-50	-24	4
WYNNE AVE NB N BELMORE	8555	8524	192	132	-60	-31	5
WYNNE AVE SB N BELMORE	8524	8555	107	121	14	13	1
CONDER ST NB S BELMORE	8559	8557	218	193	-25	-11	2
CONDER ST SB N BELMORE	8525	8557	255	228	-27	-11	2
BELMORE ST WB E CONDER	8555	8557	246	228	-18	-7	1
BELMORE ST EB E CONDER	8557	8555	164	146	-18	-11	1
BELMORE ST EB W WYNNE	8557	8555	156	146	-10	-6	1
WENTWORTH NB S RAILWAY	1367	4820	283	376	93	33	5
WENTWORTH SB S RAILWAY	4820	1367	495	529	34	7	2
RAILWAY WB E WENTWORTH	1361	4820	588	598	10	2	0
RAILWAY EB E WENTWORTH	4820	1361	617	517	-100	-16	4
WENTWORTH SB N RAILWAY	8536	4820	854	1002	148	17	5
MORWICK EB W WENTWORTH	4813	4820	553	517	-36	-7	2
SHAFTESBURY NB S RAILW	8556	4803	594	613	19	3	1
SHAFTESBURY SB S RAILW	4803	8556	683	593	-90	-13	4
PAISLEY EB E SHAFTESBU	4803	4804	415	443	28	7	1
PAISLEY WB E SHAFTESBU	4804	4803	452	432	-20	-4	1
SHAFTESBURY NB N RAILW	4803	8537	846	766	-80	-9	3
SHAFTESBURY SB N RAILW	8537	4803	879	769	-110	-13	4
RAILWAY WB W SHAFTESBU	4803	8522	376	342	-34	-9	2
SHAFTESBURY SB N WILGA	10089	4798	999	906	-93	-9	3
WILGA EB W SHAFTESBURY	4020	4798	154	146	-8	-5	1

SHAFTESBURY NB S WILGA	10095	4798	601	638	37	6	1
SHAFTESBURY SB N VICTO	4798	10095	884	917	33	4	1
VICTORIA WB E SHAFTESB	8528	10095	304	324	20	7	1
SHAFTESBURY NB S VICTO	8552	10095	698	594	-104	-15	4
VICTORIA EB W SHAFTESB	4036	10095	568	524	-44	-8	2

Summary of GEH Calibration Validation

	Counts	%
GEH <= 5 Target = > 60%	57	100
GEH <= 7 Target = > 80%	57	100
GEH <= 10 Target = > 95%	57	100
GEH <= 12 Target = 100%	57	100
GEH > 12 Target = 0%	0	0
Total Counts	57	

Mean, Mean Absolute Difference (MAD) & +/- 10% MAD Analysis - Model 17PM3

Note.... A Mean, a Mean Absolute Difference (MAD) & a MAD +/- 10% Count Variability Analysis is calculated and the results given below. The 10% MAD count variation endeavours to cater for the known 20% variation in daily traffic volumes, errors and discrepancies in SCATS and other count methods.

Observed Count Range	Mean %	MAD ABS %	MAD +-10% %	Counts
0001 to 0500	2.25	10.49	0.49	38
0501 to 1000	4.90	9.34	0.00	19
1001 to 1500	0.00	0.00	0.00	0
1501 to 2000	0.00	0.00	0.00	0
2001 to 2500	0.00	0.00	0.00	0
2501 to 3000	0.00	0.00	0.00	0
3001 to 3500	0.00	0.00	0.00	0
3501 to 4000	0.00	0.00	0.00	0
4001 to 5000	0.00	0.00	0.00	0
5001 to Maximum	0.00	0.00	0.00	0
Total of Counts 0001 to Maximum Range	3.67	9.87	0.00	57
Total of Counts 0501 to Maximum Range	4.90	9.34	0.00	19

5.9 2017 WE Peak Calibration Synopsis

Calibration Summary for Model 17AMWE6
Network = 2017BASE Trip Table = 17AMWE6
2017 WEEKEND Peak CALIBRATED BASE MODEL
Observed Counts versus Modelled Volumes

Location..........	Node	Node	Count	Model	Diff	Diff%	GEH
BURWOOD RD SB N WILGA	1348	10096	397	371	-26	-7	1
WILGA ST EB	10096	4020	577	581	4	1	0
WILGA ST WB	4020	10096	601	489	-112	-19	5
PARK AVE EB	8542	10097	504	536	32	6	1
PARK AVE WB	10097	8542	339	298	-41	-12	2
BURWOOD RD NB S PARK A	4800	10097	364	423	59	16	3
BURWOOD RD SB S PARK A	10097	4800	565	496	-69	-12	3
BURWOOD RD SB N GEORGE	4800	8541	412	346	-66	-16	3
GEORGE ST EB	8541	8506	68	106	38	56	4
GEORGE ST WB W BURWOOD	8541	8506	83	106	23	28	2
RAILWAY CRES WB	8544	1365	57	73	16	28	2
DEANE ST WB	8543	8544	82	137	55	67	5
BURWOOD RD NB N RAILWA	10094	8544	534	523	-11	-2	0
RAILWAY PDE EB W BURWO	8544	10094	416	334	-82	-20	4
RAILWAY PDE WB E BURWO	8522	10094	424	448	24	6	1
RAILWAY PDE EB E BURWO	10094	8522	422	400	-22	-5	1
BURWOOD RD NB S RAILWA	8539	10094	492	484	-8	-2	0
BURWOOD RD SB S RAILWA	10094	8539	361	274	-87	-24	5
BURWOOD CENTRAL NB	8533	848	15	11	-4	-27	1
BURWOOD CENTRAL SB	848	8533	9	13	4	44	1
RAILWAY PDE EB W WYNNE	8554	8533	522	473	-49	-9	2
RAILWAY PDE WB W WYNNE	8533	8554	475	463	-12	-3	1
RAILWAY PDE EB W CONDE	1361	8554	563	573	10	2	0
RAILWAY PDE WB W CONDE	8554	1361	473	436	-37	-8	2
CONDER ST NB	8557	8525	217	202	-15	-7	1
CONDER ST SB	8554	8525	224	183	-41	-18	3
BELMORE ST EB E WYNNE	8555	8523	164	205	41	25	3
BELMORE ST WB W BURWOO	8539	8523	172	181	9	5	1
BELMORE ST WB E BURWOO	8228	8539	162	144	-18	-11	1
BELMORE ST EB E BURWOO	8539	8228	211	201	-10	-5	1
WYNNE AVE NB N BELMORE	8555	8524	132	117	-15	-11	1
WYNNE AVE SB N BELMORE	8524	8555	84	70	-14	-17	2
CONDER ST NB S BELMORE	8559	8557	220	259	39	18	3
CONDER ST SB N BELMORE	8525	8557	278	231	-47	-17	3
BELMORE ST WB E CONDER	8555	8557	168	171	3	2	0
BELMORE ST EB E CONDER	8557	8555	236	245	9	4	1
WENTWORTH NB S RAILWAY	1367	4820	252	228	-24	-10	2
WENTWORTH SB S RAILWAY	4820	1367	496	516	20	4	1
RAILWAY WB E WENTWORTH	1361	4820	343	440	97	28	5
RAILWAY EB E WENTWORTH	4820	1361	573	581	8	1	0
WENTWORTH SB N RAILWAY	8536	4820	738	851	113	15	4
MORWICK EB W WENTWORTH	4813	4820	603	640	37	6	1
SHAFTESBURY NB S RAILW	8556	4803	635	689	54	9	2
SHAFTESBURY SB S RAILW	4803	8556	664	612	-52	-8	2
PAISLEY EB E SHAFTESBU	4803	4804	416	346	-70	-17	4
PAISLEY WB E SHAFTESBU	4804	4803	445	440	-5	-1	0
SHAFTESBURY NB N RAILW	4803	8537	925	829	-96	-10	3
SHAFTESBURY SB N RAILW	8537	4803	656	641	-15	-2	1
RAILWAY WB W SHAFTESBU	4803	8522	388	313	-75	-19	4
SHAFTESBURY SB N WILGA	10089	4798	537	569	32	6	1
WILGA EB W SHAFTESBURY	4020	4798	154	119	-35	-23	3

SHAFTESBURY NB S WILGA	10095	4798	713	718	5	1	0
SHAFTESBURY SB N VICTO	4798	10095	441	536	95	22	4
VICTORIA WB E SHAFTESB	8528	10095	373	324	-49	-13	3
SHAFTESBURY NB S VICTO	8552	10095	730	757	27	4	1
VICTORIA EB W SHAFTESB	4036	10095	434	528	94	22	4

Summary of GEH Calibration Validation

	Counts	%
GEH <= 5 Target = > 60%	56	100
GEH <= 7 Target = > 80%	56	100
GEH <= 10 Target = > 95%	56	100
GEH <= 12 Target = 100%	56	100
GEH > 12 Target = 0%	0	0
Total Counts	56	

Mean, Mean Absolute Difference (MAD) & +/- 10% MAD Analysis - Model 17AMWE6

Note.... A Mean, a Mean Absolute Difference (MAD) & a MAD +/- 10% Count Variability Analysis is calculated and the results given below. The 10% MAD count variation endeavours to cater for the known 20% variation in daily traffic volumes, errors and discrepancies in SCATS and other count methods.

Observed Count Range	Mean %	MAD ABS %	MAD +-10% %	Counts
0001 to 0500	1.62	13.11	3.11	39
0501 to 1000	0.77	6.82	0.00	17
1001 to 1500	0.00	0.00	0.00	0
1501 to 2000	0.00	0.00	0.00	0
2001 to 2500	0.00	0.00	0.00	0
2501 to 3000	0.00	0.00	0.00	0
3001 to 3500	0.00	0.00	0.00	0
3501 to 4000	0.00	0.00	0.00	0
4001 to 5000	0.00	0.00	0.00	0
5001 to Maximum	0.00	0.00	0.00	0
Total of Counts 0001 to Maximum Range	1.20	10.01	0.01	56
Total of Counts 0501 to Maximum Range	0.77	6.82	0.00	17

5.10 Travel Times

As previously discussed, travel time surveys were undertaken on Burwood Road to assist in validating and calibrating the base model.

Results indicate a maximum difference of -7.41% difference between the collated field data and modelled travel times. RMS guidelines require average modelled travel times to have a differential not greater than 15% or one (1) minute from the observed travel times for the entire route collected.

The calibrated travel times are considered acceptable within the parameters of current modelling practices and *RMS* guidelines.

Figure 28 2017 AM Calibrated Base Model

Source Road Delay Solutions, 2017

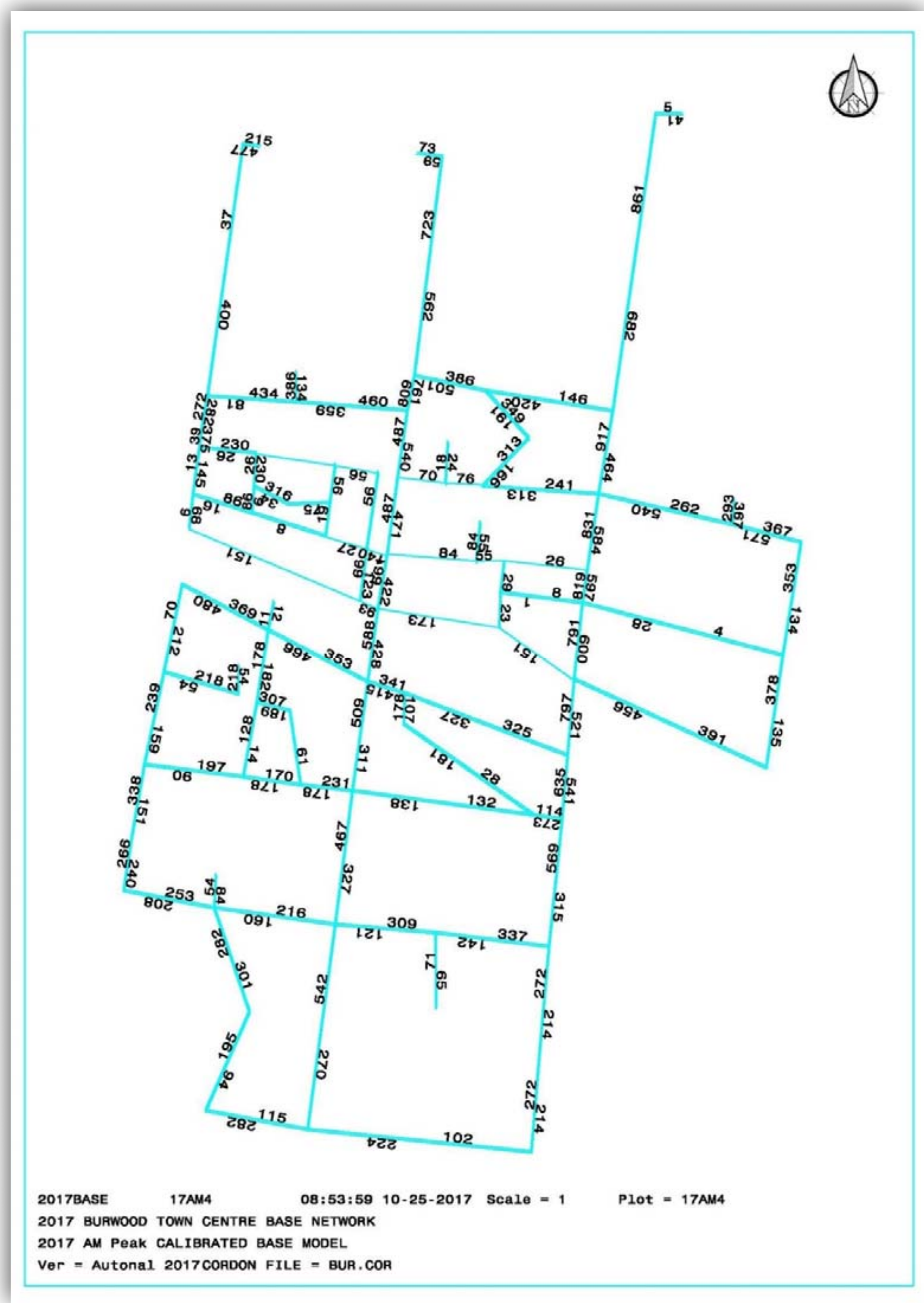


Figure 29 2017 PM Calibrated Base Model

Source Road Delay Solutions, 2017

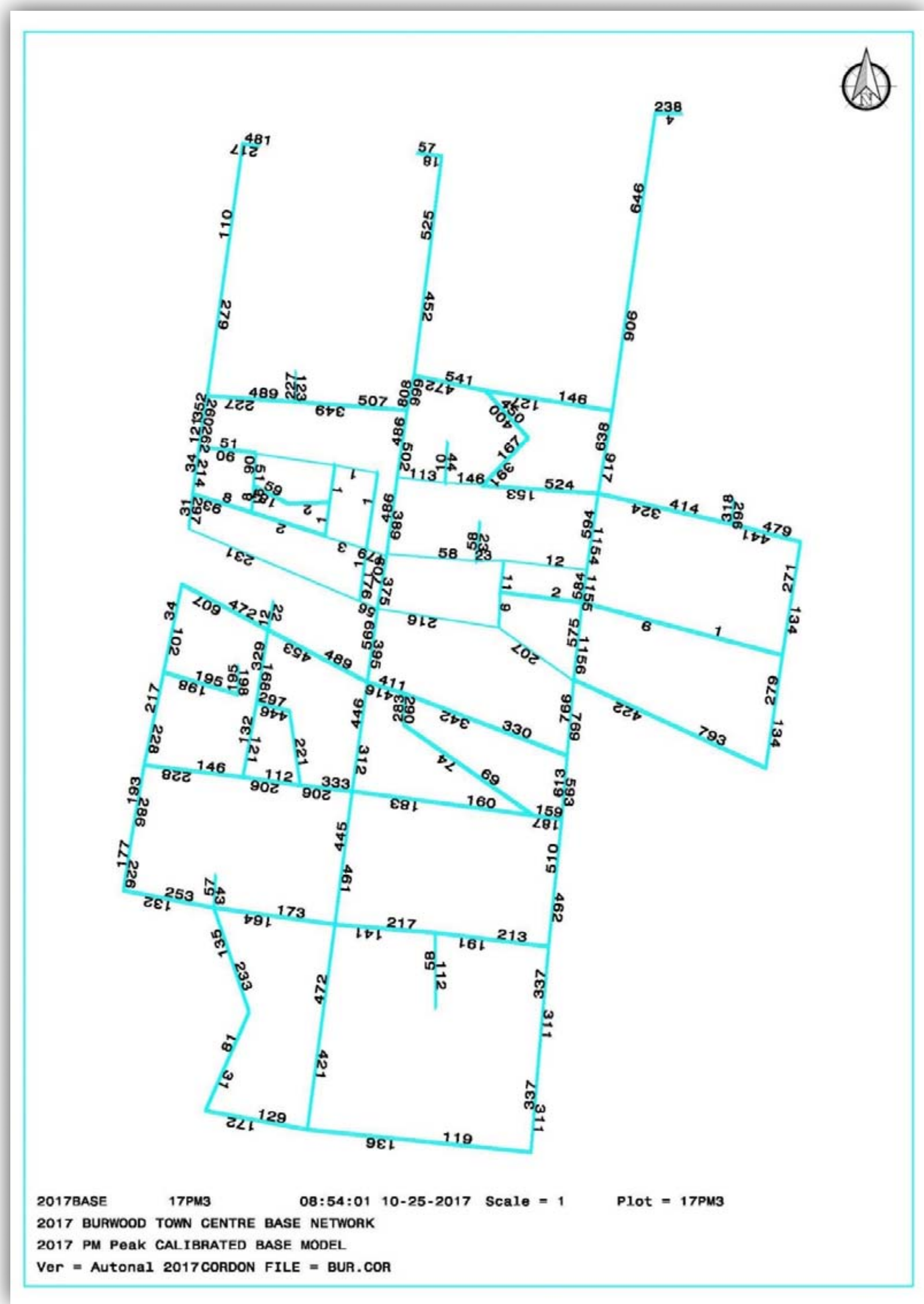
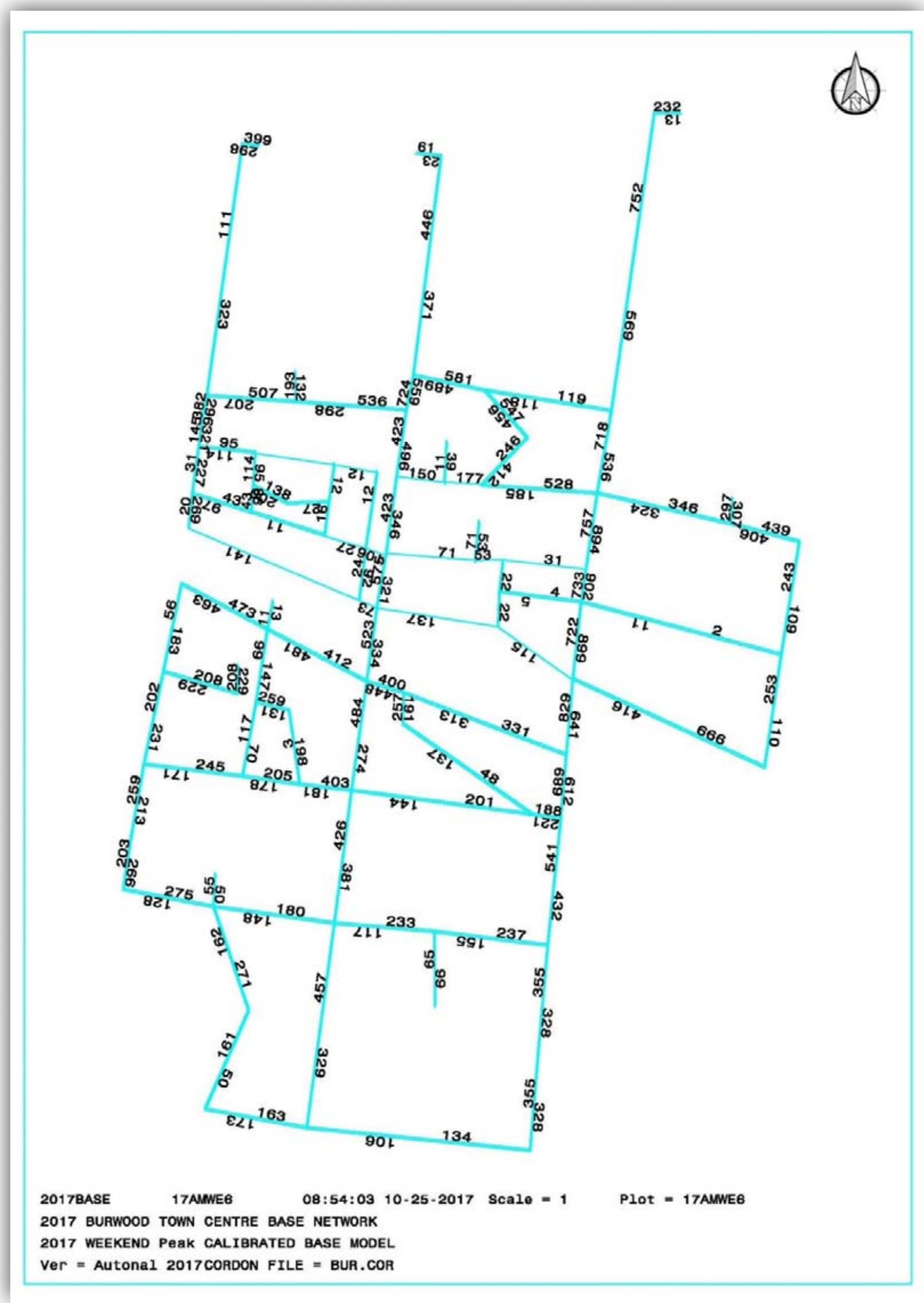


Figure 30 2017 WE Calibrated Base Model

Source Road Delay Solutions, 2017



5.11 Operational Performances

The mesoscopic modelling indicates that the Burwood Road route, both northbound and southbound, during both the AM and PM comuter peak periods between George Street and Belmore Street, currently operate at a satisfactory Level of Service (LoS) ‘D’,

Occassional residual queues are reported from several sites through preceding intersections, impeding the coordinated traffic signal operations and the through movements.

The pedestrian phases along Burwood Road are demanded each cycle and necessitate significant time to clear before allowing left and right turn vehicle movements to be performed.

This is particularly evident, southbound, at the Burwood Road intersection with Railway Parade. With a trailing and repeat right turn from the central shared through and right lane, in conjunction with the inherent delay imposed by pedestrians on the left turn movement, ‘A’ phase can ‘*trap*’ southbound motorists if the right and left turn movements are held, concurrently.

Site observations also indicated, that particularly during the morning peak and to a lesser degree during the evening peak, drop offs and pick ups at the Burwood railway station, made from the southbound kerb side lane preceding and following the pedestrian fence at Deane Street and Railway Parade, respectively, caused some minor delays when coinciding with the ‘A’ phase display at the Railway Parade intersection.

Sidra coordinated network modelling has also been undertaken, adopting a 100 second cycle length and program generated offsets to better determine the operational performance of Burwood Road during the morning and evening peak periods under the current traffic demands.

The route along Burwood Road, between George Street to the north and Clarence Street to the south, reports to operate at an unsatisfactory LoS ‘E’ in both directions during the AM and PM peak periods with an average travel speed generally less than 25km/h covering the 850m route distance. The incidence of residual queueing along the route can be attributed to the generally single lane capacity and there is no immediate opportunity, within the current road reserve, to widen and improve the route capacity and performance.

The weekend peak traffic volumes within the network, for a typical Saturday, are marginally less than those exhibited during the week day commuter peak periods.

Pedestrian activity is reduced with the reduction in Journey to Work and commercial trips and can primarily be attributed to retail activity through the centre.

Reporting an unsatisfactory LoS 'E' for the Burwood Road route during the weekend peak between George Street and Clarence Street, the road network constraints on a weekend remain the same as during the commuter peak periods.

On street parking, mid block and intersection capacity constraints and high pedestrian activity are the primary factors contributing to lower vehicle speeds and residual queueing or '*spillback*'.

Shaftesbury Road reports satisfactory operation at those intersections between Railway Pararde and Wilga Street, but capacity constraints lead to queueing between and beyond preceding intersections. This spillback is reported in the models and results in poor route performance during the weekday commuter peak periods. Shaftesbury Road operates as a significant collector road on the periphery of the Burwood Town Centre and an alternate north south corridor to Burwood Road.

Figure 31 ***2017 SIDRA 7 Modelled Road Network***

Source *Sidra/Road Delay Solutions, 2017*

NETWORK LAYOUT

Network: N101 [2017 AM Base Burwood Town Centre]

SITES IN NETWORK		
Site ID	**CCG ID**	**Site Name**
0107	NA	2017 AM Shaftesbury Rd, Railway Pde and Paisley St
0144	NA	2017 AM Shaftesbury Rd and Wilga St
0784	NA	2017 AM Shaftesbury Road and Victoria Street
GW01	NA	2017 AM Shaftesbury Rd and George St
GW02	NA	2017 AM Shaftesbury Rd and Deane St
GW04	NA	2017 AM Burwood Rd and Victoria St
GW03	NA	2017 AM Burwood Rd and George St
0174	NA	2017 AM Burwood Rd and Deane St
0014	NA	2017 AM Burwood Rd and Railway Pde
1639	NA	2017 AM Burwood Rd and Belmore St
1843	NA	2017 AM Railway Pde and Wynne Ave
R0001	NA	2017 AM Railway Pde and Conder St
R0002	NA	2017 AM Belmore St and Wynne Ave
GW05	NA	2017 AM Belmore St and Conder St
1183	NA	2017 AM Wentworth Rd, Railway Pde and Morwick St

Figure 32 2017 AM Network Summary

Source Road Delay Solutions, 2017

NETWORK SUMMARY

Network: N101 [2017 AM Base Burwood Town Centre]

New Network
Network Cycle Time = 100 seconds (Network Cycle Time - User-Given)

Network Performance - Hourly Values

Performance Measure	Vehicles	Per Unit Distance	Pedestrians	Persons
Network Level of Service (LOS)	LOS E			
Travel Time Index	2.54			
Speed Efficiency	0.33			
Congestion Coefficient	3.04			
Travel Speed (Average)	19.7 km/h		2.4 km/h	13.6 km/h
Travel Distance (Total)	6907.6 veh-km/h		466.5 ped-km/h	10151.7 pers-km/h
Travel Time (Total)	349.9 veh-h/h		198.0 ped-h/h	746.3 pers-h/h
Desired Speed	60.0 km/h			
Demand Flows (Total for all Sites)	23202 veh/h		13777 ped/h	37584 pers/h
Arrival Flows (Total for all Sites)	23031 veh/h		13777 ped/h	37195 pers/h
Demand Flows (Entry Total)	5793 veh/h			
Midblock Inflows (Total)	1936 veh/h			
Midblock Outflows (Total)	-1843 veh/h			
Percent Heavy Vehicles (Demand)	3.9 %			
Percent Heavy Vehicles (Arrival)	3.9 %			
Degree of Saturation	1.261			
Control Delay (Total)	209.51 veh-h/h		98.28 ped-h/h	444.44 pers-h/h
Control Delay (Average)	32.7 sec		25.7 sec	43.0 sec
Control Delay (Worst Lane)	291.9 sec			
Control Delay (Worst Movement)	291.9 sec		44.8 sec	291.9 sec
Geometric Delay (Average)	1.6 sec			
Stop-Line Delay (Average)	31.2 sec			
Queue Storage Ratio (Worst Lane)	1.39			
Total Effective Stops	16569 veh/h		10402 ped/h	36242 pers/h
Effective Stop Rate	0.72 per veh	2.4 per km	0.76 per ped	0.97 per pers
Proportion Queued	0.62		0.76	0.89
Performance Index	1620.7		255.7	1876.5
Cost (Total)	16152.81 $/h	2.34 $/km	4988.43 $/h	21141.23 $/h
Fuel Consumption (Total)	1068.9 L/h	154.7 mL/km		
Fuel Economy	15.5 L/100km			
Carbon Dioxide (Total)	2525.7 kg/h	365.6 g/km		
Hydrocarbons (Total)	0.281 kg/h	0.041 g/km		
Carbon Monoxide (Total)	2.343 kg/h	0.339 g/km		
NOx (Total)	3.204 kg/h	0.464 g/km		

Largest change in Average Back of Queue or Degree of Saturation for any lane during the last three iterations: 26.2 %
Number of Iterations: 10 (maximum specified: 10)
Network Level of Service (LOS) Method: SIDRA Speed Efficiency.
Software Setup used: New South Wales.

Network Performance - Annual Values

Performance Measure	Vehicles	Pedestrians	Persons
Demand Flows (Total for all Sites)	11,136,870 veh/y	6,612,885 ped/y	18,040,170 pers/y
Delay	100,563 veh-h/y	47,173 ped-h/y	213,331 pers-h/y
Effective Stops	7,953,333 veh/y	4,993,160 ped/y	17,396,020 pers/y
Travel Distance	3,315,652 veh-km/y	223,913 ped-km/y	4,872,806 pers-km/y
Travel Time	167,959 veh-h/y	95,018 ped-h/y	358,238 pers-h/y
Cost	7,753,347 $/y	2,394,444 $/y	10,147,790 $/y
Fuel Consumption	513,090 L/y		
Carbon Dioxide	1,212,322 kg/y		

Figure 33 ***2017 AM 95th % Queue Ratios***

Source *Road Delay Solutions, 2017*

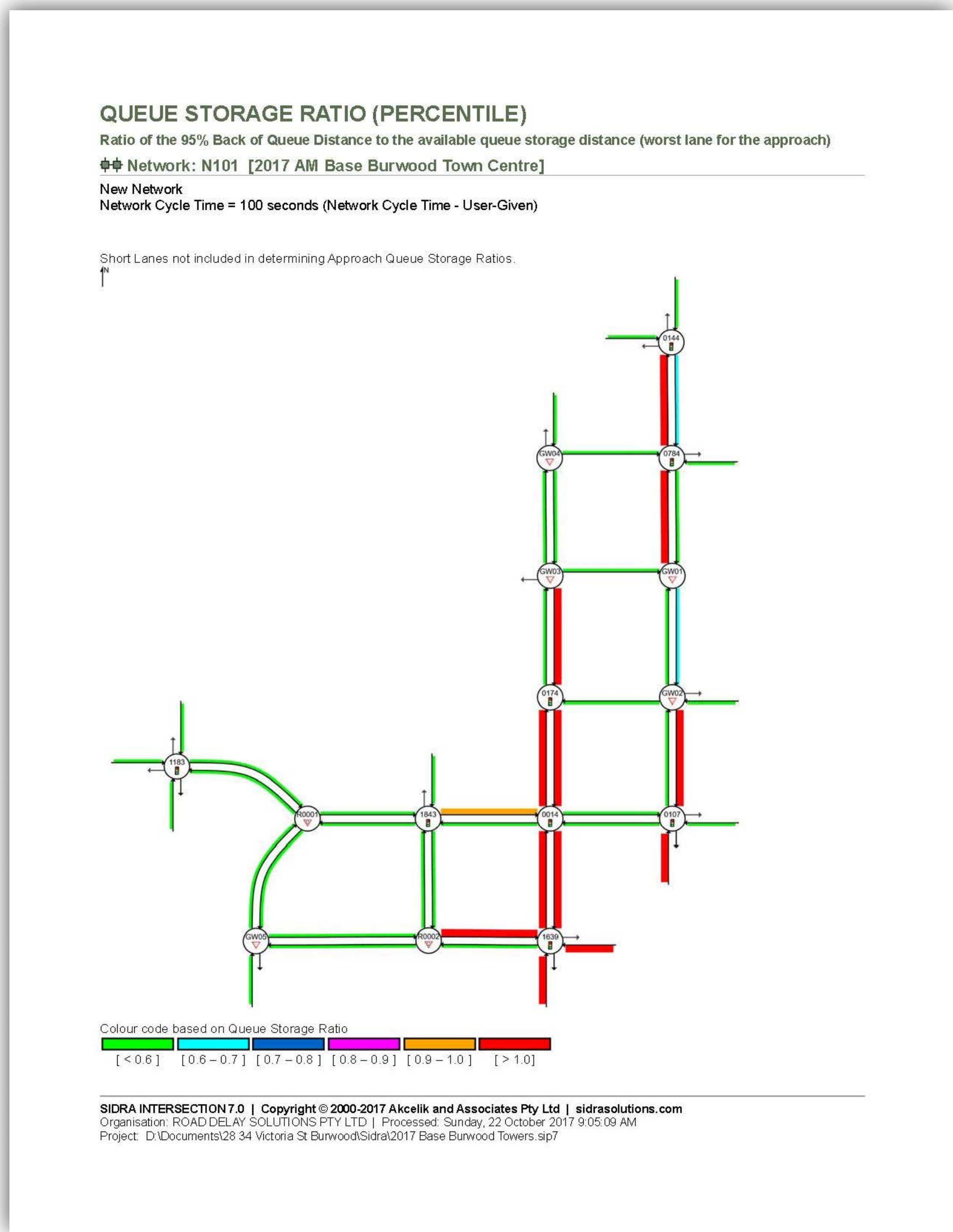


Figure 34 2017 PM Network Summary

Source Road Delay Solutions, 2017

NETWORK SUMMARY

Network: N101 [2017 PM Base Burwood Town Centre]

New Network
Network Cycle Time = 100 seconds (Network Cycle Time - User-Given)

Network Performance - Hourly Values

Performance Measure	Vehicles	Per Unit Distance	Pedestrians	Persons
Network Level of Service (LOS)	LOS E			
Travel Time Index	3.39			
Speed Efficiency	0.41			
Congestion Coefficient	2.47			
Travel Speed (Average)	24.3 km/h		2.3 km/h	16.6 km/h
Travel Distance (Total)	7226.7 veh-km/h		479.9 ped-km/h	10510.5 pers-km/h
Travel Time (Total)	297.1 veh-h/h		211.6 ped-h/h	633.7 pers-h/h
Desired Speed	60.0 km/h			
Demand Flows (Total for all Sites)	22775 veh/h		14157 ped/h	36200 pers/h
Arrival Flows (Total for all Sites)	22775 veh/h		14157 ped/h	36200 pers/h
Demand Flows (Entry Total)	5663 veh/h			
Midblock Inflows (Total)	1720 veh/h			
Midblock Outflows (Total)	-849 veh/h			
Percent Heavy Vehicles (Demand)	3.2 %			
Percent Heavy Vehicles (Arrival)	3.2 %			
Degree of Saturation	0.975			
Control Delay (Total)	154.63 veh-h/h		109.07 ped-h/h	329.50 pers-h/h
Control Delay (Average)	24.4 sec		27.7 sec	32.8 sec
Control Delay (Worst Lane)	87.9 sec			
Control Delay (Worst Movement)	87.9 sec		46.8 sec	87.9 sec
Geometric Delay (Average)	1.7 sec			
Stop-Line Delay (Average)	22.7 sec			
Queue Storage Ratio (Worst Lane)	1.11			
Total Effective Stops	13703 veh/h		10383 ped/h	30468 pers/h
Effective Stop Rate	0.60 per veh	1.9 per km	0.73 per ped	0.84 per pers
Proportion Queued	0.59		0.73	0.84
Performance Index	1234.3		269.3	1503.6
Cost (Total)	12405.48 $/h	1.72 $/km	5332.54 $/h	17738.02 $/h
Fuel Consumption (Total)	961.4 L/h	133.0 mL/km		
Fuel Economy	13.3 L/100km			
Carbon Dioxide (Total)	2267.6 kg/h	313.8 g/km		
Hydrocarbons (Total)	0.227 kg/h	0.031 g/km		
Carbon Monoxide (Total)	2.062 kg/h	0.285 g/km		
NOx (Total)	2.225 kg/h	0.308 g/km		

Largest change in Average Back of Queue or Degree of Saturation for any lane during the last three iterations: 12.0 %
Number of Iterations: 10 (maximum specified: 10)
Network Level of Service (LOS) Method: SIDRA Speed Efficiency.
Software Setup used: New South Wales.

Network Performance - Annual Values

Performance Measure	Vehicles	Pedestrians	Persons
Demand Flows (Total for all Sites)	10,931,870 veh/y	6,795,285 ped/y	17,376,030 pers/y
Delay	74,222 veh-h/y	52,356 ped-h/y	158,161 pers-h/y
Effective Stops	6,577,421 veh/y	4,983,877 ped/y	14,624,790 pers/y
Travel Distance	3,468,799 veh-km/y	230,334 ped-km/y	5,045,016 pers-km/y
Travel Time	142,587 veh-h/y	101,572 ped-h/y	304,182 pers-h/y
Cost	5,954,629 $/y	2,559,621 $/y	8,514,250 $/y
Fuel Consumption	461,466 L/y		
Carbon Dioxide	1,088,462 kg/y		

Figure 35 2017 PM 95th % Queue Ratios

Source Road Delay Solutions, 2017

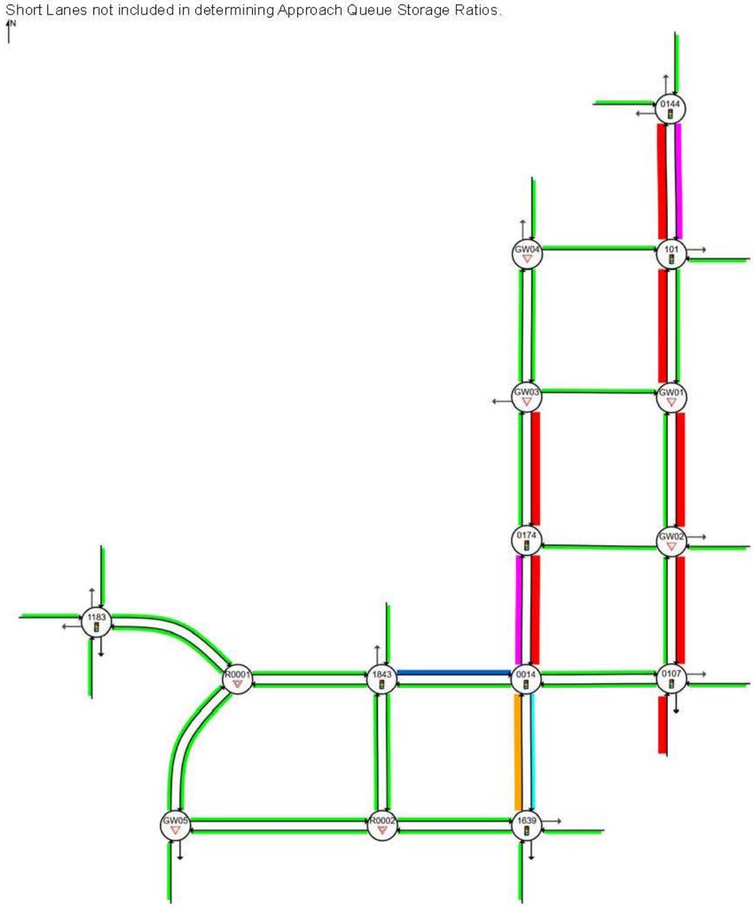
QUEUE STORAGE RATIO (PERCENTILE)

Ratio of the 95% Back of Queue Distance to the available queue storage distance (worst lane for the approach)

Network: N101 [2017 PM Base Burwood Town Centre]

New Network
Network Cycle Time = 100 seconds (Network Cycle Time - User-Given)

Short Lanes not included in determining Approach Queue Storage Ratios.



Colour code based on Queue Storage Ratio

[< 0.6] [0.6 – 0.7] [0.7 – 0.8] [0.8 – 0.9] [0.9 – 1.0] [> 1.0]

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Organisation: ROAD DELAY SOLUTIONS PTY LTD | Processed: Sunday, 22 October 2017 9:07:59 AM
Project: D:\Documents\28 34 Victoria St Burwood\Sidra\2017 Base Burwood Towers.sip7

Figure 36 2017 WE Network Summary

Source Road Delay Solutions, 2017

NETWORK SUMMARY

Network: N101 [2017 WE Base Burwood Town Centre]

New Network
Network Cycle Time = 100 seconds (Network Cycle Time - User-Given)

Network Performance - Hourly Values

Performance Measure	Vehicles	Per Unit Distance	Pedestrians	Persons
Network Level of Service (LOS)	LOS F			
Travel Time Index	2.14			
Speed Efficiency	0.29			
Congestion Coefficient	3.42			
Travel Speed (Average)	17.6 km/h		2.2 km/h	13.5 km/h
Travel Distance (Total)	6789.3 veh-km/h		468.6 ped-km/h	9917.9 pers-km/h
Travel Time (Total)	386.8 veh-h/h		212.5 ped-h/h	737.3 pers-h/h
Desired Speed	60.0 km/h			
Demand Flows (Total for all Sites)	22092 veh/h		13836 ped/h	34838 pers/h
Arrival Flows (Total for all Sites)	21888 veh/h		13836 ped/h	34577 pers/h
Demand Flows (Entry Total)	5637 veh/h			
Midblock Inflows (Total)	1795 veh/h			
Midblock Outflows (Total)	-1538 veh/h			
Percent Heavy Vehicles (Demand)	3.2 %			
Percent Heavy Vehicles (Arrival)	3.2 %			
Degree of Saturation	1.559			
Control Delay (Total)	252.04 veh-h/h		112.38 ped-h/h	445.28 pers-h/h
Control Delay (Average)	41.5 sec		29.2 sec	46.4 sec
Control Delay (Worst Lane)	551.5 sec			
Control Delay (Worst Movement)	553.2 sec		46.5 sec	553.2 sec
Geometric Delay (Average)	1.8 sec			
Stop-Line Delay (Average)	39.7 sec			
Queue Storage Ratio (Worst Lane)	1.13			
Total Effective Stops	14235 veh/h		10363 ped/h	30774 pers/h
Effective Stop Rate	0.65 per veh	2.1 per km	0.75 per ped	0.89 per pers
Proportion Queued	0.59		0.75	0.86
Performance Index	1417.6		270.1	1687.7
Cost (Total)	15314.73 $/h	2.26 $/km	5354.93 $/h	20669.66 $/h
Fuel Consumption (Total)	1061.6 L/h	156.4 mL/km		
Fuel Economy	15.6 L/100km			
Carbon Dioxide (Total)	2502.5 kg/h	368.6 g/km		
Hydrocarbons (Total)	0.259 kg/h	0.038 g/km		
Carbon Monoxide (Total)	2.211 kg/h	0.326 g/km		
NOx (Total)	2.136 kg/h	0.315 g/km		

Largest change in Average Back of Queue or Degree of Saturation for any lane during the last three iterations: 12.4 %
Number of Iterations: 10 (maximum specified: 10)
Network Level of Service (LOS) Method: SIDRA Speed Efficiency.
Software Setup used: New South Wales.

Network Performance - Annual Values

Performance Measure	Vehicles	Pedestrians	Persons
Demand Flows (Total for all Sites)	10,603,960 veh/y	6,641,179 ped/y	16,722,190 pers/y
Delay	120,977 veh-h/y	53,941 ped-h/y	213,736 pers-h/y
Effective Stops	6,832,890 veh/y	4,974,182 ped/y	14,771,550 pers/y
Travel Distance	3,258,849 veh-km/y	224,909 ped-km/y	4,760,579 pers-km/y
Travel Time	185,663 veh-h/y	101,999 ped-h/y	353,901 pers-h/y
Cost	7,351,070 $/y	2,570,368 $/y	9,921,439 $/y
Fuel Consumption	509,571 L/y		
Carbon Dioxide	1,201,216 kg/y		

Figure 37 2017 WE 95th % Queue Ratios

Source Road Delay Solutions, 2017

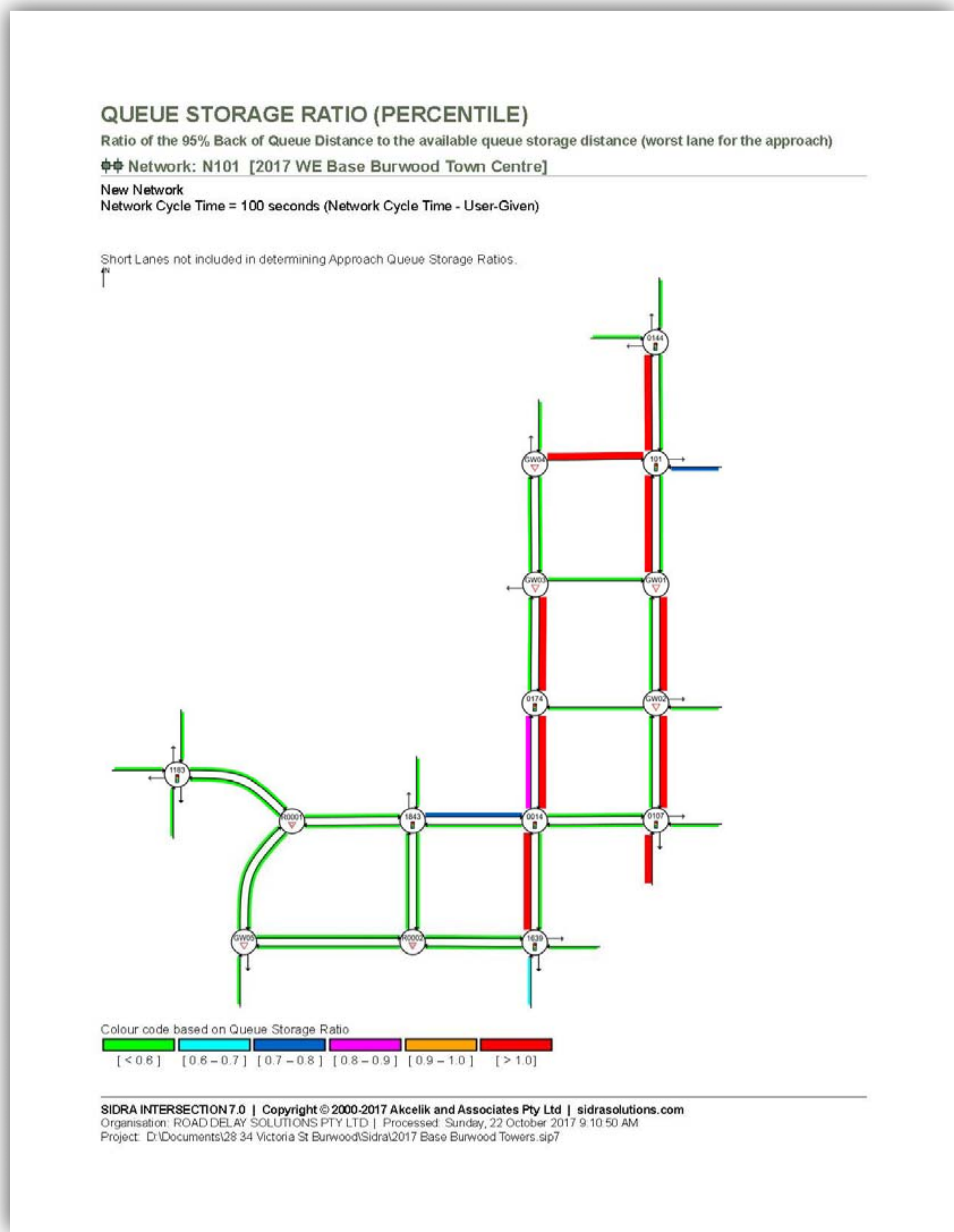
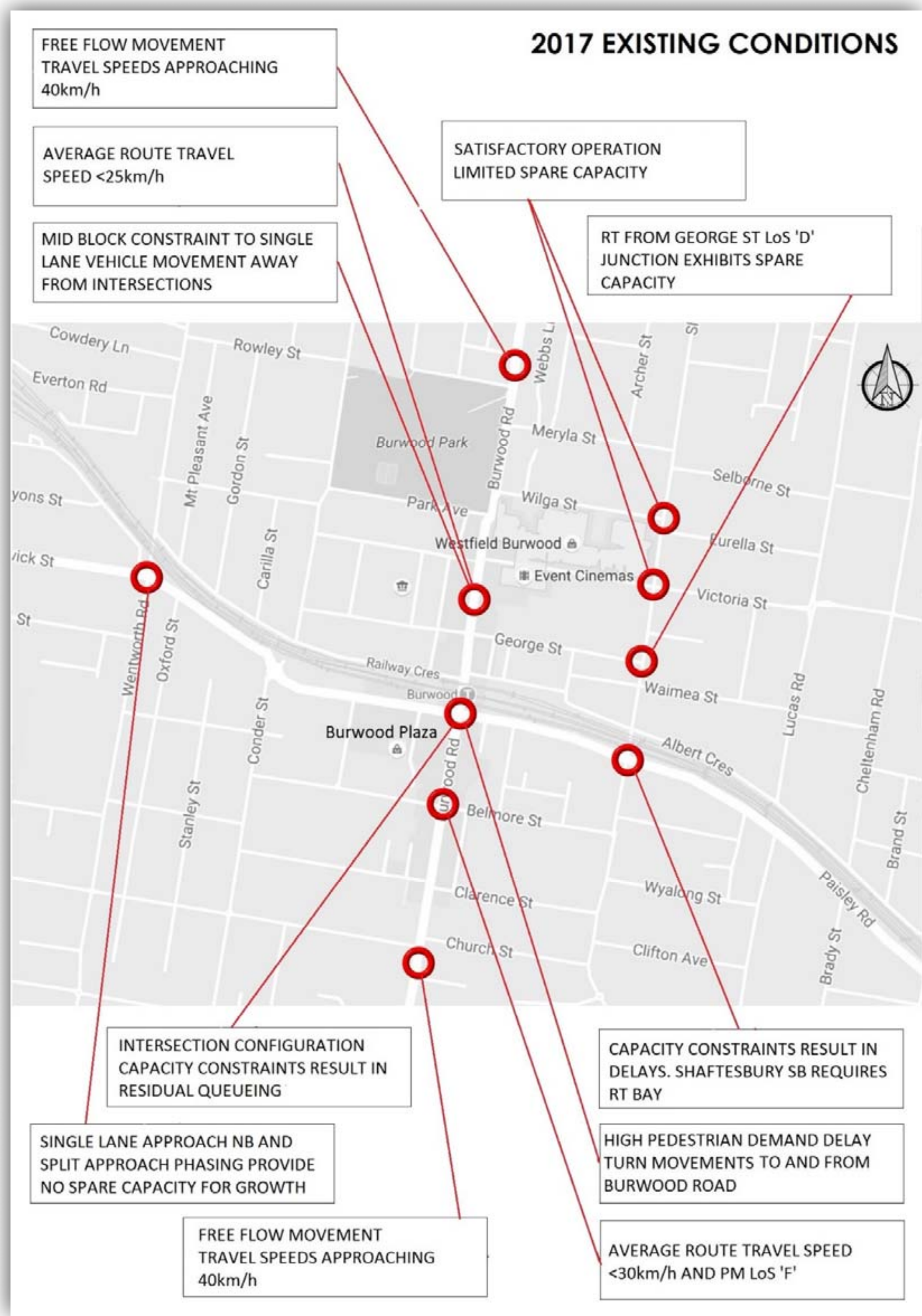


Figure 38 *2017 Existing Conditions*

Source *Road Delay Solutions, 2017*



6 FUTURE CONDITIONS

6.1 Planning Policies and Guidelines

This section contains a review of the strategic and statutory planning documents that will shape the Victoria Street & George Street development. These include the Sydney Metropolitan Strategy and subregional planning documents, as well as the current local planning strategies, environmental planning instruments and guidelines, the *Local Environmental Plan* and relevant development control plans.

The focus here will be on the policies, strategic directions and development provisions that have direct implications in the development assessment and which influence the integration of land use, transport services and facilities in the future.

6.2 Policy Context

There are a number of strategic state policies which are relevant to future development in the Sydney metropolitan area. The policies include NSW 2021, A Plan for Growing Sydney and The NSW Long Term Transport Master Plan.

6.3 NSW 2021

NSW 2021 'Plan to Make NSW Number One' sets targets to increase the number of commuter trips made by public transport within various regions through the Metropolitan area, including...

- → *80 per cent in the Sydney CBD,*
- → *50 per cent in the Parramatta CBD,*
- → *20 per cent in the Liverpool CBD, and*
- → *25 per cent in the Penrith CBD.*

The plan targets are...

- → *To improve road safety, reduce fatalities to 4.3 per 100,000 population by 2016,*
- → *Double the mode share of bicycle trips made in the metropolitan area by 2016, and*
- → *Increase the proportion of the population living within 30 minutes by public transport of a city or major centre in the metropolitan area.*

6.4 A Plan for Growing Sydney

A Plan for Growing Sydney provides a strategic plan to accommodate an additional 1.6 million people, 664,000 houses and 689,000 jobs.

The plan includes the following goals and actions...

Goal 1: A competitive economy with world class services and transport

Actions

- → *grow a more internationally competitive Sydney CBD,*
- → *grow Greater Parramatta – Sydney's second CBD,*
- → *establish a new priority growth area – Greater Parramatta to the Olympic Peninsula,*
- → *transform the productivity of western Sydney through growth and investment,*
- → *enhance capacity at Sydney's gateways and freight networks,*
- → *expand the Global Economic Corridor,*
- → *grow strategic centres – providing more jobs closer to home,*
- → *enhance linkages to regional NSW,*
- → *support priority economic sectors,*
- → *plan for education and health services to meet Sydney's growing needs, and*
- → *deliver infrastructure.*

Goal 2: A city of housing choice, with homes that meet our needs and lifestyles

Actions

- → *accelerate housing supply across Sydney,*
- → *accelerate urban renewal across Sydney – providing homes closer to employment opportunities,*
- → *improve housing choice to suit different needs and lifestyles, and*
- → *deliver timely and well planned greenfield precincts and housing.*

Goal 3: A great place to live with communities that are strong, healthy and well balanced

Actions

- → *revitalize existing suburbs,*
- → *create a network of interlinked, multipurpose open and green spaces across Sydney,*
- → *create built environments; and*
- → *promote Sydney's heritage, arts and culture.*

Goal 4: A sustainable and resilient city that protects the natural environment and has a balanced approach to the use of land and resources

Actions

- *protect our natural environment and biodiversity,*
- *build Sydney's resilience to natural hazards, and*
- *manage the impacts of development on the environment.*

The Plan for Growing Sydney defines Burwood as a 'Strategic Centre', in the 'central subregion', highlighting its importance in the metropolitan area in terms of employment and future development.

The plan provides a number of priorities specifically relating to Burwood as follows...

- *work with council to provide capacity for additional mixed use development including offices, retail, services and housing, and*
- *investigate a potential light rail corridor from Parramatta to Strathfield/Burwood via Sydney Olympic Park.*

6.5 NSW Long Term Transport Master Plan

The NSW Long Term Transport Master Plan has been developed, in association with A Plan for Growing Sydney and State Infrastructure Strategy, to support NSW 2021. The key measures identified are as follows...

- *providing a fully integrated transport system,*
- *providing a modern railway system and increase capacity by 60 per cent,*
- *providing a modern light rail system in the CBD,*
- *providing a modern bus system to complement the rail networks,*
- *connect the motorway network, including WestConnex, F3/M2 link and F6,*
- *reduce congestion in the CBD, including removing the monorail, increasing light rail, improving pedestrian links, increasing ferry use, providing increased capacity on the rail system and improved walking and cycling infrastructure,*
- *support the growth of new economic centres including the north west and*
- *south west rail links, new roads in growth areas and new bus infrastructure;*
- *connect regional communities through major highway upgrades, and*
- *improved rail, bus and air services,*
- *improve freight efficiency and productivity,*
- *improve access to Sydney Airport and Port Botany,*
- *boost walking, cycling and its integration with public transport; and*
- *preserve future transport corridors.*

6.6 The Development Footprint

The planning proposal provides for a mixed use development including approximately...

- → *436 residential apartments,*
- → *4,447m² (3,202m² GLFA) of specialty reatail floor space, and*
- → *5,849m² (4,270m² GLFA) of commercial floor space.*

Figure 39 ***The Development Footprint***

Source *Architectus, 2017*

The development '*joins*' a current site at 23–27 George Sreet with the proposed development at 28-34 Victoria Street, forming a single development site and allowing for the introduction of a thouroughfare between Victoria Street and George Street. The resultant thouroughfare will facilitate improved access with the Burwood Railway station and Westfield Shopping Complex.

Vehicular access to the site is currently under consideration from two (2) locations on both Victoria Street and George Street, allowing residential, commercial, visitor and retail parking…

- → *Victoria Street servicing a maximum of 65% of development traffic (213vph), and*
- → *George Street servicing the remaing 35% of development traffic (115vph).*

The respective access destinations will be clearly defined on the surrounding road network via the use of signposting and on the internal ramp systems within the development's underground car park, connecting to the respective parking allocations.

The preliminary allocation of traffic generation by access location are shown in the above figure and have yet to be accurately determined. These allocations, by access location, have been applied to the year 2026 development vehicle generation model and represent a '*worst case'* scenario.

The layout and internal machinations of the car park provisions and access locations are yet to be finalised, subject to the preparation of architectural drawings for DA application.

6.7 Development Access

Vehicular access to the residential, retail and commercial activities on site is currently under consideration from two (2) locations…

- → *Victoria Street servicing a maximum of 65% of development traffic, and*
- → *George Street servicing the remaing 35% of development traffic.*

Access for resident, commercial, visitor and retail spaces are currently under consideration from both Railway Parade and Wynne Avenue.

The respective access destinations will be clearly defined on the surrounding road network via the use of signposting and on the internal ramp systems within the development's underground car park, connecting to the respective parking allocations.

The preliminary allocation of traffic generation by access location are shown in the above figure and have yet to be accurately determined. These allocations, by access location, have been applied to the year 2026 development vehicle generation model and represent a '*worst case'* scenario.

The layout and internal machinations of the car park provisions and access locations are yet to be finalised, subject to the preparation of architectural drawings for DA application.

The passenger vehicle access points to the car park will be provided in accordance with the Australian Standard for Parking Facilities Part 1 Off-Street, AS 2890.1:2004.

The yet to be determined loading dock provisions will comply with *AS 2890.2 – 2002 Parking Facilities Part 2 Off-Street commercial vehicles*.

6.8 Parking Provisions

The parking provisions are to be finalised prior to DA submission. Currently, the locations, quantity and access conditions are yet to be determined, in consultation with key stakeholders.

The development will accord with Burwood City Council's DCP which includes the following parking requirements for development in centres…

Offices *One (1) parking space per 400m² (for the first 400m² plus one space per 120m² thereafter,*

Retail *One (1) space per 33m²,*

0.5 spaces per studio/bed sitter,

One (1) space per one/two bedroom apartment,

1.5 spaces per three bedroom apartment; and

One (1) space per five dwellings for visitor parking.

By comparison, the *RMS guide* suggests the following parking requirements for high density residential in sub-regional centres and CBDs…

Sub-regional centres

0.6 spaces per one bedroom apartment,

0.9 spaces per two bedroom apartment,

1.4 spaces per three bedroom apartment, and

One (1) space per five apartments for visitors.

CBDs

0.4 spaces per one bedroom apartment,

0.7 spaces per two bedroom apartment,

1.2 spaces per three bedroom apartment, and

One (1) space per seven apartments for visitors.

The appropriate parking rates will be provided at the development application stage, based on the rates in the following table. Appropriate provisions for disabled and motor cycle parking will be included in the development based upon AUSTROADS guidelines.

Figure 40 ***Development Parking Requirements***

Source *Road Delay Solutions, 2017*

DEVELOPMENT SITE PARKING TABLE					
Development Component	**Area (Units &/or GLFA m²)**	**Area (Units &/or GFA m²)**	**DCP**		
			Units	***Rate***	***Requirement***
Residential Apartments					
1 Bed Apartments	103		per unit	1	103
2 Bed Apartments	280		per unit	1	280
3 Bed Apartments	53		per unit	1.5	80
Visitor Parking	436		per 5 units	1	87
Disabled	436		per 100 units unless demand requested	1	4
Car Share$	436		per 100 units	1	4
Retail Specialty Shops	3,202	4,447	1 space first 400m² then add 1 space per 40 m2 above first 400m² GLFA	1	71
Restaurants/Cafes #	0		1 space first 400m2 then add 1 space per 40 m2 above first 400m2 GLFA	1	0
Takeaway#	0		per 3 seats	1	0
Commercial	4,270	5,849	1 space first 400 m² then add 1 space per 120 m² GFA		46
Bicycles - Residential	436		per 3 units	1	144
Commercial	5,800		per 200m2 GFA	1	29
Retail Specialty Shops	5,048		per 300m2 GLFA	1	17
Restaurants	0		per 100m2 GLFA	1	0
Café	0		per 25m2 GLFA	1	0
Takeaway	0		per 100m2 GLFA	1	0
TOTAL SPACES					**676**

**The Supermarket and Specialty Shops Generation rate is based on RMS Technical Direction TDT 2013/04a for the highest weekday generation - 5.9vph/100m2 of GLFA.*

 # Restaurants, Cafes and Takeaway Outlets are included in the retail floor space allowance

$ Car share spaces may be included within the visitor parking allocation and signposted accordingly

6.9 Growth Forecasts

Investigations into the traffic impacts associated with the *Victoria Street & George Street* Planning Proposal have required the preparation of a mesoscopic, computer based, model.

The *Department of Planning* have set the areas defining the Burwood Town Centre as Travel Zones TZ 910, 913 and 915.

The future Year trip matrices, originally produced by the *BTS* in October 2014 and revised in October 2016, have been developed from a 4 step travel model established on forecast population and employment projections throughout the Metropolitan Area and assigned to a computer based transport network.

These trip tables form the basis for the *Netanal* future year trip demands and have been applied from the 2011 *BTS* travel zone (TZ) system, through the employment of an equivalency table, prepared and provided by the *BTS*.

Generally, the *Netanal* vehicle trip distribution for the future year trip tables of the Sydney Statistical Division have been retained from the *BTS* trip matrices. However, known irregularities between the land use assumptions within the *BTS* matrices and available growth data, in particular *BTS* TZs 910, 913 and 915, make it necessary to disaggregate the zone structure to better reflect the furture year demand generations associated with the Victoria Street & George Street development.

The following figure presents the interpreted population data employed in the modelled trip matrices for TZs 910, 913 and 915…

- → *A residential population of 8,374 persons in year 2016 is anticipated to reach 11,714 by year 2026, being an increase of 3,340 persons,*
- → *Dwellings (homes and/or apartments) are set to reach 6,069 by 2026, an increase of 1,730 with an adopted occupancy rate of 1.93 persons, and*
- → *The current workforce of 4,353 is expected to reach 6,051 by year 2026.*

The *BTS* data has been compared with Council's approved and known developments which lie within the *BTS* Zones 910, 913 and 915. It has been considered that while still to be determined, the addition of growth associated with the Parramatta Road Urban Renewal Project on the southern side of Parramatta Road either side of Burwood Road is captured by the *BTS* projections. However the specific extent of the proposed Urban Renewal project and its associated traffic generation is yet to be determined.

After careful consideration and assessment it is considered that the *BTS* projections adequately encompass the approved and known development within the town centre, at this time.

The analysis also determined that the *BTS* forecast dwellings of 6,069 is in fact marginally higher than Council's current anticipated growth level achieving only 5,565 dwellings by year 2026. The *BTS* and Council growth levels are presented in the following figures.

Figure 41 Burwood Town centre Adopted Growth Projections

Source BTS Zone Explorer, 2017

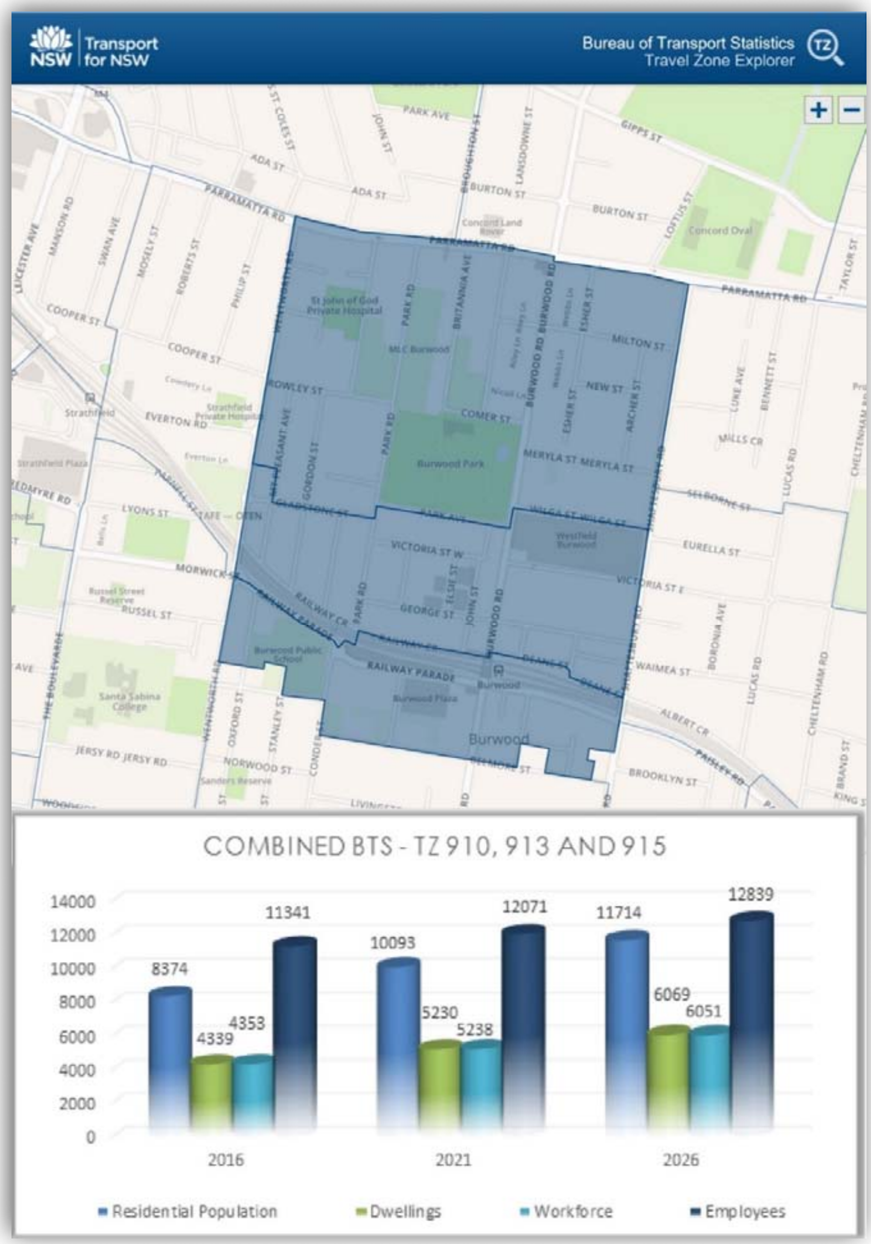


Figure 42 Burwood Council Approved and Planned Developments

Source Cardno, 2016

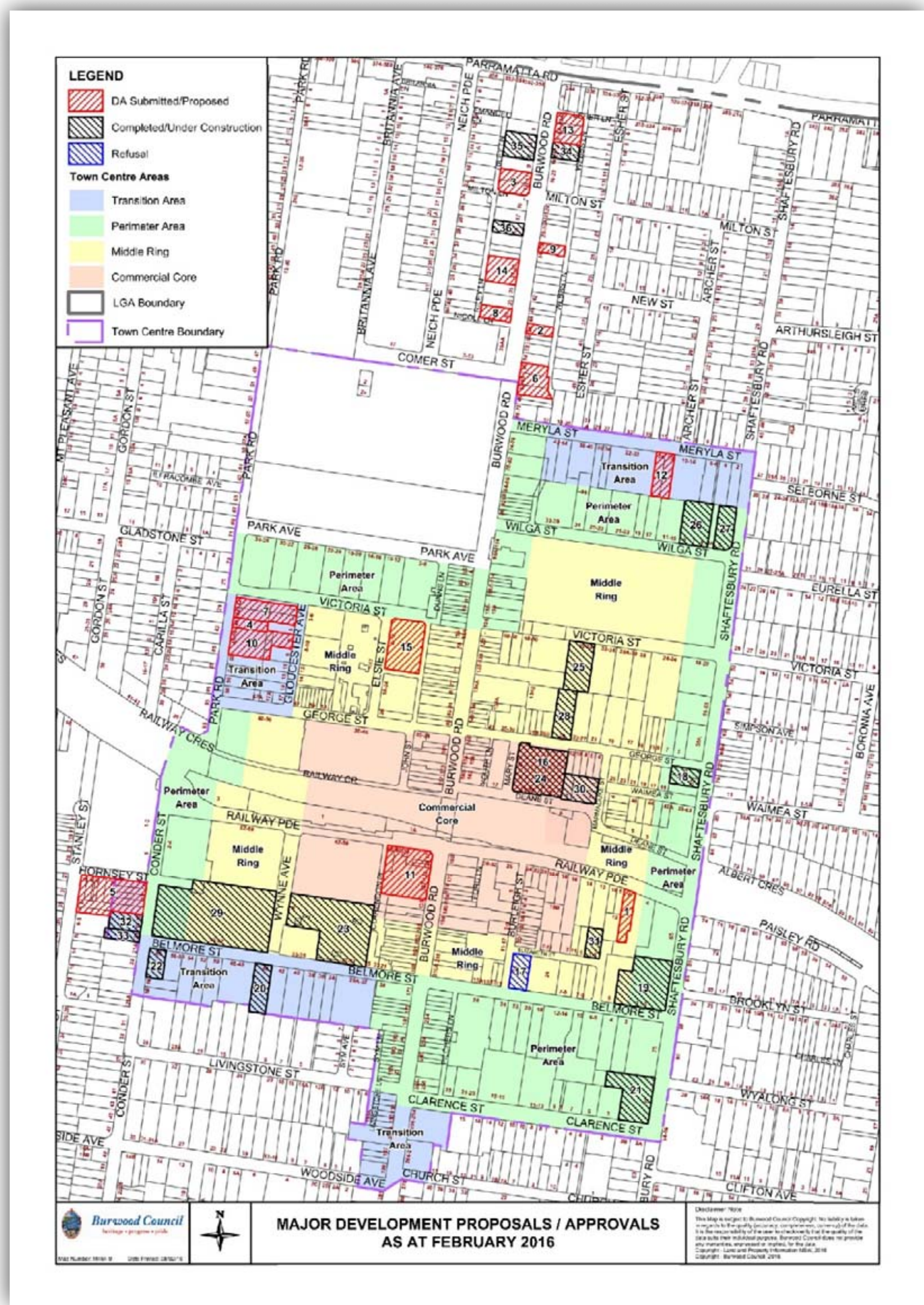
CALCULATED VEHICLE GROWTH WITHIN BTS TZ 913 and 915 PLANNED DEVELOPMENT

Identifier BTS Zone	Address	Proposed Development	Component: Residential Units	Component: Retail GLFA *(70% of Site Area)*	Component: Serviced Apartments	Component: Commercial GLFA *(70% of Site Area)*	Generation Rate: Residential	Generation Rate: Retail	Generation Rate: Serviced Apartments	Generation Rate: Commercial	Vehicle Generation: AM	Vehicle Generation: PM
1 915	6 Railway Parade BURWOOD	Constructed 17 storey mixed residential flat building containing 47 residential units, 3 levels of commercial units, over 3 level of basement parking for 48 vehicles	BURWOOD CENTRAL EXISTING TRAFFIC GENERATION 2016									
2 910	48 Burwood Road BURWOOD	Construction of a 7 storey development comprising one ground floor commercial suite and twenty residential apartments over two levels of basement parking for 17 car parking spaces	20			252	0.19	0.125	0.4	0.016	8	8
3 910	11 - 13 Burwood Road BURWOOD	Construction of an 8 storey mixed use development containing commercial space, 37 residential apartments over 3 levels of basement parking for 53 vehicles	37			504	0.19	0.125	0.4	0.016	15	15
4 **913**	46 Park Road BURWOOD	Construction of a 5 storey residential flat building containing 14 units above basement parking	14				0.19	0.125	0.4	0.016	3	3
5 915	7 – 15 Conder Street, 2 – 10 Hornsey Street and 2 – 4 Stanley Street BURWOOD	Demolition and construction of Part 4 and 5 storey residential flat above basement parking	14				0.19	0.125	0.4	0.016	3	3
6 910	56 – 60 Burwood Road BURWOOD	Construction of 9 storey mixed use development containing 46 residential units and 1 ground floor retail suite above the basement parking	46	882			0.19	0.125	0.4	0.016	119	119
7 **913**	1 – 3 Gloucester Avenue and 42 – 44 Park Road BURWOOD	Construction of a 4 storey residential flat building comprising of 129 units with 2 levels of basement parking	129				0.19	0.125	0.4	0.016	25	25
8 910	35 Burwood Road BURWOOD	Construction of a 9 storey mixed use development containing ground floor commercial suites and 22 residential units above basement parking	22			420	0.19	0.125	0.4	0.016	11	11
9 910	32 Burwood Road BURWOOD	Construction of a 6 storey mixed use development containing ground floor commercial suites and 22 residential units above basement parking	22			252	0.19	0.125	0.4	0.016	8	8
10 **913**	7 Gloucester Avenue and 48 – 50 Park Road BURWOOD	Construction of a 5 storey residential flat building containing 42 units above basement parking	42			420	0.19	0.125	0.4	0.016	15	15
11 915	121 – 133 Burwood Road and 38 – 40 Railway Parade BURWOOD	Construction of a 20 storey mixed - use development consisting of 3 levels of retail suites, 1 level of restaurant, 7 levels containing 56 serviced apartments, 9 levels containing 68 residential apartments above basement parking	68	4200	56		0.19	0.125	0.4	0.016	560	560
12 910	18 – 20 Meryla Street BURWOOD	Construction of a 5 storey multi residential flat building containing 27 residential units, 3 commercial units and over 2 levels of basement parking for 33 vehicles	27			630	0.19	0.125	0.4	0.016	15	15
13 910	2A – 8 Burwood Road BURWOOD	Construction of a 9 storey residential flat building containing 50 residential units, over 2 level of basement parking for 67 vehicles	50				0.19	0.125	0.4	0.016	10	10
14 910	27 – 29 Burwood Road BURWOOD	Construction of a 9 storey mixed use development consisting of 46 residential units, 4 commercial premise units and 2 levels of basement car parking	46			525	0.19	0.125	0.4	0.016	17	17
15 **913**	2 -14 Elsie Street BURWOOD	Retention of 7 storeys commercial building and construction of 8 storey mixed use development containg 64 units and 2 reatil units above basement parking	64	945			0.19	0.125	0.4	0.016	130	130
16 **913**	9 - 15 Deane Street and 18 - 20 George Street BURWOOD	Construction of 3 storey residential flat building above basement parking	12				0.19	0.125	0.4	0.016	2	2
		TOTALS	**613**	**6027**	**56**	**3003**					**940**	**940**
		BYS TZ 910	**270**	**0**	**0**	**2583**					**1873**	**1873**
		BTS TZ 913	**261**	**945**	**0**	**420**					**150**	**150**
		BTS TZ 915	**82**	**4200**	**56**	**0**					**563**	**563**

1. *The above excludes the Burwood Plaza Redevelopment.*
2. *Retail and commercial GLFA has been calculated as 70% of the total site area.*

Figure 43 Burwood Town Centre Development Opportunity

Source Architectus/COX, 2016



6.10 Traffic Generation

All projected traffic generation rates applied to the developments within the town centre were based on the industry standard *RMS Guide to Traffic Generating Developments*.

Based on the RMS's *Technical Direction TDT 2013/04a* entitled *'Guide to Traffic Generating Developments Updated Traffic Surveys'*, hereby referred to as the '*guide*', the Victoria Street & George Street development will generate 9,912 vehicle trips daily, with 3,200 vehicle trips, including heavy vehicles, occurring during the morning and evening commuter peak periods, combined.

The *RMS Technical Direction* outlines the generation rate for the high density residential form, per apartment, commercial and retail activities. The following presents the applied generation rates adopted for the assessment of the road network.

While the average annual growth in vehicular traffic throughout the Metropolitan area is in the order of 1.5%-1.7% the current average annual growth on Burwood Road is reported as -0.9% across the combined AM and PM peak commuter periods. The AM peak reports an average growth of 0.3% per annum while the PM peak is reported as -1.8%.

While the applied annual growth rate in traffic of 1.5% to 1.7% throughout the Metropolitan area within the models is higher than that currently reported on Burwood Road, examination of the competing parallel route of Shaftesbury Road, suggest a significant volume of through traffic and vehicles accessing the town centre utilise this corridor.

The applied annual growth rate is considered to be a conservatively high estimation within the study area given that the town centre is already well established, with Burwood Road operating near or at capacity during the commuter peak periods. Expectations are that with no change to the road network the reported growth on Burwood Road from the year 2026 '*Do Nothing*' model vehicular growth within the study area will be low.

Table 6 ***Proposed Vehicle Generation***

Source *Road Delay Solutions, 2017*

VICTORIA TOWERS VEHICLE GENERATION TABLE

Development Component	Area (Units &/or GLFA m²)	Area (Units &/or GFA m²)	Daily RMS Trip Rate	AM Peak Hour GLFA RMS Trip Rate/m²	PM Peak Hour GLFA RMS Trip Rate/m²	PM Peak Hour GLFA RMS Trip Rate/m²	AM Peak Hour Generation (vph)	PM Peak Hour Generation (vph)	WE Peak Hour Generation (vph)	AM Outbound Trips (vph)	AM Inbound Trips (vph)	PM Outbound Trips (vph)	PM Inbound Trips (vph)	WE Outbound Trips (vph)	WE Inbound Trips (vph)
Residential Apartments	436		1.52	0.19	0.15	0.1	83	65	44	66	17	13	52	24	20
1 Bed Apartments	103														
2 Bed Apartments	280														
3 Bed Apartments	53														
Retail Specialty Shops*	3,202	4,447	0.3403	0.059	0.059	0.075	189	189	240	85	104	104	85	132	108
Commercial	4,270	5,849	0.11	0.016	0.012	0.001	68	51	4	10	58	44	8	3	2
TOTAL			**2,222**				**340**	**306**	**288**	**162**	**179**	**161**	**145**	**159**	**129**

**The Specialty Shops Generation rate is based on RMS Technical Direction TDT 2013/04a for the highest weekday generation - 5.9vph/100m2 of GLFA.*

The retail GLFA excludes common areas such as walkways, garbage holding room(s), unoccupied lobby areas and the shared stock storage provisions.

6.11 Traffic Distribution

The traffic distribution through the town centre has been drawn from numerous sources.

Residential and commercial land use distribution has been based on the applied year 2026 *BTS* trip matrices, published in 2014 and revised in October 2016.

The retail distribution has been determined by a catchment analysis of simillar operations.

To determine and apply the distribution of traffic generated by the proposed retail operations, within the model, former analyses of retail operations for the Gladesville Shopping Village and Warriewood Square were undertaken by *Road Delay Solutions* in the first and third quarters of 2016, respectively

The retail distribution pattern was determined by a simple survey of 126 patrons at each surveyed complex, entering by vehicle into the carparks, and observed heading to the respective supermarkets. These patrons were asked to roughly estimated the distance they had travelled or their origin postcode. The survey did not include pedestrian foot traffic.

These investigations revealed that patrons to both centres were generally attracted from a radial catchment not exceeding 5 kilometres.

It was found that the retail operations generally attracted some 72% of patrons from within a 1.5 kilometre radius of the site, a further 19% within 2kms and with the majority of the remaining 8%, some 3.5 - 4kms.

This particular distribution pattern has been applied within the trip matrices applied to the future year 2026 model. The distribution of traffic was proportionately applied to the percentage of residential lots within adjoining catchments.

It was found that the current 2016 matrices reflected a similar trip distribution pattern with the exception of some 10% arriving from an origin some 5.5km away.

6.12 Future Year Models

The future year 2026 models were run against three different infrastructure scenarios to understand and compare the impacts associated with the Victoria Street & George Street development site and Council's proposed Section 94 infrastructure…

- *2026 'Do Nothing' - The future growth run on the current 2016 road network,*
- *2026 Section 94 Model – The developed 2026 road network including the Section 94 infrastructure improvements with the future year 2026 traffic demands, excluding the Victoria Street & George Street development traffic, and*
- *2026 Development Model – The 2026 Section 94 road network including proposed infrastructure and traffic generation from the Victoria Street & George Street development.*

Three (3) levels of road network and intersection performance have been undertaken for this project…

- *Network,*
- *Route, and*
- *Intersection.*

Network performance assess the operation of all modelled intersections and their interaction.

Route performance which focuses on Burwood Road, both northbound and southbound, between Deane Street in the north to belmore Street in the south.

Intersection performance is reported from the *SIDRA* network models and reports the operation of each individual intersection.

6.13 2026 Base Year Model

(2026AMBTB.PLT/2026PMBTB.PLT/26AMWEB.PLT)

Year 2026 was nominated as the future assessment year which is conventional practice for this form of mixed use development. The year represents a practical timeframe within which some confidence in the understanding of likely development levels and prevailing traffic patterns can be made.

The future year 2026 model was developed to understand the likely traffic impacts the general metropolitan growth, and any other potential Burwood town centre developments, would have on the traffic network.

Year 2026 is a typical planning horizon based upon 15 years since the observed census data in 2011.

The base case or hereafter termed the '*Do Nothing*' traffic model was developed with the 2026 trip matrices assigned to the 2016 road network with no infrastructure improvements or mitigation measures employed.

With the *BTS* housing and employement growth rates applied to the modelled 2026 trip matrices, the reported vehicle growth projections, within the town centre, are presented in the following table. By comparison, the Metropolitan arterial road network screen lines, including Parramatta Road and the Hume Highway, report an average growth of some 13.8% to year 2026.

Table 7 Projected 10 Year Vehicle Growth

Source Road Delay Solutions, 2017

AVERAGE PROJECTED VEHICLE GROWTH TO YEAR 2026			
Road	**AM PEAK**	**PM PEAK**	**WEEKEND PEAK**
Burwood Road	7.8%	7.6%	8.7%
Shaftesbury Avenue	16.1%	12.1%	8.7%
Wentworth Road	11.0%	12.1%	8.5%

The road network operation and Burwood Road route operation are both reported as LoS'E' The reported growth on Shaftesbury Road is greater than that on Burwood Road and suggesting that the congested state of Burwood Road will be unattractive to motorists until such time as capacity constraints can be reduced or eliminated.

Shaftesbury Road reports a route LoS 'F' which is caused by queued vehicles trailing back into preceding intersections due to capacity issues such as...

- *Shared lanes and the split approach phasing at the Railway Parade/Paisley Street intersection, and*
- *The single through lanes in Shaftesbury Road, at the signalised intersection of Wilga Street, which restricts the vehicle capacity entering and exiting the study area to the north.*

It is apparent that with the anticipated metropolitan growth, Burwood Road and Shaftesbury Road will continue to operate, at their respective levels of service, until such time as the capacity constraints along each route can be addressed.

Anecdotally, it can be supposed that Burwood Road is operating at or near its theoretical capacity and will allow for no further growth in vehichular traffic while the competing parallel route of Shaftesbury Road remains a viable option.

It is considered that the level of congestion reported on Burwood Road is acceptable as it reduces the speed of vehicles within a highly pedestrianised town centre while diminishing the attractiveness of the route to through traffic. Invariably, reducing congestion on Burwood Road would likely increase vehicle speeds and may give rise to any potential incident severity. Furthermore, all evidence would suggest that any treatment to reduce traffic on Burwood Road would see a proportionate and corresponding rise in traffic on Shaftesbury Road.

The modelling suggests that with the anticipated growth to year 2026, Shaftesbury Road will also operate close to its theoretical capacity limits but with generally, acceptable average vehicle delays along the corridor.

Table 8 ***Road Network and Route Operational Performance***

Source *Road Delay Solutions, 2017*

SIDRA NETWORK AND ROUTE PERFORMANCE												
	2016 Existing			2026 'Do Nothing' Base			2026 'With Section 94'			2026 Full Plaza Development		
	AM	PM	WE	AM	PM	WE	AM	PM	WE	AM	PM	WE
NETWORK PERFORMANCE - BURWOOD TOWN CENTRE ROAD NETWORK												
LOS	E	E	F	E	E	E	E	F	F	F	F	F
AVD *(sec)*	32.7	24.4	41.5	37.8	34.9	31.7	29.2	58.5	44.5	45.3	49.9	45.6
DS	1.261	0.975	1.559	1.152	1.227	1.303	1.499	1.503	1.684	1.501	1.274	1.382
ROUTE PERFORMANCE - BURWOOD ROAD NORTHBOUND												
LOS	E	E	E	E	E	E	E	E	E	E	E	E
AVD (sec)	120.5	11.2	15.2	18.7	15.7	9.1	11.5	10.6	9.3	45.3	49.9	45.6
DS	0.966	0.728	0.826	0.855	0.895	0.819	0.768	0.749	0.75	1.1	0.899	0.893
ROUTE PERFORMANCE - BURWOOD ROAD SOUTHBOUND												
LOS	E	E	E	E	E	E	D	E	E	E	E	E
AVD (sec)	92.1	10	9.6	18.1	11.2	11.5	13	9.1	11.4	13.6	12.5	8.8
DS	0.997	0.711	0.715	0.855	0.847	0.793	0.772	0.714	0.689	0.805	0.939	0.709
ROUTE PERFORMANCE - SHAFTESBURY ROAD NORTHBOUND												
LOS	F	E	F	F	E	F	F	E	F	F	F	F
AVD (sec)	92.1	21.3	30.4	37.4	21.6	46.1	17.4	22	43.2	41	31.9	28.5
DS	0.894	0.875	0.845	1.119	0.862	1.188	0.894	0.854	1.08	1.082	0.843	0.908
ROUTE PERFORMANCE - SHAFTESBURY ROAD SOUTHBOUND												
LOS	E	E	D	F	F	E	E	F	E	F	F	F
AVD (sec)	73.6	15.1	11.4	35.1	60.7	15.2	19.2	135.6	23.9	53.4	72.7	46.2
DS	0.849	0.868	0.835	1.053	1.227	0.866	0.895	1.503	0.934	1.095	1.274	1.07

Table 9 ***Burwood Town Centre Intersection Operational Performance***

Source *Road Delay Solutions, 2017*

BURWOOD TOWN CENTRE SIDRA NETWORK INTERSECTION PERFORMANCE	2017 Existing			2026 'Do Nothing' Base			2026 'With Section 94'			2026 Full Development		
	AM	PM	WE	AM	PM	WE	AM	PM	WE	AM	PM	WE
Burwood Road and Victoria Street East												
DS	0.156	0.182	0.165	0.158	0.275	0.231	0.171	0.206	0.186	0.44	0.752	0.525
AVD *(sec)*	1.2	1.6	1.5	1.1	1.9	1.7	1.2	1.5	1.3	11.4	15.7	11.8
LOS	A	A	A	A	A	A	A	A	A	A	B	A
Burwood Road, Deane Street and Railway Crescent												
DS	0.881	0.711	0.723	0.288	0.772	0.755	0.671	0.72	0.819	0.871	0.731	0.883
AVD *(sec)*	19.6	14	13.9	2.4	14.7	14.1	14.2	14.3	16.3	14.2	14.1	19.8
LOS	B	A	A	A	B	B	A	B	B	A	B	B
Burwood Road and Railway Parade												
DS	0.861	0.798	0.798	0.855	0.882	0.869	0.772	0.831	0.71	0.924	0.986	0.896
AVD *(sec)*	36.3	25.5	25.5	27.4	36.3	31.2	20.8	24.9	20.3	34.2	54.6	33.3
LOS	C	B	B	B	C	C	B	B	B	C	D	C
Burwood Road and Belmore Street												
DS	1.177	0.666	0.856	0.799	0.791	0.73	1.07	0.709	0.895	0.918	0.824	0.692
AVD *(sec)*	72.3	16.4	21.1	18.9	21.5	20.4	45.7	19.9	36.1	25.5	21.9	20.8
LOS	F	B	B	B	B	B	D	B	C	B	B	B
Shaftesbury Road and Wilga Avenue												
DS	0.639	0.871	0.794	1.157	0.857	0.898	0.981	0.864	0.878	1.039	0.945	0.995
AVD *(sec)*	16.5	21.3	19.6	123	21.4	32	44.2	24.7	29.7	55.8	44.5	43.7
LOS	B	B	B	F	B	C	D	B	C	D	D	D
Shaftesbury Road and Victoria Street												
DS	0.892	0.763	0.728	0.824	0.791	0.842	0.873	0.845	0.845	0.907	0.903	0.867
AVD *(sec)*	45.2	22.4	48.8	26.4	22.1	44.2	31.9	40.8	41.9	48.7	46.4	32.5
LOS	B	B	D	B	B	D	C	C	C	D	D	C
Shaftesbury Road and George Street												
DS	0.182	0.28	0.415	0.196	0.84	0.793	0.623	1.008	1.689	0.668	0.838	0.736
AVD *(sec)*	1	1.3	1.9	0.4	3.8	3.7	2.1	6.8	28	8.8	13.4	10.5
LOS	A	A	A	A	A	A	A	A	B	A	A	A
Shaftesbury Road, Railway Parade and Paisley Street												
DS	0.91	0.84	0.84	0.829	0.856	0.762	0.853	0.854	0.854	0.925	0.876	0.852
AVD *(sec)*	44.4	41.9	37.7	34.1	45.5	26.6	29.2	39.8	31.6	49.1	41.6	41.6
LOS	D	C	C	C	D	B	C	C	C	D	C	C
Wentworth Road, Railway Parade and Morwick Street												
DS	0.879	0.975	0.84	0.796	0.975	0.807	0.911	1.121	1.129	0.911	1.174	0.919
AVD *(sec)*	43.9	61.4	37.7	33	61.4	37.8	49.8	139.1	127.7	49.8	172.2	57.8
LOS	D	E	C	C	E	C	D	F	F	D	F	D
Burwood Road and George Street												
DS	0.196	0.164	0.17	0.196	0.194	0.19	0.167	0.172	0.208	0.167	0.18	0.208
AVD *(sec)*	0.7	0.7	1	0.4	0.7	0.9	1.3	1.1	1.3	1.3	1.1	1.3
LOS	A	A	A	A	A	A	A	A	A	A	A	A

Figure 44 2026 AM 'Do Nothing' Traffic Projections

Source Road Delay Solutions, 2017

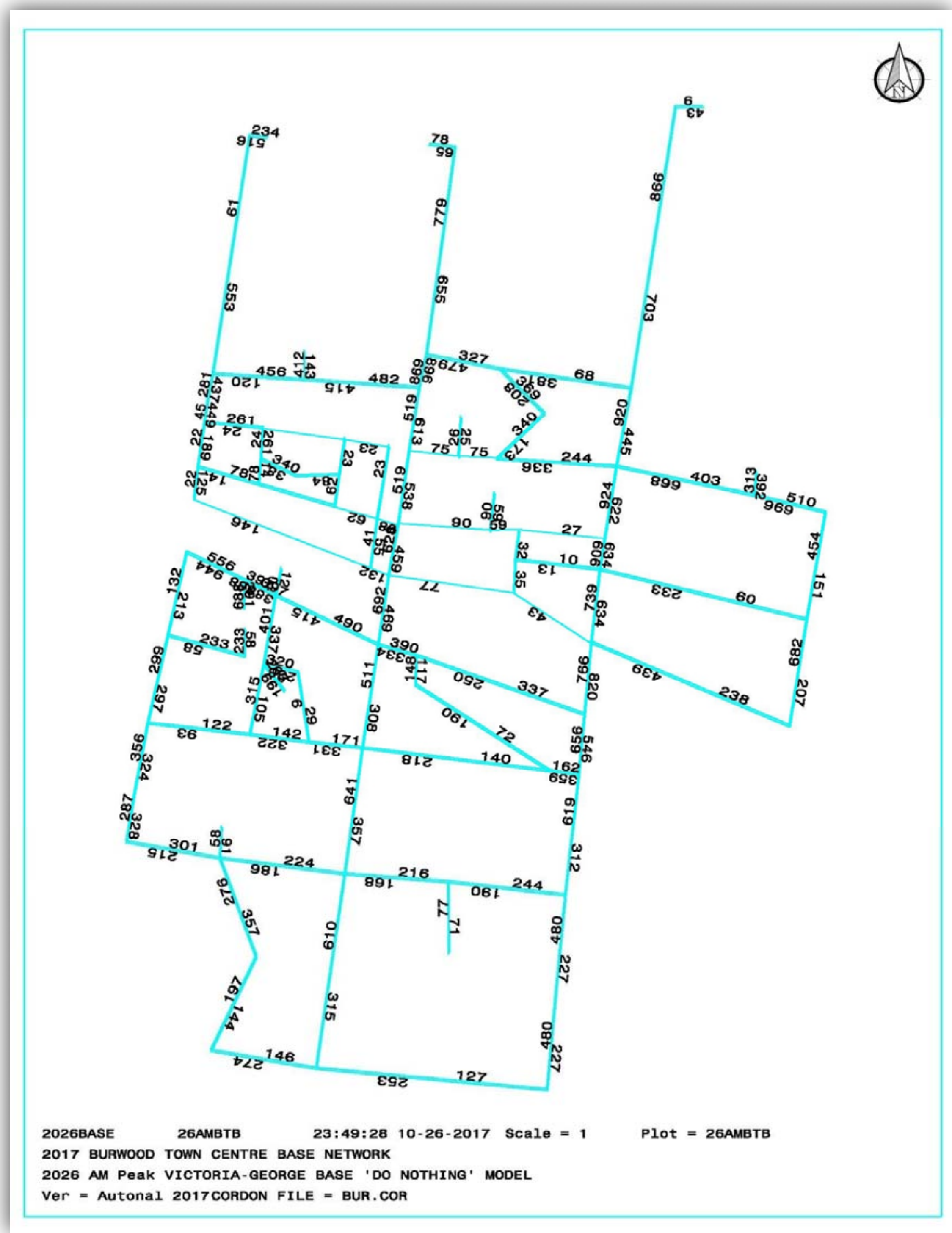


Figure 45 ***2026 PM 'Do Nothing' Traffic Projections***

Source *Road Delay Solutions, 2017*

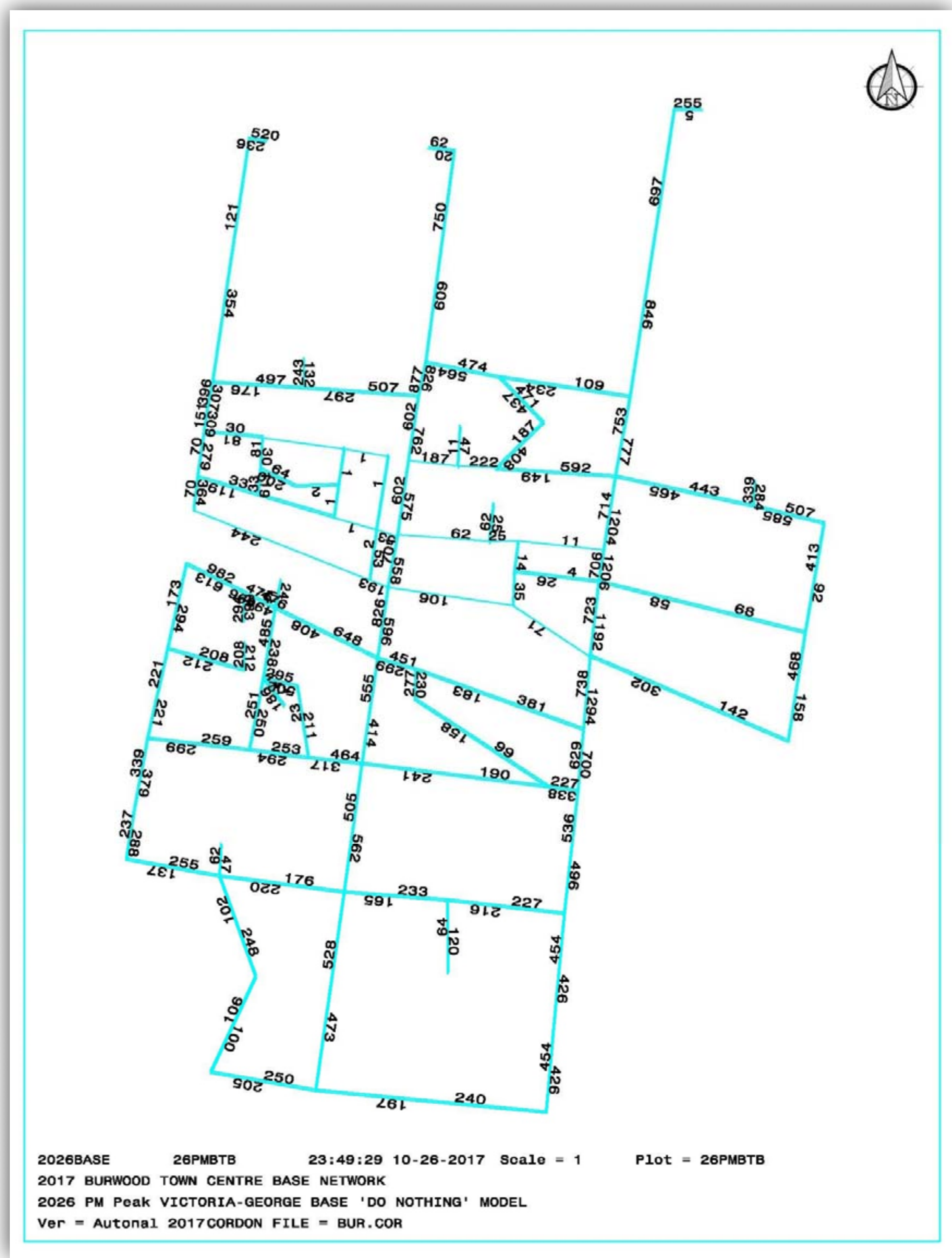


Figure 46 2026 WE 'Do Nothing' Traffic Projections

Source Road Delay Solutions, 2017

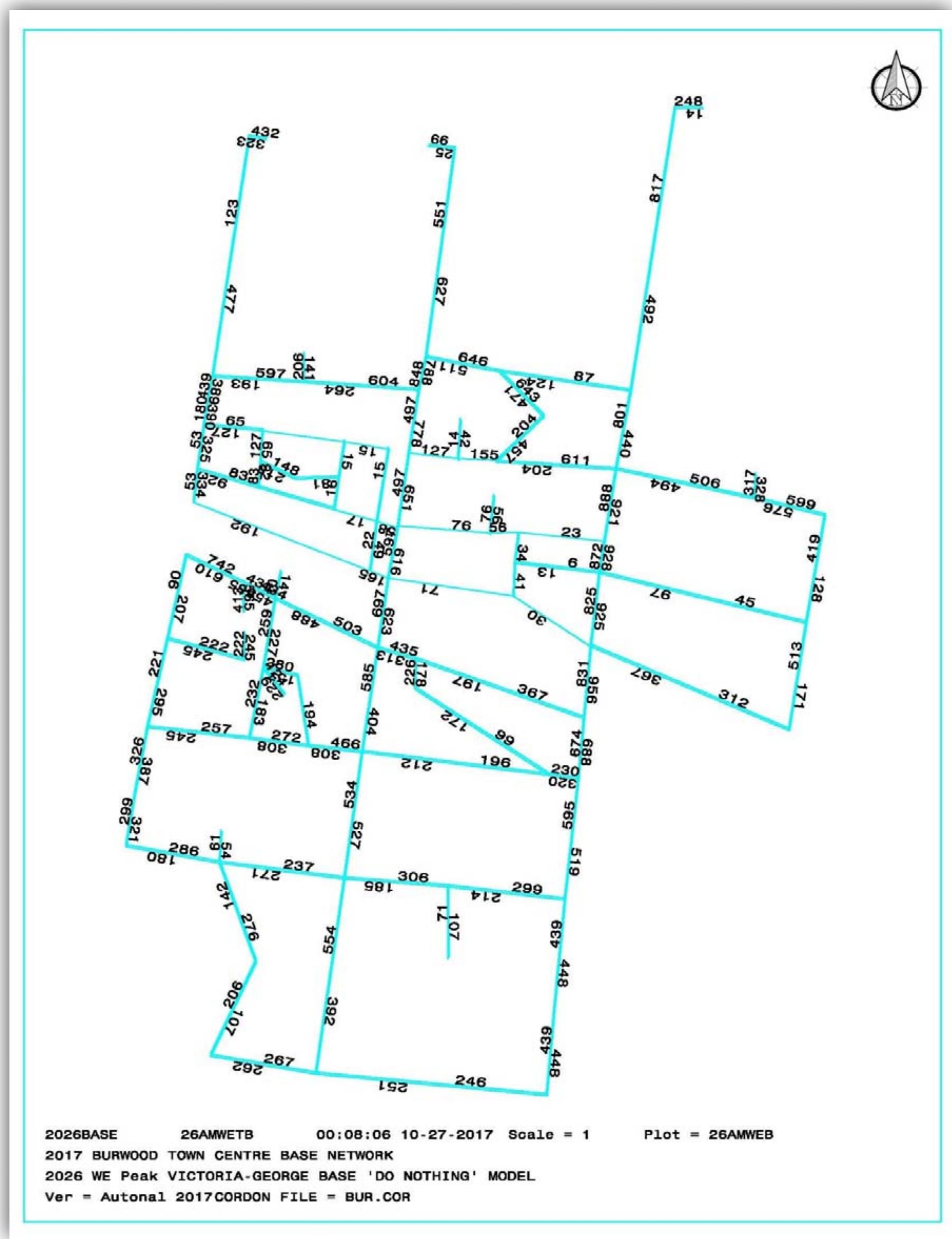
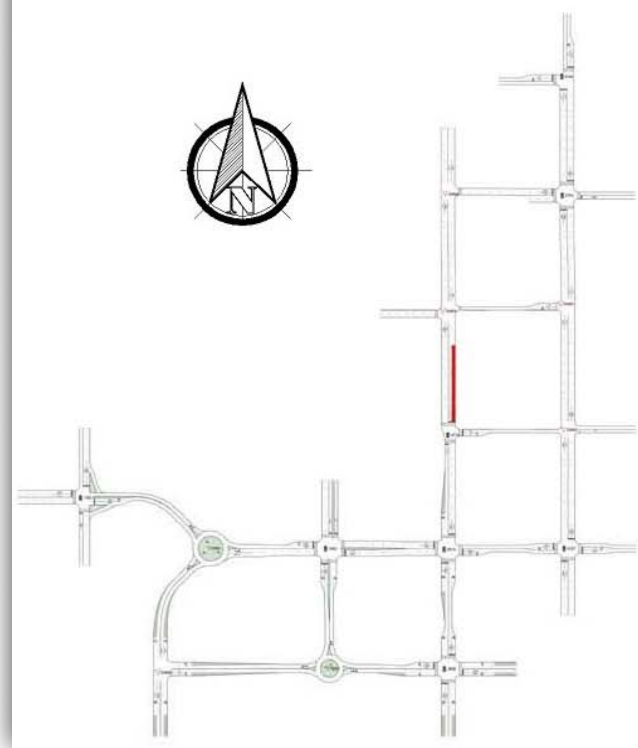


Figure 47 2026 SIDRA 7 'Do Nothing' Modelled Road Network

Source Sidra/Road Delay Solutions, 2017

NETWORK LAYOUT

Network: N101 [2026 AM Base Burwood Town Centre]



SITES IN NETWORK		
Site ID	**CCG ID**	**Site Name**
0107	NA	2026 AM Do Nothing Shaftesbury Rd, Railway Pde and Paisley St
0144	NA	2026 AM Do Nothing Shaftesbury Rd and Wilga St
0784	NA	2026 AM Do Nothing Shaftesbury Road and Victoria Street
GW01	NA	2026 AM Do Nothing Shaftesbury Rd and George St
GW02	NA	2026 AM Do Nothing Shaftesbury Rd and Deane St
GW04	NA	2026 AM Do Nothing Burwood Rd and Victoria St
GW03	NA	2026 AM Do Nothing Burwood Rd and George St
0174	NA	2026 AM Do Nothing Burwood Rd and Deane St
0014	NA	2026 AM Do Nothing Burwood Rd and Railway Pde
1639	NA	2026 AM Do Nothing Burwood Rd and Belmore St
1843	NA	2026 AM Do Nothing Railway Pde and Wynne Ave
R0001	NA	2026 AM Do Nothing Railway Pde and Conder St
R0002	NA	2026 AM Do Nothing Belmore St and Wynne Ave
GW05	NA	2026 AM Do Nothing Belmore St and Conder St
1183	NA	2026 AM Do Nothing Wentworth Rd, Railway Pde and Morwick St

Figure 48 2026 SIDRA 7 'Do Nothing' AM Peak Network Report

Source Sidra/Road Delay Solutions, 2017

NETWORK SUMMARY

Network: N101 [2026 AM Base Burwood Town Centre]

New Network
Network Cycle Time = 100 seconds (Network Cycle Time - User-Given)

Network Performance - Hourly Values

Performance Measure	Vehicles	Per Unit Distance	Pedestrians	Persons
Network Level of Service (LOS)	LOS E			
Travel Time Index	2.39			
Speed Efficiency	0.31			
Congestion Coefficient	3.18			
Travel Speed (Average)	18.9 km/h		2.5 km/h	14.6 km/h
Travel Distance (Total)	6953.3 veh-km/h		466.5 ped-km/h	10251.6 pers-km/h
Travel Time (Total)	368.2 veh-h/h		187.8 ped-h/h	701.0 pers-h/h
Desired Speed	60.0 km/h			
Demand Flows (Total for all Sites)	21655 veh/h		13777 ped/h	35237 pers/h
Arrival Flows (Total for all Sites)	21615 veh/h		13777 ped/h	35189 pers/h
Demand Flows (Entry Total)	6094 veh/h			
Midblock Inflows (Total)	1594 veh/h			
Midblock Outflows (Total)	-1746 veh/h			
Percent Heavy Vehicles (Demand)	3.7 %			
Percent Heavy Vehicles (Arrival)	3.7 %			
Degree of Saturation	1.152			
Control Delay (Total)	226.86 veh-h/h		88.17 ped-h/h	399.15 pers-h/h
Control Delay (Average)	37.8 sec		23.0 sec	40.8 sec
Control Delay (Worst Lane)	191.1 sec			
Control Delay (Worst Movement)	191.1 sec		44.8 sec	191.1 sec
Geometric Delay (Average)	1.7 sec			
Stop-Line Delay (Average)	36.1 sec			
Queue Storage Ratio (Worst Lane)	1.00			
Total Effective Stops	15540 veh/h		10456 ped/h	33980 pers/h
Effective Stop Rate	0.72 per veh	2.2 per km	0.76 per ped	0.97 per pers
Proportion Queued	0.60		0.76	0.89
Performance Index	1302.5		245.9	1548.5
Cost (Total)	15164.80 $/h	2.18 $/km	4733.64 $/h	19898.44 $/h
Fuel Consumption (Total)	1062.2 L/h	152.8 mL/km		
Fuel Economy	15.3 L/100km			
Carbon Dioxide (Total)	2506.2 kg/h	360.4 g/km		
Hydrocarbons (Total)	0.258 kg/h	0.037 g/km		
Carbon Monoxide (Total)	2.186 kg/h	0.314 g/km		
NOx (Total)	2.532 kg/h	0.364 g/km		

Largest change in Average Back of Queue or Degree of Saturation for any lane during the last three iterations: 205.7 %
Number of Iterations: 10 (maximum specified: 10)
Network Level of Service (LOS) Method: SIDRA Speed Efficiency.
Software Setup used: New South Wales.

Network Performance - Annual Values

Performance Measure	Vehicles	Pedestrians	Persons
Demand Flows (Total for all Sites)	10,394,270 veh/y	6,612,885 ped/y	16,913,810 pers/y
Delay	108,894 veh-h/y	42,320 ped-h/y	191,592 pers-h/y
Effective Stops	7,458,992 veh/y	5,018,665 ped/y	16,310,160 pers/y
Travel Distance	3,337,566 veh-km/y	223,913 ped-km/y	4,920,749 pers-km/y
Travel Time	176,713 veh-h/y	90,165 ped-h/y	336,485 pers-h/y
Cost	7,279,103 $/y	2,272,147 $/y	9,551,250 $/y
Fuel Consumption	509,853 L/y		
Carbon Dioxide	1,202,954 kg/y		

Figure 49 2026 AM 'Do Nothing' 95th Percentile Queue Ratios

Source Road Delay Solutions, 2017

QUEUE DISTANCE (%ILE)

95% Back of Queue Distance per lane (metres)

Network: N101 [2026 AM Base Burwood Town Centre]

New Network
Network Cycle Time = 100 seconds (Network Cycle Time - User-Given)

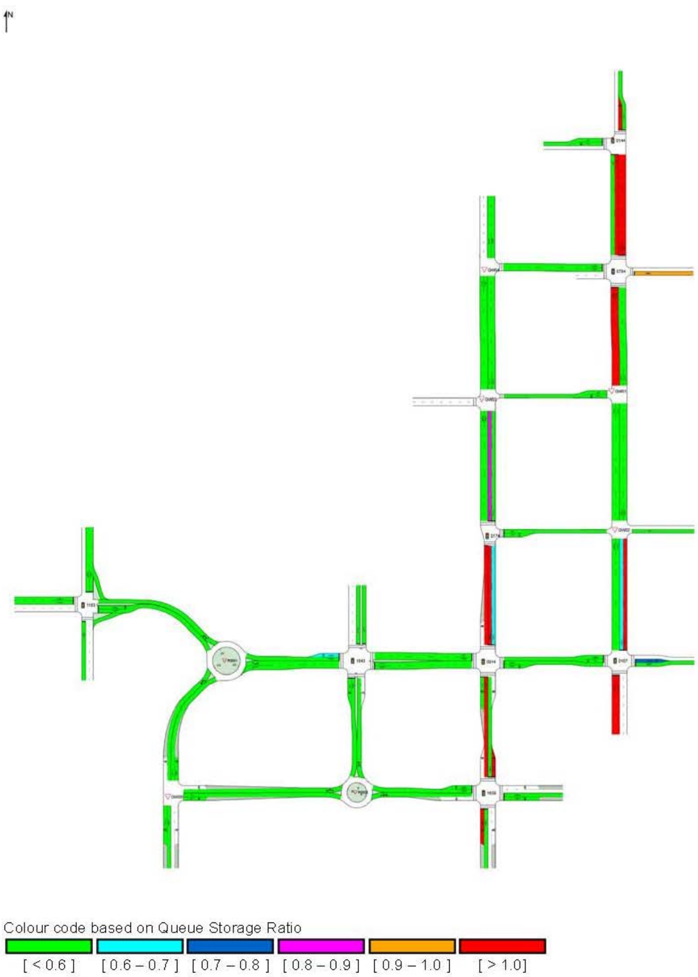


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Figure 50 2026 SIDRA 7 'Do Nothing' PM Peak Network Report

Source Sidra/Road Delay Solutions, 2017

NETWORK SUMMARY

Network: N101 [2026 PM Base Burwood Town Centre]

New Network
Network Cycle Time = 100 seconds (Network Cycle Time - User-Given)

Network Performance - Hourly Values

Performance Measure	Vehicles	Per Unit Distance	Pedestrians	Persons
Network Level of Service (LOS)	LOS E			
Travel Time Index	2.55			
Speed Efficiency	0.33			
Congestion Coefficient	3.04			
Travel Speed (Average)	19.8 km/h		2.4 km/h	15.2 km/h
Travel Distance (Total)	8302.0 veh-km/h		479.9 ped-km/h	11917.5 pers-km/h
Travel Time (Total)	420.0 veh-h/h		204.0 ped-h/h	781.8 pers-h/h
Desired Speed	60.0 km/h			
Demand Flows (Total for all Sites)	26394 veh/h		14157 ped/h	41528 pers/h
Arrival Flows (Total for all Sites)	26298 veh/h		14157 ped/h	41413 pers/h
Demand Flows (Entry Total)	6332 veh/h			
Midblock Inflows (Total)	2044 veh/h			
Midblock Outflows (Total)	-1477 veh/h			
Percent Heavy Vehicles (Demand)	3.0 %			
Percent Heavy Vehicles (Arrival)	3.0 %			
Degree of Saturation	1.227			
Control Delay (Total)	254.86 veh-h/h		101.49 ped-h/h	447.68 pers-h/h
Control Delay (Average)	34.9 sec		25.8 sec	38.9 sec
Control Delay (Worst Lane)	260.0 sec			
Control Delay (Worst Movement)	260.0 sec		46.8 sec	260.0 sec
Geometric Delay (Average)	1.6 sec			
Stop-Line Delay (Average)	33.2 sec			
Queue Storage Ratio (Worst Lane)	1.02			
Total Effective Stops	18181 veh/h		10076 ped/h	36233 pers/h
Effective Stop Rate	0.69 per veh	2.2 per km	0.71 per ped	0.87 per pers
Proportion Queued	0.61		0.71	0.82
Performance Index	1669.5		260.0	1929.5
Cost (Total)	16975.19 $/h	2.04 $/km	5141.36 $/h	22116.54 $/h
Fuel Consumption (Total)	1220.8 L/h	147.1 mL/km		
Fuel Economy	14.7 L/100km			
Carbon Dioxide (Total)	2877.8 kg/h	346.6 g/km		
Hydrocarbons (Total)	0.293 kg/h	0.035 g/km		
Carbon Monoxide (Total)	2.514 kg/h	0.303 g/km		
NOx (Total)	2.525 kg/h	0.304 g/km		

Largest change in Average Back of Queue or Degree of Saturation for any lane during the last three iterations: 54.6 %
Number of Iterations: 10 (maximum specified: 10)
Network Level of Service (LOS) Method: SIDRA Speed Efficiency.
Software Setup used: New South Wales.

Network Performance - Annual Values

Performance Measure	Vehicles	Pedestrians	Persons
Demand Flows (Total for all Sites)	12,668,970 veh/y	6,795,285 ped/y	19,933,280 pers/y
Delay	122,334 veh-h/y	48,714 ped-h/y	214,886 pers-h/y
Effective Stops	8,727,092 veh/y	4,836,501 ped/y	17,391,830 pers/y
Travel Distance	3,984,953 veh-km/y	230,334 ped-km/y	5,720,391 pers-km/y
Travel Time	201,623 veh-h/y	97,931 ped-h/y	375,286 pers-h/y
Cost	8,148,089 $/y	2,467,852 $/y	10,615,940 $/y
Fuel Consumption	585,999 L/y		
Carbon Dioxide	1,381,334 kg/y		

Figure 51 2026 PM 'Do Nothing' 95th Percentile Queue Ratios

Source Road Delay Solutions, 2017

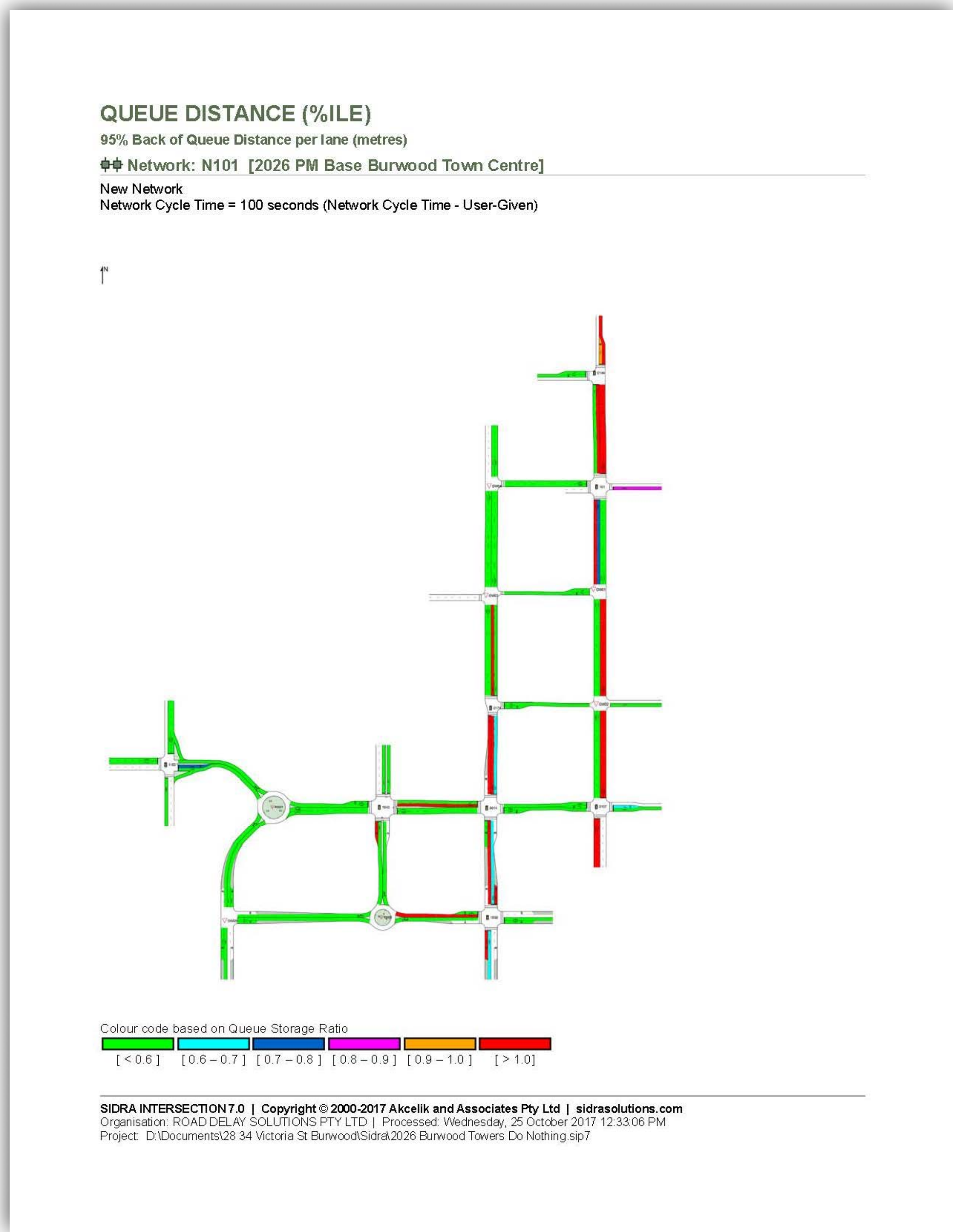


Figure 52 2026 SIDRA 7 'Do Nothing' WE Peak Network Report

Source Sidra/Road Delay Solutions, 2017

NETWORK SUMMARY

Network: N101 [2026 WE Base Burwood Town Centre]

New Network
Network Cycle Time = 100 seconds (Network Cycle Time - User-Given)

Network Performance - Hourly Values

Performance Measure	Vehicles	Per Unit Distance	Pedestrians	Persons
Network Level of Service (LOS)	LOS E			
Travel Time Index	2.72			
Speed Efficiency	0.34			
Congestion Coefficient	2.90			
Travel Speed (Average)	20.7 km/h		2.3 km/h	15.6 km/h
Travel Distance (Total)	7295.2 veh-km/h		468.6 ped-km/h	10697.0 pers-km/h
Travel Time (Total)	352.7 veh-h/h		201.7 ped-h/h	686.8 pers-h/h
Desired Speed	60.0 km/h			
Demand Flows (Total for all Sites)	23824 veh/h		13836 ped/h	38376 pers/h
Arrival Flows (Total for all Sites)	23725 veh/h		13836 ped/h	38256 pers/h
Demand Flows (Entry Total)	5945 veh/h			
Midblock Inflows (Total)	1812 veh/h			
Midblock Outflows (Total)	-1286 veh/h			
Percent Heavy Vehicles (Demand)	3.2 %			
Percent Heavy Vehicles (Arrival)	3.2 %			
Degree of Saturation	1.303			
Control Delay (Total)	209.16 veh-h/h		101.61 ped-h/h	380.31 pers-h/h
Control Delay (Average)	31.7 sec		26.4 sec	35.8 sec
Control Delay (Worst Lane)	327.5 sec			
Control Delay (Worst Movement)	327.5 sec		44.8 sec	327.5 sec
Geometric Delay (Average)	1.7 sec			
Stop-Line Delay (Average)	30.0 sec			
Queue Storage Ratio (Worst Lane)	1.23			
Total Effective Stops	14608 veh/h		9970 ped/h	30989 pers/h
Effective Stop Rate	0.62 per veh	2.0 per km	0.72 per ped	0.81 per pers
Proportion Queued	0.55		0.72	0.77
Performance Index	1296.1		257.1	1553.2
Cost (Total)	14203.93 $/h	1.95 $/km	5083.53 $/h	19287.46 $/h
Fuel Consumption (Total)	1053.6 L/h	144.4 mL/km		
Fuel Economy	14.4 L/100km			
Carbon Dioxide (Total)	2484.0 kg/h	340.5 g/km		
Hydrocarbons (Total)	0.253 kg/h	0.035 g/km		
Carbon Monoxide (Total)	2.244 kg/h	0.308 g/km		
NOx (Total)	2.128 kg/h	0.292 g/km		

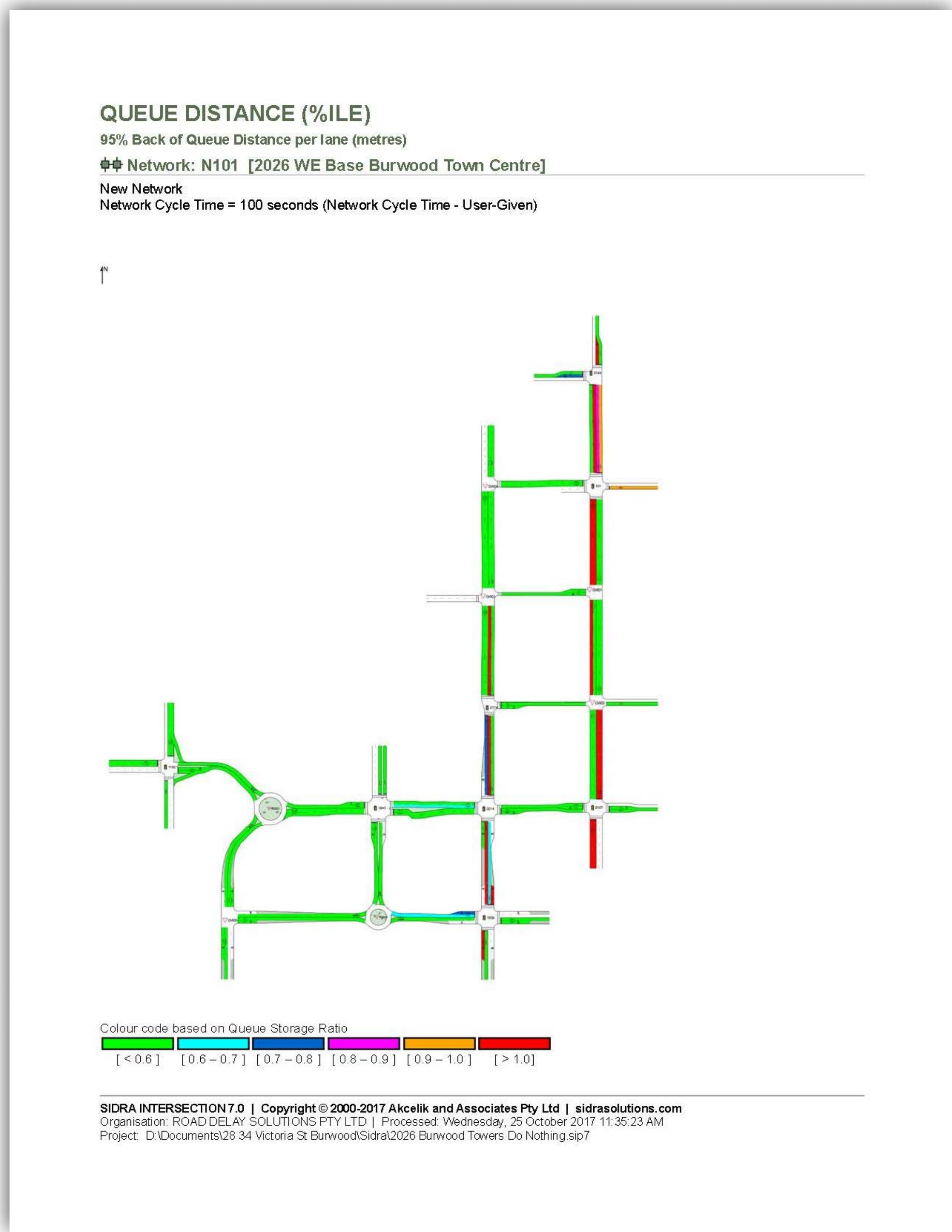
Largest change in Average Back of Queue or Degree of Saturation for any lane during the last three iterations: 390.0 %
Number of Iterations: 10 (maximum specified: 10)
Network Level of Service (LOS) Method: SIDRA Speed Efficiency.
Software Setup used: New South Wales.

Network Performance - Annual Values

Performance Measure	Vehicles	Pedestrians	Persons
Demand Flows (Total for all Sites)	11,435,620 veh/y	6,641,179 ped/y	18,420,710 pers/y
Delay	100,399 veh-h/y	48,772 ped-h/y	182,551 pers-h/y
Effective Stops	7,011,819 veh/y	4,785,548 ped/y	14,874,650 pers/y
Travel Distance	3,501,686 veh-km/y	224,909 ped-km/y	5,134,539 pers-km/y
Travel Time	169,315 veh-h/y	96,829 ped-h/y	329,659 pers-h/y
Cost	6,817,887 $/y	2,440,092 $/y	9,257,978 $/y
Fuel Consumption	505,743 L/y		
Carbon Dioxide	1,192,316 kg/y		

Figure 53 2026 WE 'Do Nothing' 95th Percentile Queue Ratios

Source Road Delay Solutions, 2017



6.14 2026 Section 94 Infrastructure Model

(26AMS94B.PLT/26PMS94B.PLT/26AMWESB.PLT)

The second scenario model of the Year 2026 was prepared inclusive of…

- → *The BTS growth rates,*
- → *Stage 1 of the West Connex project (M4 East – Homebush Bay Drive to Pomeroy Street/Tunnelled Pomeroy Street to City West Link Road), which is scheduled for opening in 2019, and*
- → *Burwood Council's Section 94 Infrastructure Plan.*

Figure 54 Westconnex Stage 1 M4 East – M4 to City West Link Road

Source http://www.westconnex.com.au, 2016

The Section 94 infrastructure plan and anticipated implementation dates include…

- → *Future signalised right turn movement from Burwood Road, southbound, into Belmore Street, westbound, (2016-2018),*
- → *Upgrade to the signalised intersection at Burwood Road and Railway Parade, (2016-2018),*
- → *New traffic signals at the intersection of Railway Parade and Conder Street, (2016-2018),*
- → *Widening of Railway Parade east of Burwood Road (2024-2027),*
- → *New mid-block traffic signals in Wynne Avenue (2012-2015),*
- → *New traffic signals at Belmore Street and Wynne Avenue (2012-2015),*
- → *New traffic signals at Belmore Street and Conder Street (2012-2015),*
- → *Widening of Railway Parade adjacent to Victoria Street & George Street (after 2035),*
- → *Streetscape upgrades in Belmore Street, Conder Street, Wynne Avenue (2012 - after 2020), and*
- → *Shared zones in Conder Street and Clarendon Place (2016-2018).*

The intention of this model is to adopt the Section 94 infrastructure measures, as proposed by Council, and report the road network operation under the demands of year 2026 growth.

Figure 55 Section 94 Infrastructure Plan

Source Burwood Council, 2016

The 2026 Section 94 model does not assess each measure proposed under the Council plan but adopts the proposed improvements and excludes any and all traffic generation associated with the Victoria Street & George Street development.

It has been reported from the modelling that with the introduction of the Section 94 improvements, the operational performance of Burwood Road, both northbound and southbound will operate at a LoS 'E', further consolidating the view that Burwood Road is operating at capacity and the competing parallel routes of Wentworth Road and Shaftesbury Road remain viable alternative paths into and out of the town centre with motorists utilising side street entry to the centre and access to the available parking provisions.

The Section 94 Infrastructure Plan outlines provision for modification to the Burwood Road intersection with Railway Parade. After dicussions with Council it is intended to retain the current movement conditions including the right turn from Burwood Road, southbound, into Railway Parade under the plan.

There is some discrepancy over the intersection of Burwood Road and Belmore Street. An *RMS* traffic signal design layout depicts a future dedicated, right turn movement, southbound, in Burwood Road, replacing the current filterd right turn movement for all vehicles,

Under the Section 94 Infrastructure Plan the introduction of traffic signals in Belmore Street at Wynne Avenue and Conder Street and the further introduction of traffic signals at Railway Parade and Conder Street create a circulatory route around the development site which meets the needs of both motorists and pedestrians. The introduction of signalised pedestrian crossings at the new signal sites will improve community mobility and safety.

Modelling supports Council's view thatr the Burwood Road intersection with Railway Parade and also with Belmore Street, should be retained in their current form as no significant improvement is reported with the relocation of the right turn movement, southbound, in Burwood Road from Railway Parade to Belmore Street, as reported in the body of this document.

Sensitivity Model (2026AMS94S.PLT/2026PMS94S.PLT)

> *An alternate, sensitivity, model was also run banning completely, the right turn movement from Burwood Road, southbound, at Railway Parade. This ban included buses.*
>
> *This model was run appreciating that some buses currently perform a U-Turn manoeuvre at the Railway Parade intersection with Conder Street at the existing roundabout, then proceed to a lay over in Railway Parade adjacent to Burwood Central. While buses may perform the same U-Turn movement at the intersection once signalised and with the installation of a dedicated bus only*

movement, it was considered that if buses were directed to Belmore Street to perform the righ turn movement to the west they would be able to travel in a circulatory route via Belmore Street, right into Conder Street and a further right Into Railway Parade.

This particular sensitivity model did report that the Burwood Road southbound route would improve during the morning AM peak to a LoS 'D' in comparison to the LoS 'E' reported in the Section 94 model. During the PM peak the modelled 18 bus movements turning right at Railway Parade resulted in a consistant LoS 'E'. However, the circulatory route, via Belmore Street, is considered to pose issues with the turning path into Conder Street and pedestrian movements in the vicinity of Burwood Public School.

The network model did indicate that if the right turn movement for all vehicles was banned, southbound on Burwood Road at Railway Parade and a corresponding right turn phase introduced from Burwood Road into Belmore Street, significant queuing and delay would result on Burwood Road between Railway Parade and Belmore Street.

The model indicated that with the presence of on street parking and the narrow road carriageway at the Belmore Street intersection, contributed to increasing vehicle delays during the PM peak period and did not provide any significant improvement in the road network operation. Effectively, the sensitivity model reported the vehicle delays, which were reported at the Railway Parade intersection, with retention of the right turn movement for all vehicles, simply relocated to the Belmore Street intersection.

Given the outcome of the sensitivity model it was concluded that…

- → *All vehicles be allowed to turn right from Burwood Road, southbound, into Railway Parade via the current dedicated 'B' phase right turn,*
- → *The modest improvement in performance reported during the morning peak was not significant enough to impose the Belmore Street circulatory route on buses, and*
- → *The right turn movement from Burwood Road, southbound, at Belmore Street be retained as a filter movement only.*

The modelling has evidenced that the outcome of the S94 infrastructure improvements adequately manage the planned future growth, of which the Victoria Street & George Street development is one. This was the intention of the S94 plan and the modelling does not indicate to the contrary. The S94 plan appears to have been carefully constructed and capable of sustaining the level of development for which it was intended at an operational level comparable with the current state.

Following discussions with Council, it is Holdmark's intention to consult fully with Council early in the DA design stage all aspects of the road network operation and access provisions in an attempt to achieve the optimum and sustainable outcomes for both community and development.

Figure 56 2026 AM Section 94 Traffic Projections

Source Road Delay Solutions, 2017

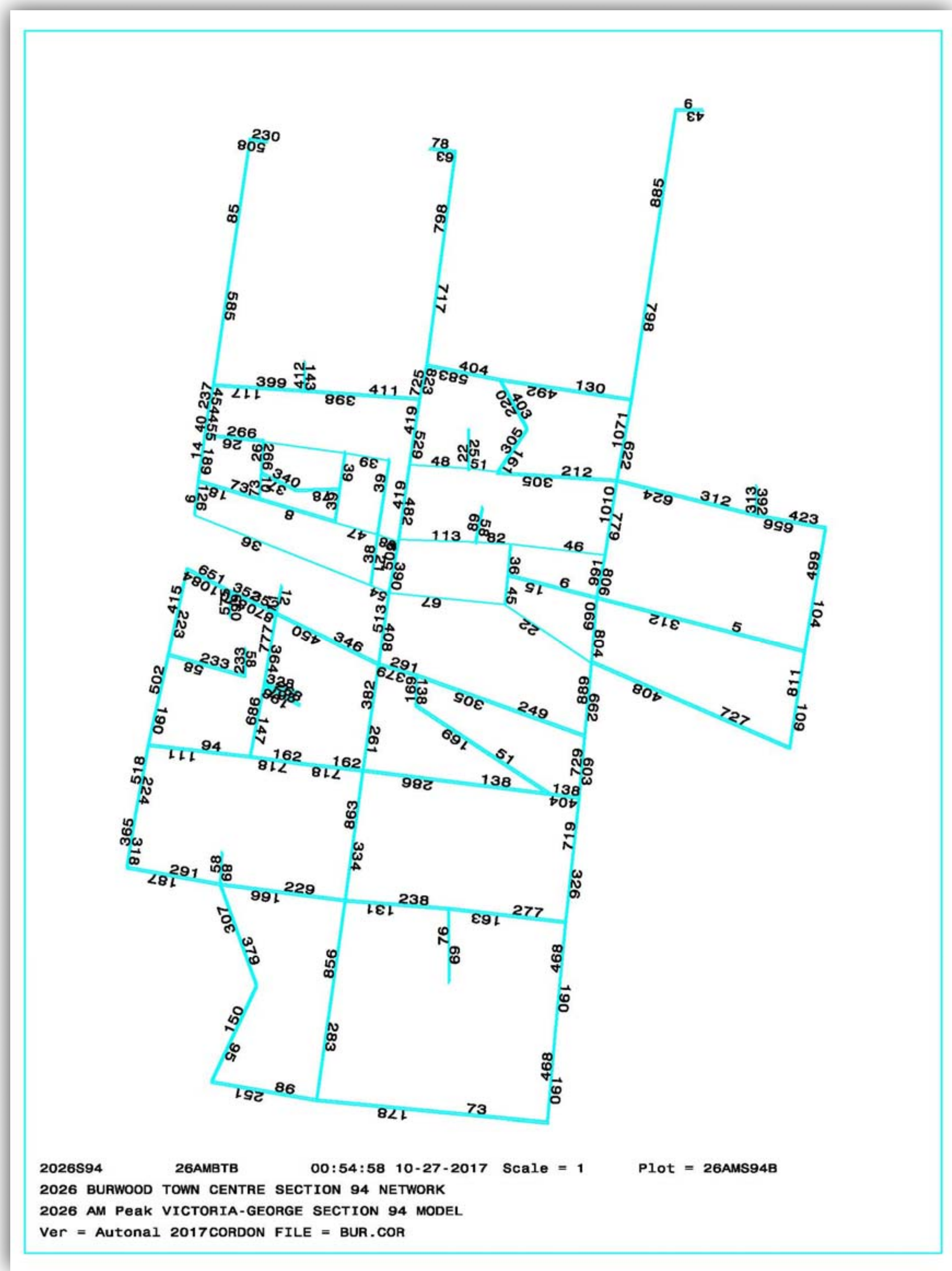


Figure 57 2026 PM Section 94 Traffic Projections

Source Road Delay Solutions, 2017

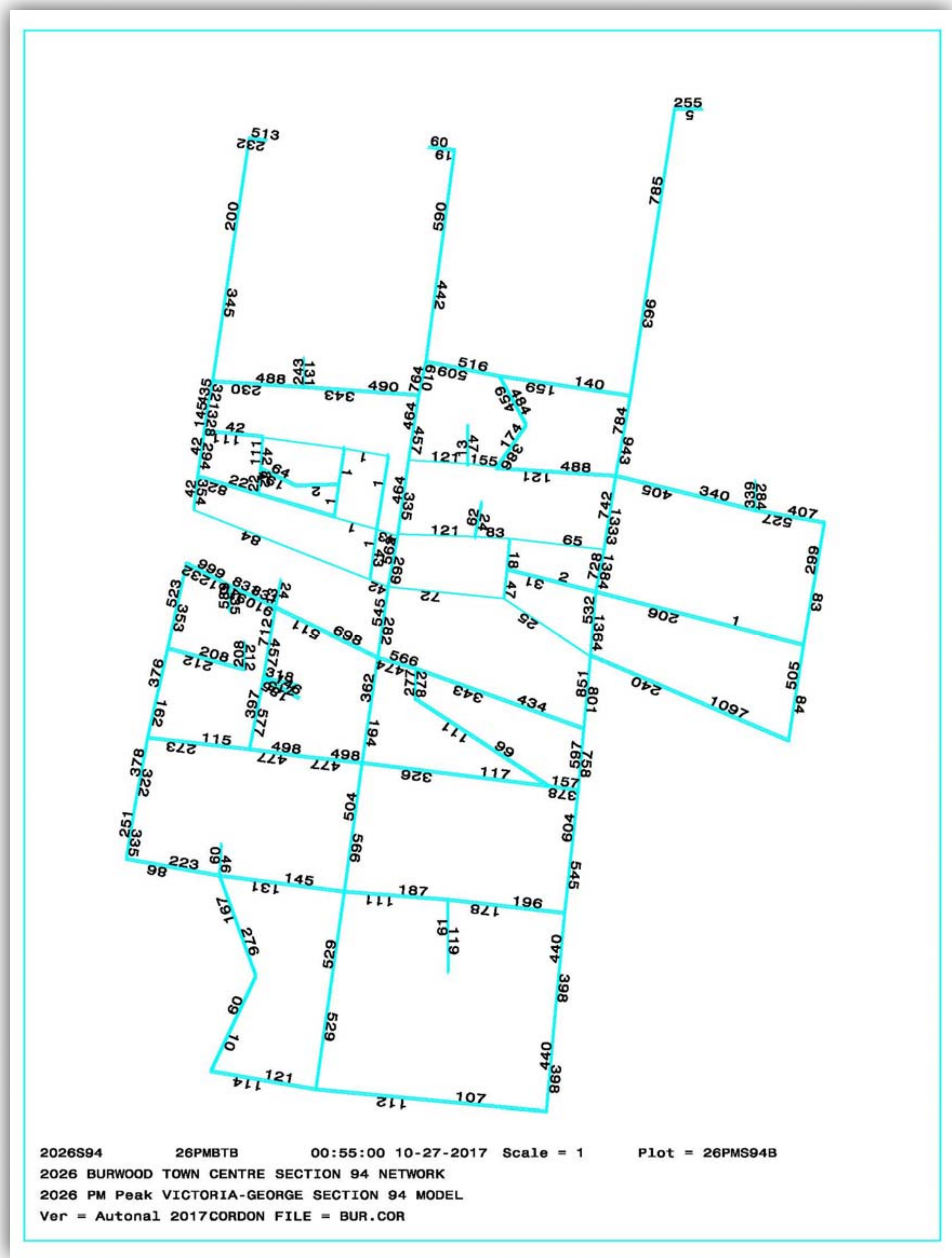


Figure 58 ***2026 WE Section 94 Traffic Projections***

Source *Road Delay Solutions, 2017*

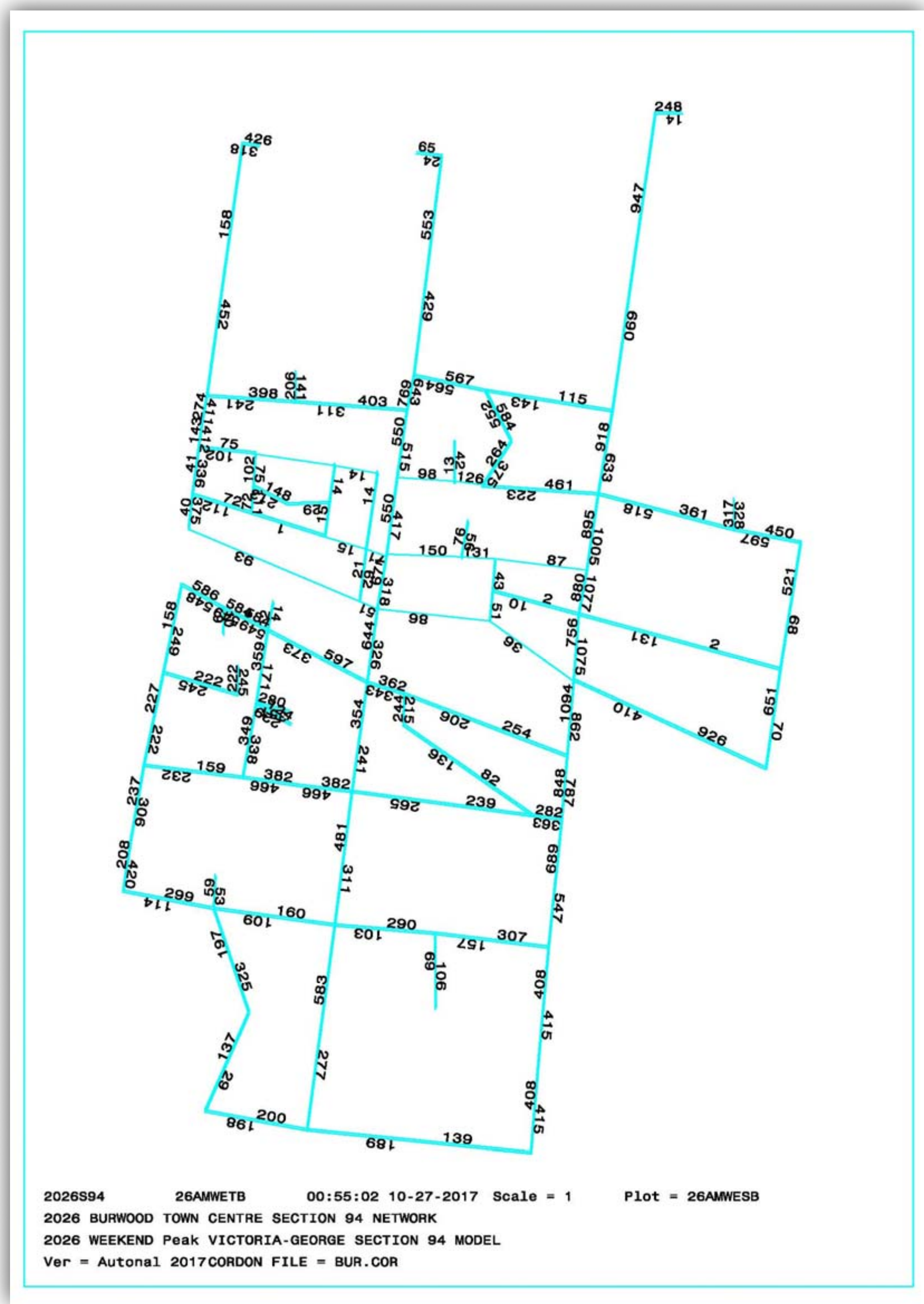


Figure 59 2026 SIDRA 7 Section 94 Modelled Road Network

Source Sidra/Road Delay Solutions, 2017

NETWORK LAYOUT

Network: N101 [2026 AM S94 Burwood Town Centre]

SITES IN NETWORK		
Site ID	CCG ID	Site Name
0107	NA	2026 AM S94 Shaftesbury Rd, Railway Pde and Paisley St
0144	NA	2026 AM S94 Shaftesbury Rd and Wilga St
0784	NA	2026 AM S94 Shaftesbury Road and Victoria Street
GW01	NA	2026 AM S94 Shaftesbury Rd and George St
GW02	NA	2026 AM S94 Shaftesbury Rd and Deane St
GW04	NA	2026 AM S94 Burwood Rd and Victoria St
GW03	NA	2026 AM S94 Burwood Rd and George St
0174	NA	2026 AM S94 Burwood Rd and Deane St
0014	NA	2026 AM S94 Burwood Rd and Railway Pde
1639	NA	2026 AM S94 Burwood Rd and Belmore St
1843	NA	2026 AM S94 Railway Pde and Wynne Ave
TCS001	NA	2026 AM S94 Railway Pde and Conder St
TCS002	NA	2026 AM S94 Belmore St and Wynne Ave
TCS003	NA	2026 AM S94 Belmore St and Conder St
1183	NA	2026 AM S94 Wentworth Rd, Railway Pde and Morwick St

Figure 60 2026 SIDRA 7 Section 94 AM Peak Network Report

Source Sidra/Road Delay Solutions, 2017

NETWORK SUMMARY

Network: N101 [2026 AM S94 Burwood Town Centre]

New Network
Network Cycle Time = 100 seconds (Network Cycle Time - User-Given)

Network Performance - Hourly Values

Performance Measure	Vehicles	Per Unit Distance	Pedestrians	Persons
Network Level of Service (LOS)	LOS E			
Travel Time Index	2.97			
Speed Efficiency	0.37			
Congestion Coefficient	2.72			
Travel Speed (Average)	22.0 km/h		2.5 km/h	16.3 km/h
Travel Distance (Total)	7504.9 veh-km/h		490.1 ped-km/h	10833.2 pers-km/h
Travel Time (Total)	340.8 veh-h/h		199.6 ped-h/h	665.6 pers-h/h
Desired Speed	60.0 km/h			
Demand Flows (Total for all Sites)	23641 veh/h		14459 ped/h	37106 pers/h
Arrival Flows (Total for all Sites)	23627 veh/h		14459 ped/h	37086 pers/h
Demand Flows (Entry Total)	6458 veh/h			
Midblock Inflows (Total)	3090 veh/h			
Midblock Outflows (Total)	-2679 veh/h			
Percent Heavy Vehicles (Demand)	3.3 %			
Percent Heavy Vehicles (Arrival)	3.3 %			
Degree of Saturation	1.499			
Control Delay (Total)	191.63 veh-h/h		94.90 ped-h/h	351.75 pers-h/h
Control Delay (Average)	29.2 sec		23.6 sec	34.1 sec
Control Delay (Worst Lane)	497.9 sec			
Control Delay (Worst Movement)	497.9 sec		45.2 sec	497.9 sec
Geometric Delay (Average)	1.6 sec			
Stop-Line Delay (Average)	27.6 sec			
Queue Storage Ratio (Worst Lane)	1.00			
Total Effective Stops	16273 veh/h		11546 ped/h	35067 pers/h
Effective Stop Rate	0.69 per veh	2.2 per km	0.80 per ped	0.95 per pers
Proportion Queued	0.65		0.80	0.93
Performance Index	1318.9		263.8	1582.6
Cost (Total)	13768.67 $/h	1.83 $/km	5030.80 $/h	18799.47 $/h
Fuel Consumption (Total)	1065.7 L/h	142.0 mL/km		
Fuel Economy	14.2 L/100km			
Carbon Dioxide (Total)	2514.6 kg/h	335.1 g/km		
Hydrocarbons (Total)	0.252 kg/h	0.034 g/km		
Carbon Monoxide (Total)	2.259 kg/h	0.301 g/km		
NOx (Total)	2.647 kg/h	0.353 g/km		

Largest change in Average Back of Queue or Degree of Saturation for any lane during the last three iterations: 213.6 %
Number of Iterations: 10 (maximum specified: 10)
Network Level of Service (LOS) Method: SIDRA Speed Efficiency.
Software Setup used: New South Wales.

Network Performance - Annual Values

Performance Measure	Vehicles	Pedestrians	Persons
Demand Flows (Total for all Sites)	11,347,820 veh/y	6,940,334 ped/y	17,811,100 pers/y
Delay	91,983 veh-h/y	45,554 ped-h/y	168,842 pers-h/y
Effective Stops	7,811,231 veh/y	5,542,279 ped/y	16,832,350 pers/y
Travel Distance	3,602,348 veh-km/y	235,269 ped-km/y	5,199,936 pers-km/y
Travel Time	163,562 veh-h/y	95,825 ped-h/y	319,510 pers-h/y
Cost	6,608,961 $/y	2,414,785 $/y	9,023,746 $/y
Fuel Consumption	511,554 L/y		
Carbon Dioxide	1,207,011 kg/y		

Figure 61 2026 SIDRA 7 Section 94 AM Peak 95th % Queues

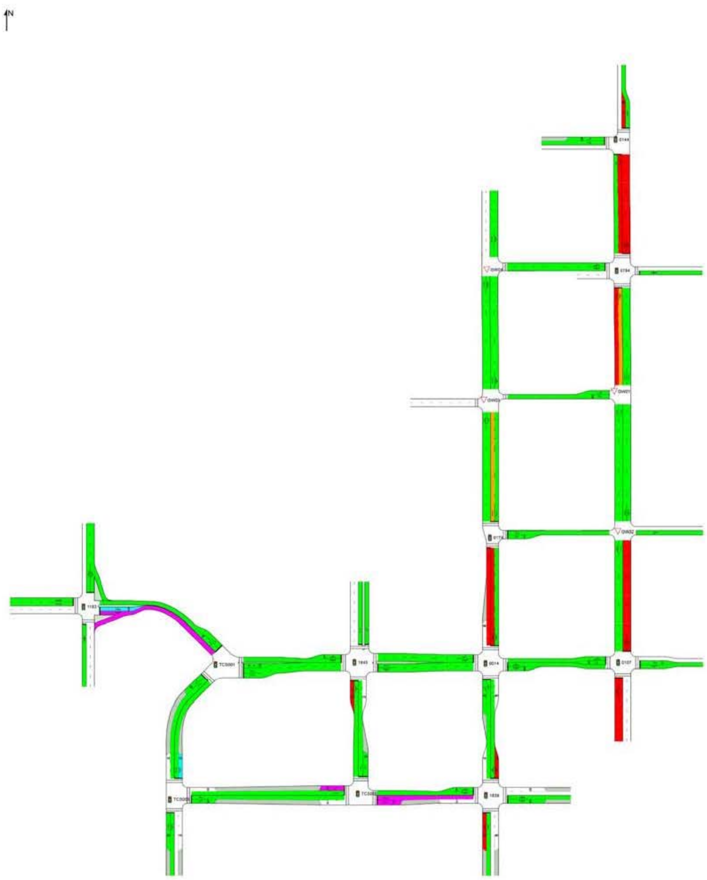
Source Sidra/Road Delay Solutions, 2017

QUEUE DISTANCE (%ILE)

95% Back of Queue Distance per lane (metres)

Network: N101 [2026 AM S94 Burwood Town Centre]

New Network
Network Cycle Time = 100 seconds (Network Cycle Time - User-Given)



Colour code based on Queue Storage Ratio

[< 0.6] [0.6 – 0.7] [0.7 – 0.8] [0.8 – 0.9] [0.9 – 1.0] [> 1.0]

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Figure 62 2026 SIDRA 7 Section 94 PM Peak Network Report

Source Sidra/Road Delay Solutions, 2017

NETWORK SUMMARY

Network: N101 [2026 PM S94 Burwood Town Centre]

New Network
Network Cycle Time = 100 seconds (Network Cycle Time - User-Given)

Network Performance - Hourly Values

Performance Measure	Vehicles	Per Unit Distance	Pedestrians	Persons
Network Level of Service (LOS)	LOS F			
Travel Time Index	1.56			
Speed Efficiency	0.24			
Congestion Coefficient	4.16			
Travel Speed (Average)	14.4 km/h		2.3 km/h	12.1 km/h
Travel Distance (Total)	8458.5 veh-km/h		503.9 ped-km/h	11937.2 pers-km/h
Travel Time (Total)	586.5 veh-h/h		217.4 ped-h/h	984.0 pers-h/h
Desired Speed	60.0 km/h			
Demand Flows (Total for all Sites)	25522 veh/h		14839 ped/h	38739 pers/h
Arrival Flows (Total for all Sites)	24945 veh/h		14839 ped/h	38009 pers/h
Demand Flows (Entry Total)	6969 veh/h			
Midblock Inflows (Total)	3292 veh/h			
Midblock Outflows (Total)	-3122 veh/h			
Percent Heavy Vehicles (Demand)	2.6 %			
Percent Heavy Vehicles (Arrival)	2.6 %			
Degree of Saturation	1.503			
Control Delay (Total)	405.70 veh-h/h		109.68 ped-h/h	629.82 pers-h/h
Control Delay (Average)	58.5 sec		26.6 sec	59.7 sec
Control Delay (Worst Lane)	503.9 sec			
Control Delay (Worst Movement)	503.9 sec		45.0 sec	503.9 sec
Geometric Delay (Average)	1.5 sec			
Stop-Line Delay (Average)	57.1 sec			
Queue Storage Ratio (Worst Lane)	1.59			
Total Effective Stops	21011 veh/h		10794 ped/h	39700 pers/h
Effective Stop Rate	0.84 per veh	2.5 per km	0.73 per ped	1.04 per pers
Proportion Queued	0.69		0.73	0.95
Performance Index	1992.2		277.3	2269.5
Cost (Total)	22234.92 $/h	2.63 $/km	5477.25 $/h	27712.18 $/h
Fuel Consumption (Total)	1463.6 L/h	173.0 mL/km		
Fuel Economy	17.3 L/100km			
Carbon Dioxide (Total)	3447.6 kg/h	407.6 g/km		
Hydrocarbons (Total)	0.361 kg/h	0.043 g/km		
Carbon Monoxide (Total)	2.906 kg/h	0.344 g/km		
NOx (Total)	2.500 kg/h	0.296 g/km		

Largest change in Average Back of Queue or Degree of Saturation for any lane during the last three iterations: 10.1 %
Number of Iterations: 10 (maximum specified: 10)
Network Level of Service (LOS) Method: SIDRA Speed Efficiency.
Software Setup used: New South Wales.

Network Performance - Annual Values

Performance Measure	Vehicles	Pedestrians	Persons
Demand Flows (Total for all Sites)	12,250,530 veh/y	7,122,734 ped/y	18,594,740 pers/y
Delay	194,734 veh-h/y	52,645 ped-h/y	302,314 pers-h/y
Effective Stops	10,085,140 veh/y	5,181,309 ped/y	19,056,120 pers/y
Travel Distance	4,060,084 veh-km/y	241,880 ped-km/y	5,729,861 pers-km/y
Travel Time	281,513 veh-h/y	104,329 ped-h/y	472,330 pers-h/y
Cost	10,672,760 $/y	2,629,082 $/y	13,301,840 $/y
Fuel Consumption	702,513 L/y		
Carbon Dioxide	1,654,854 kg/y		

Figure 63 2026 SIDRA 7 Section 94 PM Peak 95th % Queues

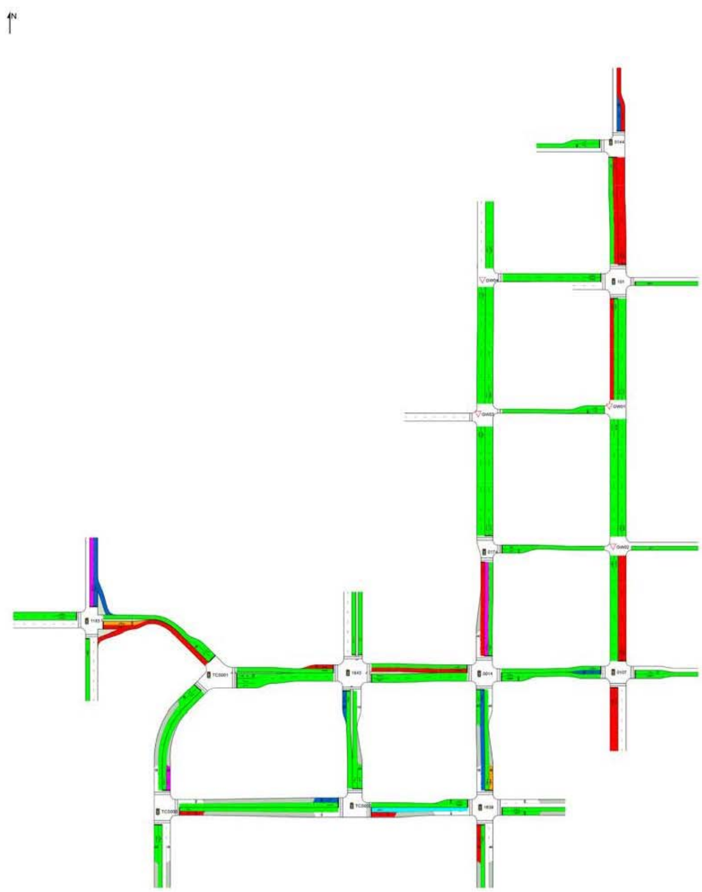
Source Sidra/Road Delay Solutions, 2017

QUEUE DISTANCE (%ILE)

95% Back of Queue Distance per lane (metres)

Network: N101 [2026 PM S94 Burwood Town Centre]

New Network
Network Cycle Time = 100 seconds (Network Cycle Time - User-Given)



Colour code based on Queue Storage Ratio

[< 0.6] [0.6 – 0.7] [0.7 – 0.8] [0.8 – 0.9] [0.9 – 1.0] [> 1.0]

Organisation: ROAD DELAY SOLUTIONS PTY LTD | Processed: Thursday, 26 October 2017 10:27:24 PM
Project: D:\Documents\28 34 Victoria St Burwood\Sidra\2026 Burwood Towers S94.sip7

Figure 64 ***2026 SIDRA 7 Section 94 WE Peak Network Report***

Source *Sidra/Road Delay Solutions, 2017*

NETWORK SUMMARY

Network: N101 [2026 WE S94 Burwood Town Centre]

New Network
Network Cycle Time = 100 seconds (Network Cycle Time - User-Given)

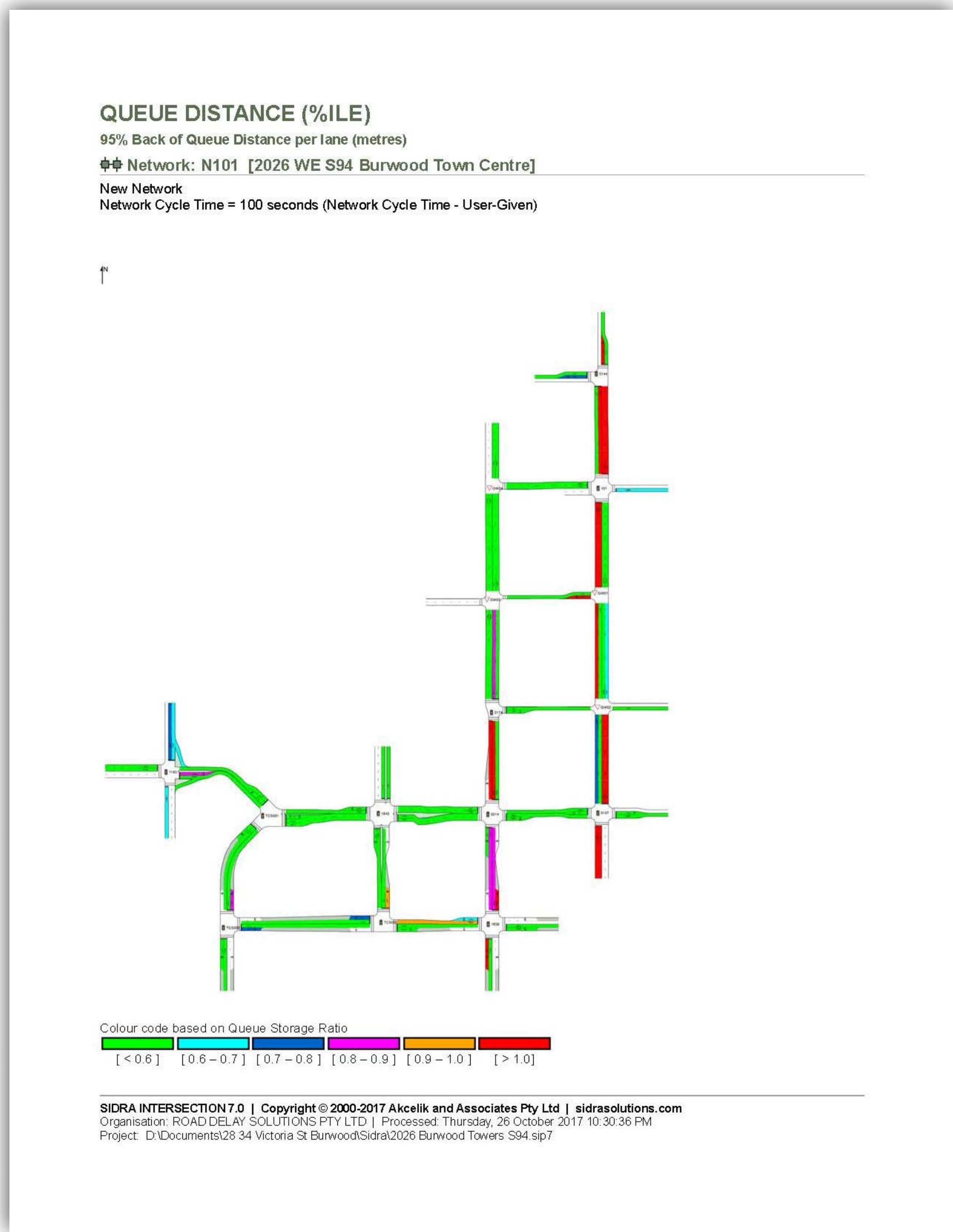
Network Performance - Hourly Values				
Performance Measure	**Vehicles**	**Per Unit Distance**	**Pedestrians**	**Persons**
Network Level of Service (LOS)	LOS F			
Travel Time Index	2.02			
Speed Efficiency	0.28			
Congestion Coefficient	3.55			
Travel Speed (Average)	16.9 km/h		2.3 km/h	13.3 km/h
Travel Distance (Total)	7542.8 veh-km/h		492.6 ped-km/h	10910.3 pers-km/h
Travel Time (Total)	445.7 veh-h/h		217.7 ped-h/h	820.9 pers-h/h
Desired Speed	60.0 km/h			
Demand Flows (Total for all Sites)	23932 veh/h		14518 ped/h	37742 pers/h
Arrival Flows (Total for all Sites)	23811 veh/h		14518 ped/h	37566 pers/h
Demand Flows (Entry Total)	6443 veh/h			
Midblock Inflows (Total)	3063 veh/h			
Midblock Outflows (Total)	-2578 veh/h			
Percent Heavy Vehicles (Demand)	2.9 %			
Percent Heavy Vehicles (Arrival)	2.9 %			
Degree of Saturation	1.465			
Control Delay (Total)	293.09 veh-h/h		112.42 ped-h/h	500.31 pers-h/h
Control Delay (Average)	44.3 sec		27.9 sec	47.9 sec
Control Delay (Worst Lane)	511.3 sec			
Control Delay (Worst Movement)	511.3 sec		44.4 sec	511.3 sec
Geometric Delay (Average)	1.5 sec			
Stop-Line Delay (Average)	42.8 sec			
Queue Storage Ratio (Worst Lane)	2.35			
Total Effective Stops	18011 veh/h		10816 ped/h	36570 pers/h
Effective Stop Rate	0.76 per veh	2.4 per km	0.75 per ped	0.97 per pers
Proportion Queued	0.65		0.75	0.90
Performance Index	1673.6		277.8	1951.3
Cost (Total)	17577.75 $/h	2.33 $/km	5485.48 $/h	23063.23 $/h
Fuel Consumption (Total)	1210.1 L/h	160.4 mL/km		
Fuel Economy	16.0 L/100km			
Carbon Dioxide (Total)	2852.1 kg/h	378.1 g/km		
Hydrocarbons (Total)	0.298 kg/h	0.040 g/km		
Carbon Monoxide (Total)	2.497 kg/h	0.331 g/km		
NOx (Total)	2.280 kg/h	0.302 g/km		

Largest change in Average Back of Queue or Degree of Saturation for any lane during the last three iterations: 39.5 %
Number of Iterations: 10 (maximum specified: 10)
Network Level of Service (LOS) Method: SIDRA Speed Efficiency.
Software Setup used: New South Wales.

Network Performance - Annual Values			
Performance Measure	**Vehicles**	**Pedestrians**	**Persons**
Demand Flows (Total for all Sites)	11,487,550 veh/y	6,968,629 ped/y	18,116,390 pers/y
Delay	140,685 veh-h/y	53,961 ped-h/y	240,147 pers-h/y
Effective Stops	8,645,348 veh/y	5,191,856 ped/y	17,553,560 pers/y
Travel Distance	3,620,528 veh-km/y	236,456 ped-km/y	5,236,923 pers-km/y
Travel Time	213,941 veh-h/y	104,485 ped-h/y	394,019 pers-h/y
Cost	8,437,321 $/y	2,633,031 $/y	11,070,350 $/y
Fuel Consumption	580,857 L/y		
Carbon Dioxide	1,368,986 kg/y		

Figure 65 ***2026 SIDRA 7 Section 94 WE Peak 95th % Queues***

Source *Sidra/Road Delay Solutions, 2017*



6.15 2026 Victoria Street & George Street development

(26AMBTD.PLT/26PMBTD.PLT/26AMWED.PLT)

The third scenario model of the Year 2026 includes the impacts of the Victoria Street & George Street development.

The Victoria Street & George Street development model was specifically constructed to shape the necessary mitigation treatments to sustain the planned growth levels within and immediate Burwood town centre surrounds. The model addresses the following objectives…

- → *The minimisation of impacts from development generated traffic on Burwood Road, Shaftesbury Road and local streets,*
- → *The optimisation of traffic operations on Burwood Road and Shaftesbury Road during the commuter peak periods within the current road reserve constraints, where possible,*
- → *To maintain and/or improve pedestrian mobility and safety within the study area, and*
- → *Realise a traffic management outcome which retains a level of amenity while allowing further development necessary for economic growth within the retail and commercial sectors of the town centre.*

The major input parameters incorporated in the 2026 Victoria Street & George Street development model, comprise…

- → *The introduction of committed road network infrastructure improvements outlined in Burwood Council's Section 94 Plan,*
- → *Trip matrices for the AM, PM and WE peak periods encapsulating the planned growth levels to year 2026, as defined by the BTS, within the Metropolitan Area, and specifically, the BTS TZs 910, 913 and 915,*
- → *The introduction of traffic generation associated with the Victoria Street & George Street development, via the proposed access locations on Victoria Street and George Street, and*
- → *A general 3% increase in pedestrian traffic associated with the population growth within the Burwood town centre.*

To achieve the objectives of this assessment, it was necessary to consider a number of treatments, including several from the Section 94 Infrastructure Plan, which will meet the amenity and capacity objectives associated with the Victoria Street & George Street development.

Figure 66 ***2026 Victoria Street & George Street development Model – Road Network Treatment Options***

Source *Road Delay Solutions, 2017*

Identifier	Proposed Road Network Component	Priority in Relation to Burwood Towers Development	Reasoning
1	Widening of pedestrian crossings to 5m at select locations.	**Medium**	To increase the pedestrian capacity and attempt to reduce the incidence of demand for the pedestrian 'WALK' during each cycle.
2	Retention of right turn for all vehicles, SB on Burwood Road at Railway Parade.	**High**	Afford buses access to the stops in Railway Parade on the northern side of Burwood Plaza.
3	Introduction of a pedestrian 'scramble' phase.	**High**	A pedestrian 'scramble' phase will reduce the impacts of pedestrian movements on the SB left turn movement in Burwood Road.
4	Introduction of traffic signals at Shaftesbury Road and George Street.	**High**	Right turn delays from George Street onto Shaftesbury Road require the signalisation of the site. Improved pedestrian access to the proposed retail component of the development by local patrons.
5	Signalisation of Burwood Road intersection at Victoria Street East. Buses Only RT movement from Burwood Road NB (Interim measure).	**Low**	Necessary to formalise both bus and pedestrian movements. Intended to reduce the incidence of 'J' walking across Burwood Road.
6	`Increased capacity at the intersection of Shaftesbury Road and Wiga Street by developing and introducing... ** A shared through and left turn lane NB in Shaftesbury Road,* ** A corresponding 80m kerbside departure lane, and* ** An 80m long RT bay SB in Shafesbury Road.*	**High**	The Wilga Street intersection currently has capacity constraints with only a single lane NB on Shaftesbury Road limiting the potential growth of traffic with development. Widening is necessary to sustain the Towers and Burwood RSL developments.

With the proposed mixed use development the subsequent, calculated,vehicle generation is 340vph during the AM peak and 306vph during the PM.

The development vehicle generation has been applied to the year 2026 trip matrices. The operational modelling generally reports a LoS 'E' for the morning, evening and weekend peak periods.

Detailed assessment of each key intersection and the town centre route was undertaken to determine the impact on average vehicle delay, level of service and the resultant queue lengths.

The mesoscopic modelling indicates that with the addition of the Victoria Street & George Street traffic generation, Burwood Road traffic volumes do not rise significantly. However, traffic vehicle volume increases do occur on Shaftesbury Road as this is the primary egress corridor from the development. Residents on George Street do have the alternative of utilising Marmaduke Street to access Burwood Road via Deane Street. However, only 35% or some 119vph are generated from the George Street site and of these, only 60vph leave the development site and can potentially utilise Marmaduke Street to access Burwood Road.

The growth reported in the modelling along Burwood Road is consistent with that reported from collected data between the years 2000 and 2016.

6.16 Widening of Pedestrian Crossings

Consideration has been given to widening of the marked foot crossings on Burwood Road at…

- → *Victoria Road East,*
- → *Dean Street,*
- → *Railway Parade, and*
- → *Belmore Street.*

The measure will increase pedestrian '*throughput*', reduce pedestrian delays and may reduce the incidence of the pedestrian '*walk phase*' being called each cycle of the traffic signals throughout the day.

Widening of the crossings will also improve pedestrian mobility within the confines of the marked crossings and may reduce the incidence of 'J' walking.

Modelling of the widened crossings was undertaken and found to reduce pedestrian delays by up to 20 seconds per person per cycle of the traffic lights.

This action may be undertaken when each signal site undergoes reconstruction.

6.17 Burwood Road and Railway Parade

A number of options have been considered and modelled for this site. The signalised intersection is currently operating a dedicated right turn phase, from the central shared lane, on Burwood Road northbound into Railway Parade, modelling indicated no significant improvement in the network operation would result from banning the movement ot all vehicles, with the exception of buses.

Reloction of the right turn phase from Railway Parade to Belmore Street yielded no significant benefit. The action reported significant increases in vehicle delay and queues for southbound motorists between Belmore Street and Railway Parade.

The pedestrian demand at the intersection is high and causes delay to turn movements. To eliminate this delay a '*scramble*' pedestrian phase has been analysed. By introducing the signle walk phase all left turn movements are no longer held by the movement of pedestrians. The '*scramble'* phase is introduced as the last phase of the cycle and has been timed to coincide with the longest perpendicular walk through the intersection.

Introduction of a *scramble* crossing phase at the intersection of Burwood Road and Railway Parade, will improve vehicle flow by eliminating delays to the left turn movements within the intersection. Currently red roundel and red arrow protection is afforded pedestrians at each of the left turn movements. A scramble phase eliminates this hold on left turn vehicles and allows them to clear upon display of the respective green signal, without restriction.

With the Burwood railway station only 170m from the Plaza site, the scramble walk will afford pedestrians improved connectivity and a shorter walk time.

The retention of the right turn movement and introduction of the scramble walk phase, the signals report LoS 'D' during the week day commuter peak periods and LoS 'C' during the weekend peak.

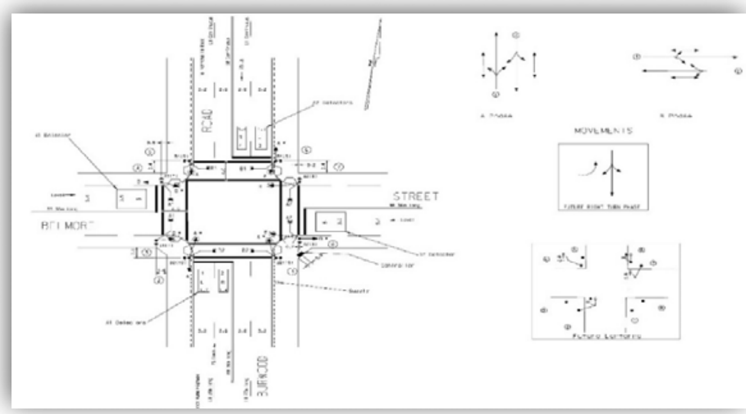
6.18 Burwood Road and Belmore Street

With the retention of the right turn movement for all vehicles, southbound in Burwood Road at Railway Parade, route modelling indicates that the Belmore Street intersection performs best if retained in its current state.

The *RMS* have indicated future plans to introduce a dedicated right turn phase from Burwood Road, southbound, into Belmore Street. Modelling shows that the introduction of an additional phase in the cycle will cause queueing and increase vehicle delays in Burwood Road.

Figure 67 ***Future Right Turn Treatment at Belmore Street***

Source *Extract RMS Traffic Signal Design, 2016*



6.19 Burwood Road and Victoria Street East

TfNSW has formerly requested consideration of traffic signalisation of the Burwood Road intersection with Victoria Street East to facilitate the right turn movement northbound for buses only to enable access to bus layover provisions in Victoria Street East, adjacent to the Westfield Shopping Complex.

Bus priority and a 'B' signal lantern display is proposed at the Burwood Road intersection with Victoria Street East. The bus movement is proposed to occur during the intergreen period prior to 'A' phase.

The proposal considers the introduction of through and right turn movements by buses only from the kerb side lane during the peak periods 6 to 10am and 3 to 7pm, Monday to Friday. This measure will eliminate the need for buses to merge from the kerb side lane to the centre lane prior to turning right into Victoria Street reducing the incidence of delay to the central through lane traffic.

The design of the site should incorporate 5m wide signalised pedestrian crossings to increase throughput and reduce delays per phase.

The area around the site has been identified as a known 'J' walking location and with the introduction of traffic signals, and the incorporation of controlled pedestrian crossings, pedestrian amenity and safety will be improved.

The site reports a LoS 'B' across the peak periods, satisfactory DS levels and modest spare capacity for further growth.

6.20 Shaftesbury Road and George Street

The introduction of traffic signal control at the site is proposed to…

- *Facilitate a safe right turn movement from George Street onto Shaftesbury Road,*
- *Improve pedestrian mobility between the residential catchment to the east of Shaftesbury Road and the Burwood Railway station and retail operations at the proposed development, and*
- *Reduce the potential intrusion of traffic on Marmaduke Street.*

The proposed traffic signal operation reports a LoS 'B' during each of the modelled peak hour periods.

6.21 Capacity Increase on Shaftesbury Road at Wilga Street

With only single through traffic lanes on Shaftesbury Road at Wilga Street, the traffic signal controlled intersection, particularly northbound, becomes a pinch point requiring increased capacity to sustain development growth and some 300vph during the commuter peaks.

As the Victoria Street & George Street development has access from both Victoria Street and George Street, with the latter being one way, the southbound increase in Shaftesbury Road is not significant enough to require widening of the southbound carriageway. However, egress from the proposed development is entirely onto Shaftesbury Road and with the directional flow towards the Sydney CBD during the morning peak, the intersection reports unsatisfactory service.

The volume of through traffic, under full development of the town centre, will require the widening of Shaftesbury Road to accommodate two (2) trafficable lanes northbound and lengthening of the southbound right turn bay into Wilga Street.

Figure 68 Proposed Intersection Treatment at Wilga Street

Source Road Delay Solutions, 2017, 2016

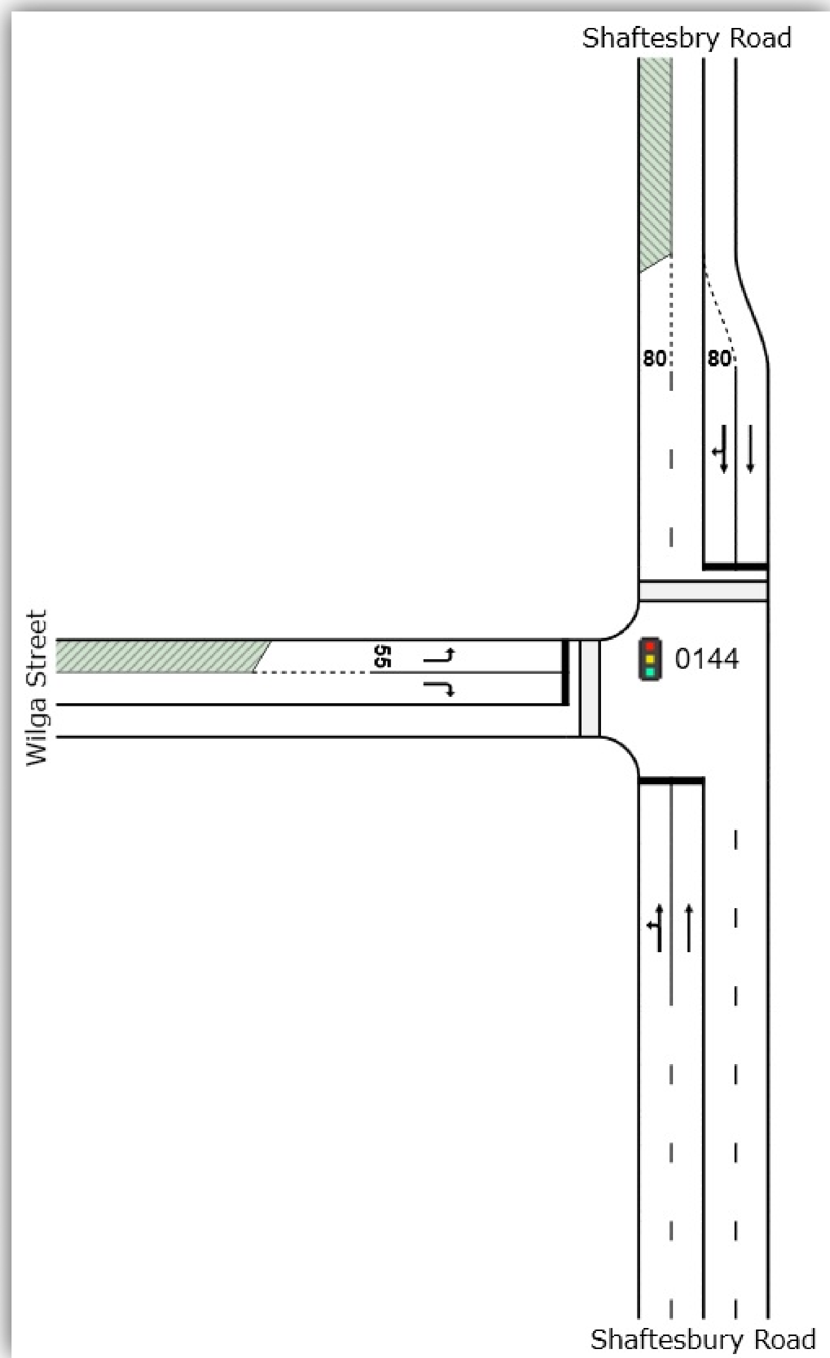


Figure 69 2026 AM Peak Victoria Street & George Street Development Model

Source Road Delay Solutions, 2017

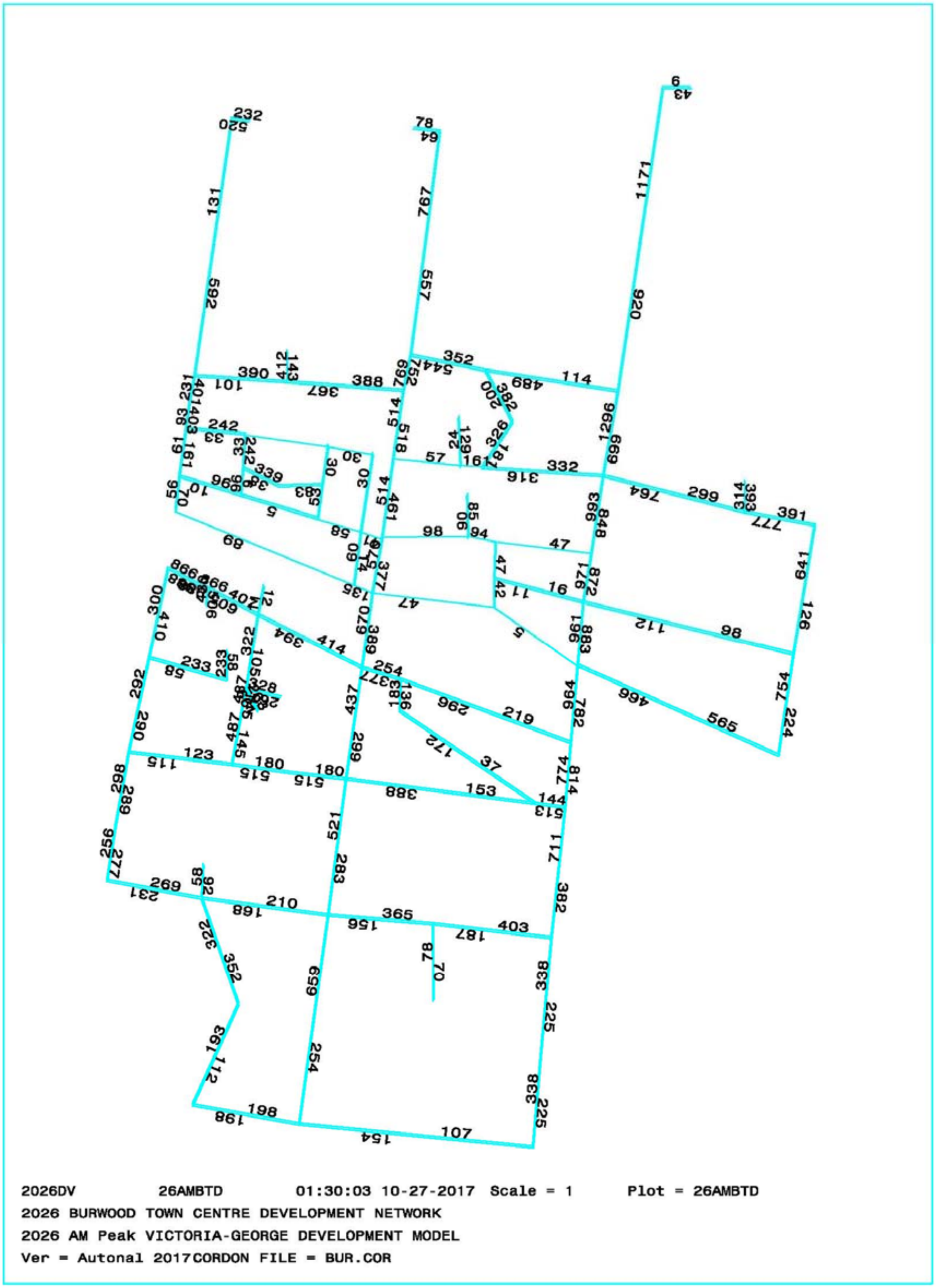


Figure 70 2026 PM Peak Victoria Street & George Street Development Model

Source Road Delay Solutions, 2017

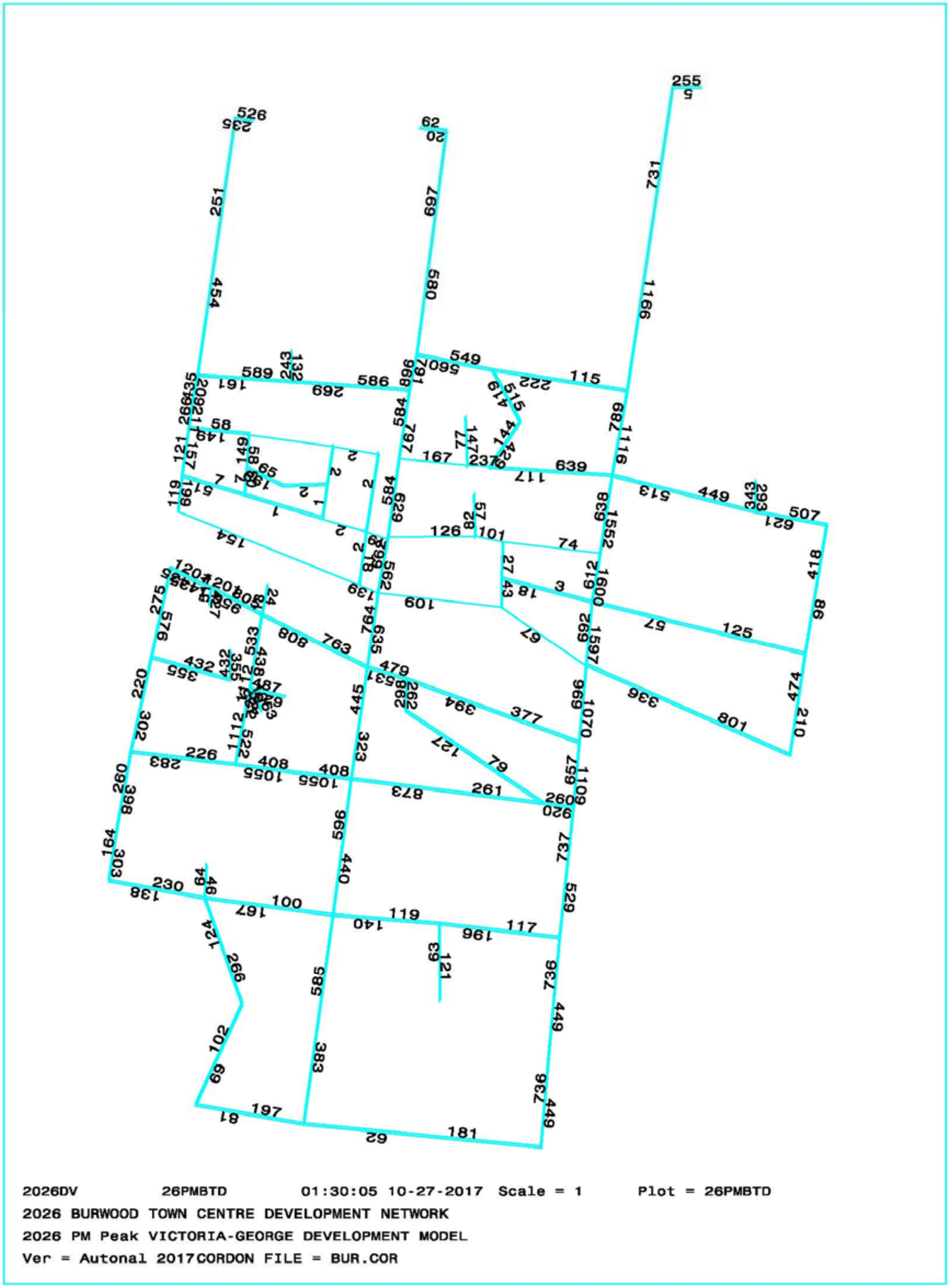


Figure 71 2026 WE Peak Victoria Street & George Street Development Model

Source Road Delay Solutions, 2017

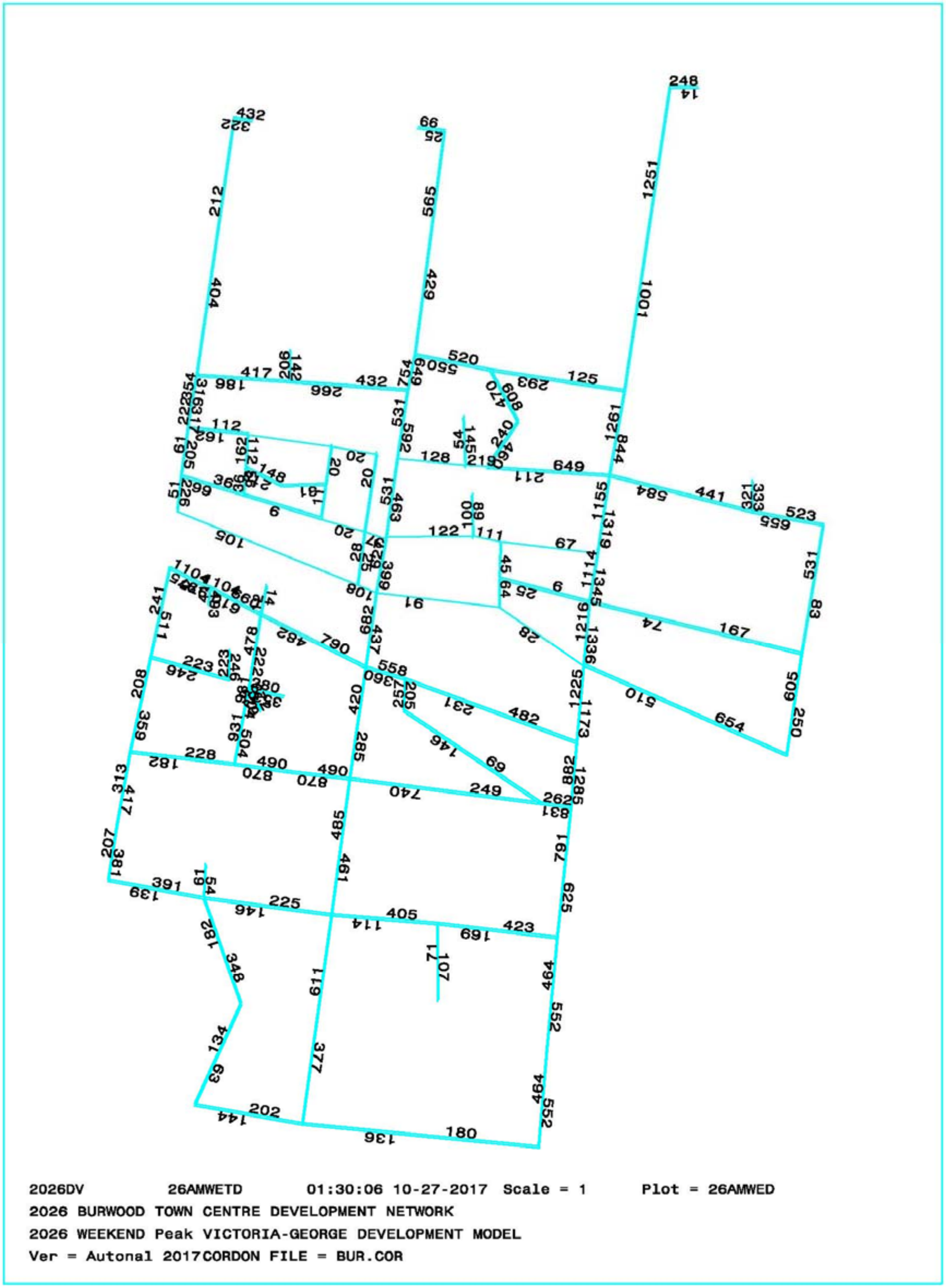


Figure 72 2026 SIDRA 7 Development Model Road Network

Source Sidra/Road Delay Solutions, 2017

NETWORK LAYOUT

Network: N101 [2026 AM Burwood Town Centre]

SITES IN NETWORK		
Site ID	**CCG ID**	**Site Name**
0107	NA	2026 AM Shaftesbury Rd, Railway Pde and Paisley St
0144	NA	2026 AM Shaftesbury Rd and Wilga St UPGRADED
0784	NA	2026 AM Shaftesbury Road and Victoria Street
TCS007	NA	2026 AM Shaftesbury Rd and George St - Conversion
GW02	NA	2026 AM Shaftesbury Rd and Deane St
TCS0008	NA	2026 AM Burwood Rd and Victoria St - Conversion
GW03	NA	2026 AM Burwood Rd and George St
0174	NA	2026 AM S94 Burwood Rd and Deane St
0014	NA	2026 AM S94 Burwood Rd and Railway Pde
1639	NA	2026 AM S94 Burwood Rd and Belmore St
1843	NA	2026 AM S94 Railway Pde and Wynne Ave
TCS001	NA	2026 AM S94 Railway Pde and Conder St
TCS002	NA	2026 AM S94 Belmore St and Wynne Ave
TCS003	NA	2026 AM S94 Belmore St and Conder St
1183	NA	2026 AM S94 Wentworth Rd, Railway Pde and Morwick St

Figure 73 2026 SIDRA 7 Development Model AM Peak Network Report

Source Sidra/Road Delay Solutions, 2017

NETWORK SUMMARY

Network: N101 [2026 AM Burwood Town Centre]

New Network
Network Cycle Time = 100 seconds (Network Cycle Time - User-Given)

Network Performance - Hourly Values

Performance Measure	Vehicles	Per Unit Distance	Pedestrians	Persons
Network Level of Service (LOS)	LOS F			
Travel Time Index	1.99			
Speed Efficiency	0.28			
Congestion Coefficient	3.58			
Travel Speed (Average)	16.8 km/h		2.3 km/h	13.1 km/h
Travel Distance (Total)	7965.7 veh-km/h		540.0 ped-km/h	11522.8 pers-km/h
Travel Time (Total)	475.0 veh-h/h		234.2 ped-h/h	880.7 pers-h/h
Desired Speed	60.0 km/h			
Demand Flows (Total for all Sites)	25483 veh/h		16009 ped/h	39782 pers/h
Arrival Flows (Total for all Sites)	25328 veh/h		16009 ped/h	39589 pers/h
Demand Flows (Entry Total)	6812 veh/h			
Midblock Inflows (Total)	3050 veh/h			
Midblock Outflows (Total)	-2553 veh/h			
Percent Heavy Vehicles (Demand)	3.1 %			
Percent Heavy Vehicles (Arrival)	3.2 %			
Degree of Saturation	1.501			
Control Delay (Total)	313.35 veh-h/h		118.86 ped-h/h	538.61 pers-h/h
Control Delay (Average)	44.5 sec		26.7 sec	49.0 sec
Control Delay (Worst Lane)	499.6 sec			
Control Delay (Worst Movement)	499.6 sec		45.2 sec	499.6 sec
Geometric Delay (Average)	1.6 sec			
Stop-Line Delay (Average)	43.0 sec			
Queue Storage Ratio (Worst Lane)	1.53			
Total Effective Stops	21050 veh/h		12792 ped/h	43346 pers/h
Effective Stop Rate	0.83 per veh	2.6 per km	0.80 per ped	1.09 per pers
Proportion Queued	0.72		0.80	1.01
Performance Index	1770.0		305.3	2075.3
Cost (Total)	19069.31 $/h	2.39 $/km	5902.87 $/h	24972.18 $/h
Fuel Consumption (Total)	1309.6 L/h	164.4 mL/km		
Fuel Economy	16.4 L/100km			
Carbon Dioxide (Total)	3088.3 kg/h	387.7 g/km		
Hydrocarbons (Total)	0.323 kg/h	0.041 g/km		
Carbon Monoxide (Total)	2.667 kg/h	0.335 g/km		
NOx (Total)	2.893 kg/h	0.363 g/km		

Largest change in Average Back of Queue or Degree of Saturation for any lane during the last three iterations: 21.5 %
Number of Iterations: 10 (maximum specified: 10)
Network Level of Service (LOS) Method: SIDRA Speed Efficiency.
Software Setup used: New South Wales.

Network Performance - Annual Values

Performance Measure	Vehicles	Pedestrians	Persons
Demand Flows (Total for all Sites)	12,232,030 veh/y	7,684,081 ped/y	19,095,440 pers/y
Delay	150,410 veh-h/y	57,053 ped-h/y	258,534 pers-h/y
Effective Stops	10,103,780 veh/y	6,139,967 ped/y	20,806,190 pers/y
Travel Distance	3,823,515 veh-km/y	259,192 ped-km/y	5,530,959 pers-km/y
Travel Time	227,990 veh-h/y	112,436 ped-h/y	422,719 pers-h/y
Cost	9,153,271 $/y	2,833,376 $/y	11,986,650 $/y
Fuel Consumption	628,619 L/y		
Carbon Dioxide	1,482,380 kg/y		

Figure 74 2026 SIDRA 7 Development Model AM Peak 95th % Queues

Source Sidra/Road Delay Solutions, 2017

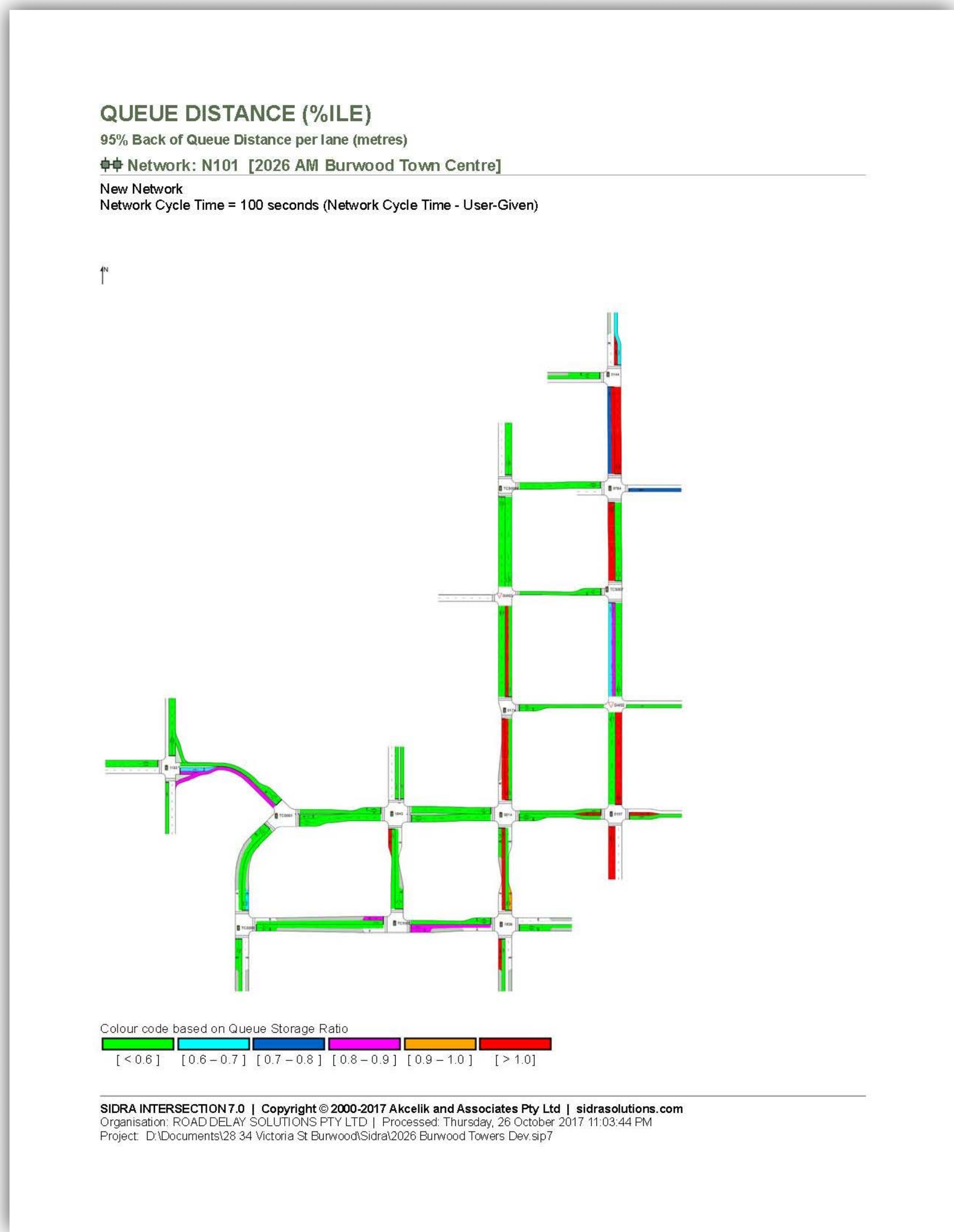


Figure 75 2026 SIDRA 7 Development Model PM Peak Network Report

Source Sidra/Road Delay Solutions, 2017

NETWORK SUMMARY

Network: N101 [2026 PM Burwood Town Centre]

New Network
Network Cycle Time = 100 seconds (Network Cycle Time - User-Given)

Network Performance - Hourly Values				
Performance Measure	**Vehicles**	**Per Unit Distance**	**Pedestrians**	**Persons**
Network Level of Service (LOS)	LOS F			
Travel Time Index	1.68			
Speed Efficiency	0.25			
Congestion Coefficient	3.98			
Travel Speed (Average)	15.1 km/h		2.1 km/h	12.0 km/h
Travel Distance (Total)	8957.4 veh-km/h		586.3 ped-km/h	12895.0 pers-km/h
Travel Time (Total)	594.7 veh-h/h		276.7 ped-h/h	1070.9 pers-h/h
Desired Speed	60.0 km/h			
Demand Flows (Total for all Sites)	28688 veh/h		17358 ped/h	44875 pers/h
Arrival Flows (Total for all Sites)	27917 veh/h		17358 ped/h	43862 pers/h
Demand Flows (Entry Total)	7397 veh/h			
Midblock Inflows (Total)	4021 veh/h			
Midblock Outflows (Total)	-3398 veh/h			
Percent Heavy Vehicles (Demand)	3.0 %			
Percent Heavy Vehicles (Arrival)	3.0 %			
Degree of Saturation	1.244			
Control Delay (Total)	402.54 veh-h/h		151.42 ped-h/h	678.27 pers-h/h
Control Delay (Average)	51.9 sec		31.4 sec	55.7 sec
Control Delay (Worst Lane)	272.4 sec			
Control Delay (Worst Movement)	272.4 sec		46.7 sec	272.4 sec
Geometric Delay (Average)	1.4 sec			
Stop-Line Delay (Average)	50.5 sec			
Queue Storage Ratio (Worst Lane)	1.17			
Total Effective Stops	23001 veh/h		13460 ped/h	45734 pers/h
Effective Stop Rate	0.82 per veh	2.6 per km	0.78 per ped	1.04 per pers
Proportion Queued	0.71		0.78	0.98
Performance Index	2117.2		351.5	2468.7
Cost (Total)	23180.28 $/h	2.59 $/km	6972.67 $/h	30152.95 $/h
Fuel Consumption (Total)	1544.2 L/h	172.4 mL/km		
Fuel Economy	17.2 L/100km			
Carbon Dioxide (Total)	3639.4 kg/h	406.3 g/km		
Hydrocarbons (Total)	0.384 kg/h	0.043 g/km		
Carbon Monoxide (Total)	3.115 kg/h	0.348 g/km		
NOx (Total)	2.967 kg/h	0.331 g/km		

Largest change in Average Back of Queue or Degree of Saturation for any lane during the last three iterations: 494.0 %
Number of Iterations: 10 (maximum specified: 10)
Network Level of Service (LOS) Method: SIDRA Speed Efficiency.
Software Setup used: New South Wales.

Network Performance - Annual Values			
Performance Measure	**Vehicles**	**Pedestrians**	**Persons**
Demand Flows (Total for all Sites)	13,770,370 veh/y	8,331,829 ped/y	21,539,970 pers/y
Delay	193,220 veh-h/y	72,683 ped-h/y	325,569 pers-h/y
Effective Stops	11,040,430 veh/y	6,460,779 ped/y	21,952,310 pers/y
Travel Distance	4,299,542 veh-km/y	281,407 ped-km/y	6,189,589 pers-km/y
Travel Time	285,474 veh-h/y	132,813 ped-h/y	514,009 pers-h/y
Cost	11,126,540 $/y	3,346,881 $/y	14,473,420 $/y
Fuel Consumption	741,232 L/y		
Carbon Dioxide	1,746,916 kg/y		

Figure 76 2026 SIDRA 7 Development Model PM Peak 95th % Queues

Source Sidra/Road Delay Solutions, 2017

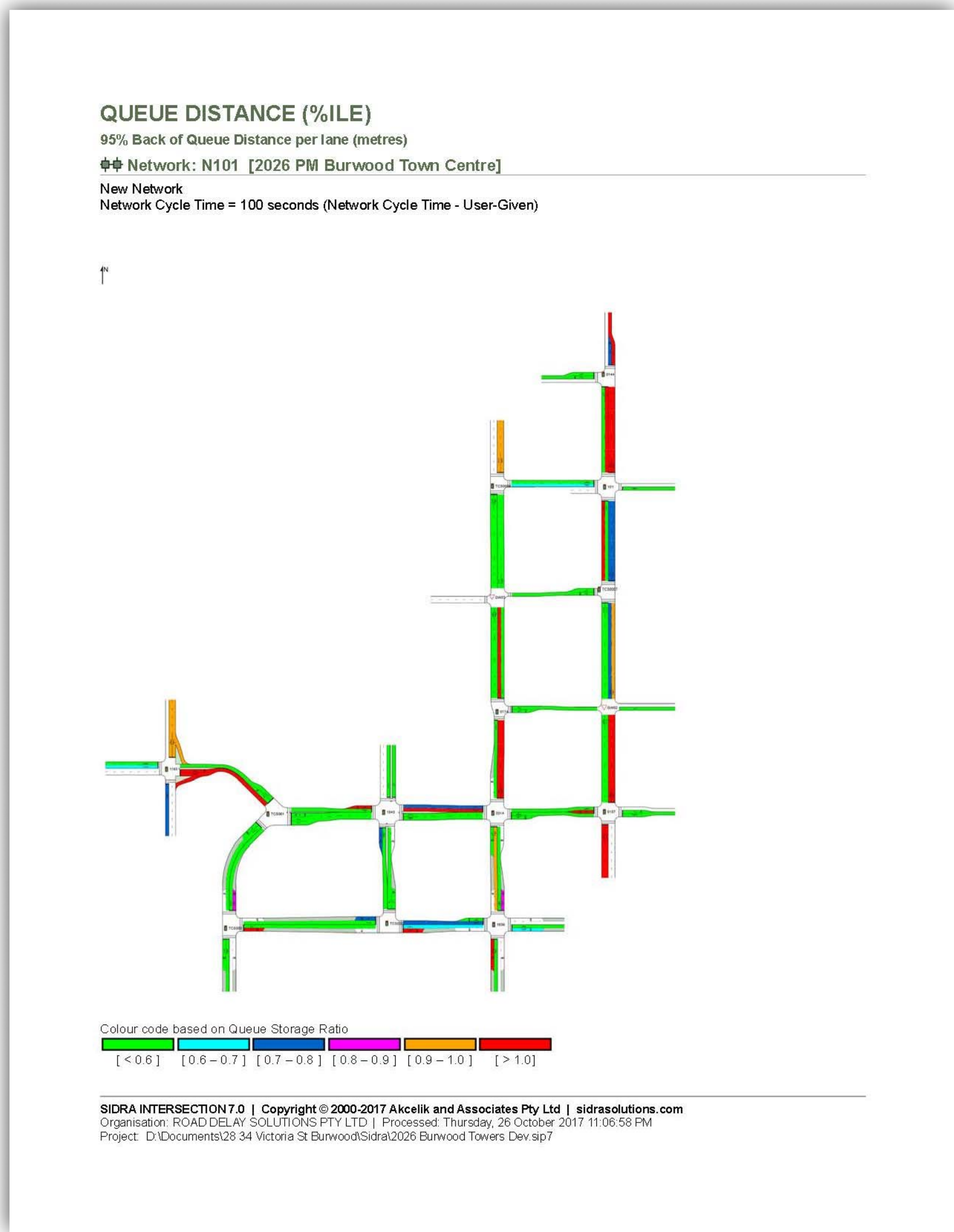


Figure 77 2026 SIDRA 7 Development Model WE Peak Network Report

Source Sidra/Road Delay Solutions, 2017

NETWORK SUMMARY

Network: N101 [2026 WE Burwood Town Centre]

New Network
Network Cycle Time = 100 seconds (Network Cycle Time - User-Given)

Network Performance - Hourly Values

Performance Measure	Vehicles	Per Unit Distance	Pedestrians	Persons
Network Level of Service (LOS)	LOS E			
Travel Time Index	2.38			
Speed Efficiency	0.31			
Congestion Coefficient	3.19			
Travel Speed (Average)	18.8 km/h		2.1 km/h	13.6 km/h
Travel Distance (Total)	7619.4 veh-km/h		546.1 ped-km/h	11045.0 pers-km/h
Travel Time (Total)	404.7 veh-h/h		259.3 ped-h/h	812.7 pers-h/h
Desired Speed	60.0 km/h			
Demand Flows (Total for all Sites)	24600 veh/h		16166 ped/h	39020 pers/h
Arrival Flows (Total for all Sites)	24399 veh/h		16166 ped/h	38771 pers/h
Demand Flows (Entry Total)	6983 veh/h			
Midblock Inflows (Total)	2632 veh/h			
Midblock Outflows (Total)	-2943 veh/h			
Percent Heavy Vehicles (Demand)	2.9 %			
Percent Heavy Vehicles (Arrival)	2.9 %			
Degree of Saturation	1.382			
Control Delay (Total)	252.38 veh-h/h		142.60 ped-h/h	480.90 pers-h/h
Control Delay (Average)	37.2 sec		31.8 sec	44.7 sec
Control Delay (Worst Lane)	398.2 sec			
Control Delay (Worst Movement)	398.2 sec		44.6 sec	398.2 sec
Geometric Delay (Average)	1.5 sec			
Stop-Line Delay (Average)	35.7 sec			
Queue Storage Ratio (Worst Lane)	1.44			
Total Effective Stops	17593 veh/h		12818 ped/h	37715 pers/h
Effective Stop Rate	0.72 per veh	2.3 per km	0.79 per ped	0.97 per pers
Proportion Queued	0.67		0.79	0.95
Performance Index	1545.9		330.5	1876.4
Cost (Total)	16304.31 $/h	2.14 $/km	6534.02 $/h	22838.33 $/h
Fuel Consumption (Total)	1156.6 L/h	151.8 mL/km		
Fuel Economy	15.2 L/100km			
Carbon Dioxide (Total)	2725.8 kg/h	357.7 g/km		
Hydrocarbons (Total)	0.280 kg/h	0.037 g/km		
Carbon Monoxide (Total)	2.367 kg/h	0.311 g/km		
NOx (Total)	2.183 kg/h	0.287 g/km		

Largest change in Average Back of Queue or Degree of Saturation for any lane during the last three iterations: 13.0 %
Number of Iterations: 10 (maximum specified: 10)
Network Level of Service (LOS) Method: SIDRA Speed Efficiency.
Software Setup used: New South Wales.

Network Performance - Annual Values

Performance Measure	Vehicles	Pedestrians	Persons
Demand Flows (Total for all Sites)	11,807,880 veh/y	7,759,871 ped/y	18,729,660 pers/y
Delay	121,140 veh-h/y	68,448 ped-h/y	230,832 pers-h/y
Effective Stops	8,444,745 veh/y	6,152,659 ped/y	18,103,190 pers/y
Travel Distance	3,657,305 veh-km/y	262,124 ped-km/y	5,301,611 pers-km/y
Travel Time	194,260 veh-h/y	124,458 ped-h/y	390,094 pers-h/y
Cost	7,826,068 $/y	3,136,331 $/y	10,962,400 $/y
Fuel Consumption	555,166 L/y		
Carbon Dioxide	1,308,375 kg/y		

Figure 78 2026 SIDRA 7 Development Model WE Peak 95th % Queues

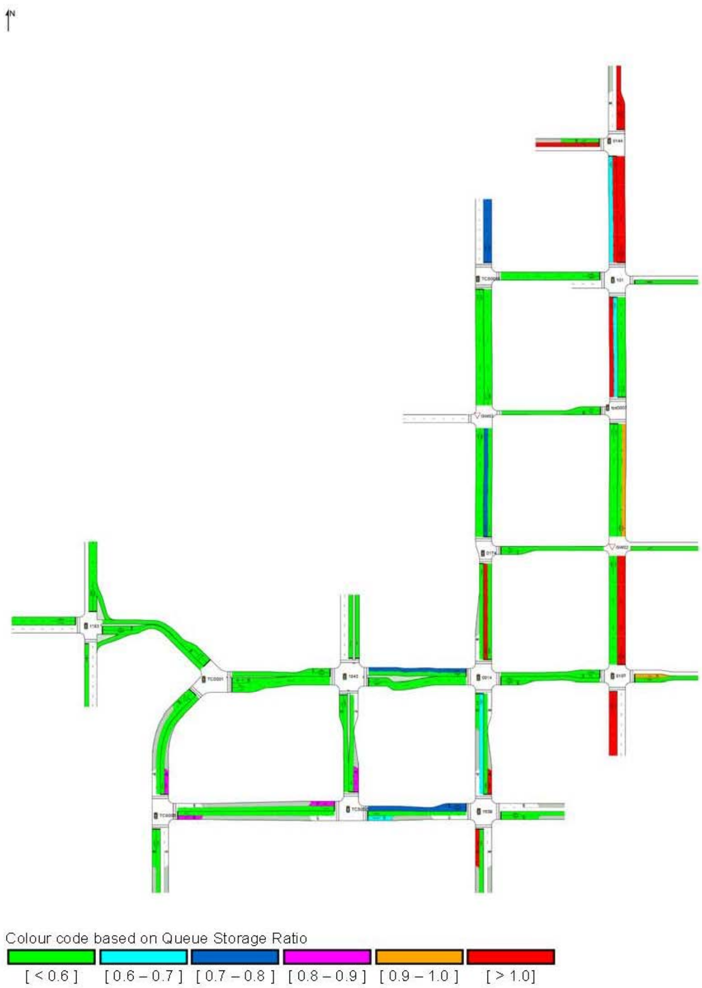
Source Sidra/Road Delay Solutions, 2017

QUEUE DISTANCE (%ILE)

95% Back of Queue Distance per lane (metres)

Network: N101 [2026 WE Burwood Town Centre]

New Network
Network Cycle Time = 100 seconds (Network Cycle Time - User-Given)



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Organisation: ROAD DELAY SOLUTIONS PTY LTD | Processed: Thursday, 26 October 2017 11:10:10 PM
Project: D:\Documents\28 34 Victoria St Burwood\Sidra\2026 Burwood Towers Dev.sip7

Table 10 ***Modelled Vehicle Projections***

Source *Road Delay Solutions, 2017*

MESOSCOPIC MODEL HOURLY TRAFFIC VOLUME PROJECTIONS																					
	Model																				
Road Link	17AM4	26AMBTB	Variance 2026 Base Model minus Existing	26AMS94B	Variance 2026 S94 Model minus Existing	26AMBTD	Variance 2026 Towers Model minus Existing	17PM3	26PMBTB	Variance 2026 Base Model minus Existing	26PMS94B	Variance 2026 S94 Model minus Existing	26PMBTD	Variance 2026 Towers Model minus Existing	17AMWE6	26AMWEB	Variance 2026 Base Model minus Existing	26AMWESB	Variance 2026 S94 Model minus Existing	26AMWED	Variance 2026 Towers Model minus Existing
BURWOOD RD SB N WILGA ST	562	655	93	717	62	557	-5	452	609	157	442	-10	580	128	371	627	256	429	58	429	58
WILGA ST EB	386	327	-59	404	77	352	-34	541	474	-67	516	-25	549	8	581	646	65	567	-14	520	-61
WILGA ST WB	501	479	-22	583	104	544	43	472	564	92	509	37	560	88	489	511	22	564	75	550	61
PARK AVE EB	460	482	22	411	-71	388	-72	507	507	0	490	-17	586	79	536	604	68	403	-133	432	-104
PARK AVE WB	359	415	56	398	-17	367	8	349	297	-52	343	-6	269	-80	298	264	-34	311	13	266	-32
BURWOOD RD NB S PARK AVE	487	519	32	419	-100	514	27	486	602	116	464	-22	584	98	423	497	74	550	127	531	108
BURWOOD RD SB S PARK AVE	540	613	73	529	-84	518	-22	502	762	260	457	-45	797	295	496	778	282	515	19	592	96
BURWOOD RD SB N GEORGE ST	471	538	67	482	-56	461	-10	389	575	186	335	-54	629	240	346	651	305	417	71	463	117
GEORGE ST EB	84	244	160	212	-32	332	248	58	592	534	488	430	639	581	71	611	540	461	390	649	578
GEORGE ST WB W BURWOOD RD	140	98	-42	68	-30	41	-99	179	53	-126	43	-136	19	-160	106	58	-48	71	-35	37	-69
RAILWAY CRES WB	93	132	39	54	-78	135	42	56	193	137	42	-14	139	83	73	165	92	51	-22	108	35
DEANE ST WB	173	77	-96	67	-10	47	-126	216	106	-110	72	-144	109	-107	137	71	-66	86	-51	91	-46
BURWOOD RD NB N RAILWAY PDE	588	692	104	513	-179	670	82	569	826	257	545	-24	764	195	523	697	174	644	121	682	159
RAILWAY PDE EB W BURWOOD RD	428	469	41	408	-61	389	-39	395	596	201	282	-113	635	240	334	623	289	326	-8	437	103
RAILWAY PDE WB E BURWOOD RD	415	334	-81	379	45	377	-38	416	299	-117	474	58	531	115	448	313	-135	343	-105	360	-88
RAILWAY PDE EB E BURWOOD RD	341	390	49	291	-99	254	-87	411	451	40	566	155	479	68	400	435	35	362	-38	558	158
BURWOOD RD NB S RAILWAY PDE	509	511	2	382	-129	437	-72	446	555	109	362	-84	445	-1	484	585	101	354	-130	420	-64
BURWOOD RD SB S RAILWAY PDE	311	308	-3	261	-47	299	-12	312	414	102	194	-118	323	11	274	404	130	241	-33	285	11
BURWOOD CENTRAL NB	11	10	-1	11	1	11	0	12	11	-1	13	1	13	1	11	10	-1	12	1	12	1
BURWOOD CENTRAL SB	12	12	0	12	0	12	0	22	24	2	24	2	24	2	13	14	1	14	1	14	1
RAILWAY PDE EB W WYNNE AVE	369	397	28	352	-45	407	38	472	476	4	831	359	805	333	473	434	-39	584	111	660	187
RAILWAY PDE WB W WYNNE AVE	480	388	-92	870	482	605	125	607	496	-111	910	303	956	349	463	455	-8	549	86	610	147
RAILWAY PDE EB W CONDER ST	507	689	182	361	-328	959	452	516	1188	672	638	122	1149	633	573	855	282	657	84	1208	635
RAILWAY PDE WB W CONDER ST	476	997	521	986	-11	971	495	584	699	115	1041	457	1082	498	436	606	170	528	92	809	373
CONDER ST NB	239	299	60	502	203	292	53	217	221	4	376	159	220	3	202	221	19	227	25	208	6
CONDER ST SB	212	213	1	223	10	410	198	102	294	192	353	251	576	474	183	207	24	249	66	511	328
BELMORE ST EB W BURWOOD RD	231	171	-60	162	-9	180	-51	333	464	131	498	165	408	75	403	466	63	382	-21	490	87
BELMORE ST WB W BURWOOD RD	178	331	153	718	387	515	337	206	317	111	477	271	1055	849	181	308	127	466	285	870	689
BELMORE ST WB E BURWOOD RD	138	218	80	286	68	388	250	183	241	58	326	143	873	690	144	212	68	265	121	740	596
BELMORE ST EB E BURWOOD RD	132	140	8	138	-2	153	21	160	190	30	117	-43	261	101	201	196	-5	239	38	249	48
WYNNE AVE NB N BELMORE RD	128	401	273	777	376	322	194	132	485	353	712	580	533	401	117	259	142	359	242	478	361
WYNNE AVE SB N BELMORE RD	182	337	155	364	27	105	-77	168	238	70	457	289	438	270	147	227	80	171	24	222	75
CONDER ST NB S BELMORE ST	338	356	18	518	162	298	-40	193	339	146	378	185	260	67	259	326	67	237	-22	313	54
CONDER ST SB N BELMORE ST	159	297	138	190	-107	290	131	228	221	-7	162	-66	302	74	231	295	64	222	-9	359	128
BELMORE ST WB E CONDER ST	90	93	3	111	18	115	25	228	299	71	273	45	283	55	171	245	74	232	61	182	11
BELMORE ST EB E CONDER ST	197	122	-75	94	-28	123	-74	146	259	113	115	-31	226	80	245	257	12	159	-86	228	-17
WENTWORTH NB S RAILWAY	223	781	558	339	-442	157	-66	376	444	68	319	-57	256	-120	228	220	-8	415	187	212	-16
WENTWORTH SB S RAILWAY	337	513	176	467	-46	254	-83	529	853	324	662	133	403	-126	516	390	-126	576	60	398	-118
RAILWAY WB E WENTWORTH	478	1511	1033	986	-525	971	493	598	1032	434	1041	443	1082	484	440	610	170	528	88	809	369
RAILWAY EB E WENTWORTH	516	1288	772	361	-927	959	443	517	1367	850	638	121	1149	632	581	863	282	657	76	1208	627
WENTWORTH SB N RAILWAY	643	793	150	747	-46	913	270	1002	1315	313	1066	64	1275	273	851	1056	205	1075	224	1247	396
MORWICK EB W WENTWORTH	596	515	-81	257	-258	391	-205	517	687	170	548	31	454	-63	640	618	-22	396	-244	498	-142
SHAFTESBURY NB S RAILWAY	635	656	21	729	73	774	139	613	629	16	597	-16	657	44	689	674	-15	848	159	882	193
SHAFTESBURY SB S RAILWAY	541	546	5	603	57	814	273	593	700	107	758	165	1109	516	612	688	76	787	175	1285	673
PAISLEY EB E SHAFTESBURY	380	355	-25	137	-218	190	-190	443	758	315	180	-263	282	-161	346	370	24	85	-261	219	-127
PAISLEY WB E SHAFTESBURY	564	104	-460	295	191	489	-75	432	74	-358	301	-131	376	-56	440	89	-351	208	-232	422	-18
SHAFTESBURY NB N RAILWAY	797	766	-31	889	123	964	167	766	738	-28	851	85	696	-70	829	831	2	1094	265	1225	396
SHAFTESBURY SB N RAILWAY	521	820	299	662	-158	782	261	769	1294	525	801	32	1070	301	641	956	315	862	221	1173	532
RAILWAY WB W SHAFTESBURY	327	250	-77	305	55	296	-31	342	183	-159	343	1	394	52	313	197	-116	206	-107	231	-82
SHAFTESBURY SB N WILGA	682	703	21	798	95	920	238	906	846	-60	963	57	1166	260	569	492	-77	690	121	1001	432
WILGA EB W SHAFTESBURY	146	68	-78	130	62	114	-32	146	109	-37	140	-6	115	-31	119	87	-32	115	-4	125	6
SHAFTESBURY NB S WILGA	917	920	3	1071	151	1296	379	638	753	115	784	146	789	151	718	801	83	918	200	1261	543
SHAFTESBURY SB N VICTORIA	464	445	-19	622	177	669	205	917	777	-140	943	26	1116	199	536	440	-96	633	97	844	308
VICTORIA WB E SHAFTESBURY	540	668	128	624	-44	764	224	324	465	141	405	81	513	189	324	494	170	518	194	584	260
SHAFTESBURY NB S VICTORIA	831	924	93	1010	86	993	162	594	714	120	742	148	638	44	757	888	131	895	138	1155	398
VICTORIA EB W SHAFTESBURY	241	244	3	212	-32	332	91	524	592	68	488	-36	639	115	528	611	83	461	-67	649	121

ROAD DELAY SOLUTIONS

PARKING

DEVELOPMENT SITE PARKING TABLE					
Development Component	Area (Units &/or GLFA m^2)	Area (Units &/or GFA m^2)	DCP Units	DCP Rate	DCP Requirement
Residential Apartments					
1 Bed Apartments	103		per unit	1	103
2 Bed Apartments	280		per unit	1	280
3 Bed Apartments	53		per unit	1.5	80
Visitor Parking	436		per 5 units	1	87
Disabled	436		per 100 units unless demand requested	1	4
Car Share$	436		per 100 units	1	4
Retail Specialty Shops	3,202	4,447	1 space first 400m^2 then add 1 space per 40 m2 above first 400m^2 GLFA	1	71
Restaurants/Cafes #	0		1 space first 400m2 then add 1 space per 40 m2 above first 400m2 GLFA	1	0
Takeaway#	0		per 3 seats	1	0
Commercial	4,270	5,849	1 space first 400 m^2 then add 1 space per 120 m^2 GFA		46
Bicycles - Residential	436		per 3 units	1	144
Commercial	5,800		per 200m2 GFA	1	29
Retail Specialty Shops	5,048		per 300m2 GLFA	1	17
Restaurants	0		per 100m2 GLFA	1	0
Café	0		per 25m2 GLFA	1	0
Takeaway	0		per 100m2 GLFA	1	0
TOTAL SPACES					**676**

**The Supermarket and Specialty Shops Generation rate is based on RMS Technical Direction TDT 2013/04a for the highest weekday generation - 5.9vph/100m2 of GLFA.*

 # Restaurants, Cafes and Takeaway Outlets are included in the retail floor space allowance

$ Car share spaces may be included within the visitor parking allocation and signposted accordingly

SUSTAINABLE TRAVEL PLAN

Prior to submission of the DA a concise Sustainable Travel Plan will be prepared and presented addressing the opportunities for a reduction in private and commercial vehicle usage.

CONCLUSION

Road Delay Solutions has been engaged by *VSD Developments Pty Ltd* to undertake the preparation of a Traffic Impact Assessment in support of the Planning Proposal for a mixed use development at 28-32 Victoria Street and 23-27 George Street, Burwood, to be commonly known as '*Victoria Street & George Street*'.

Burwood is a dynamic LGA with the town centre constantly growing with planned residential, retail and commercial developments, some well into their construction phases. The Victoria Street & George Street development is just one of these.

This report has critically analysed the impacts of the proposed Victoria Street & George Street development on the Burwood Town Centre road network and concluded that the impacts of traffic generation associated with the proposed development alone, both vehicular and pedestrian, will be relatively benign on a network of roads which currently operate at or near capacity.

The impacts of growth throughout the centre, not only that of the Victoria Street & George Street site, indicate that future traffic is able to mesh with the current travel patterns indicating a degree of '*elasticity'* which can be supported until such time as capacity constraints prevent use of the road network bordering the town centre.

Extensive mesoscopic and operational modelling has reported that vehicular growth, particularly along Burwood Road has been relatively static over the past years given the corridor currently operates at capacity and any further growth is shared with the competing parallel route of Shaftesbury Road. Shaftesbury Road provides a viable through traffic avenue between the Hume Highway to the south and Great Western Highway to the north which removes pressure from Burwood Road.

A number of measures have been identified and assessed, in unison with Council's Section 94 Plan, to sustain the movement of traffic within the town centre and support the planned level of growth anticipated with the Victoria Street & George Street development to year 2026…

- → *Widening of existing signalised foot crossings along Burwood Road between Wilga Street and Belmore Street to 5m,*
- → *General retention of the current traffic signal operations at the Burwood Road intersections with Railway Parade (including retention of the right turn movement for all vehicles southbound turning into Railway Parade) and Belmore Street,*
- → *The introduction of a 'scramble' phase pedestrian crossing at the Burwood Road intersection with Railway Parade,*
- → *The introduction of site specific access from Victoria Street and George Street,*
- → *Widening of Shaftesbury Road to accommodate two (2) through lanes northbound at Wilga Street and lengthening of the right turn bay into Wilga Street, and*
- → *The introduction of traffic signal control at the intersections of…*
  - o *Shaftesbury Road and George Street, and*
  - o *Burwood Road and Victoria Street East.*

In conclusion, if the aforementioned measures are implemented, the impact of traffic generation associated with the Victoria Street & George Street development will be effectively managed while reducing the impedence of pedestrian traffic.

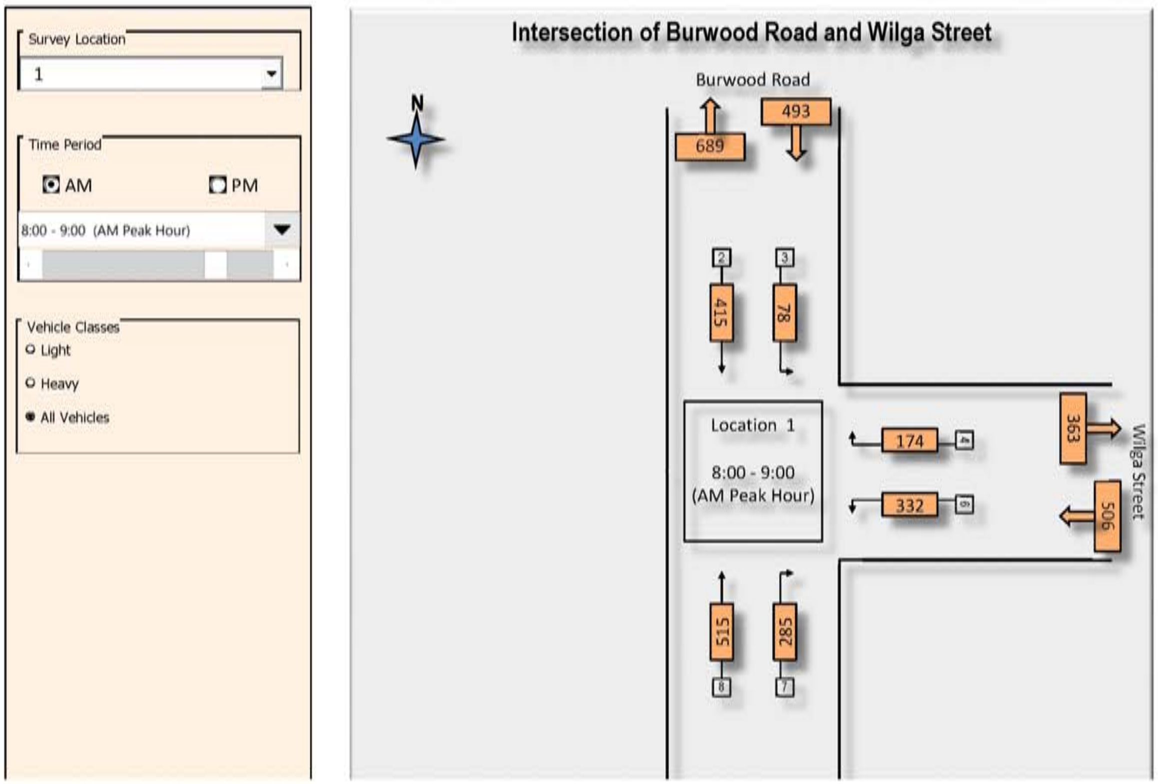
It is recommended that the traffic measures outlined be implemented over the coming five (5) years to retain the current service and amenity levels within the Burwood Town Centre.

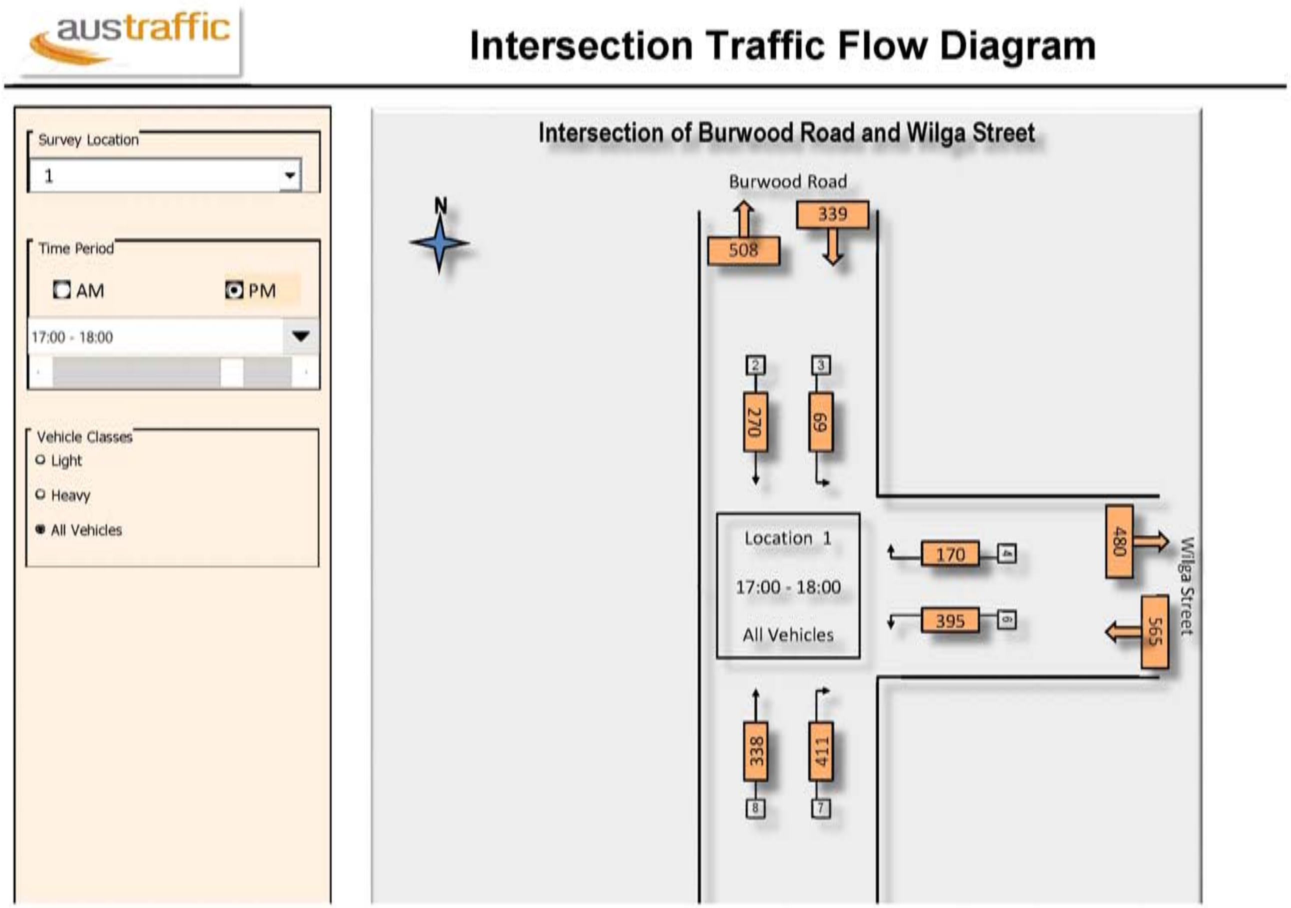
APPENDIX A – TRAFFIC COUNT FIELD DATA

(A full copy of the traffic data is available on USB Flash Drive from Road Delay Solutions)

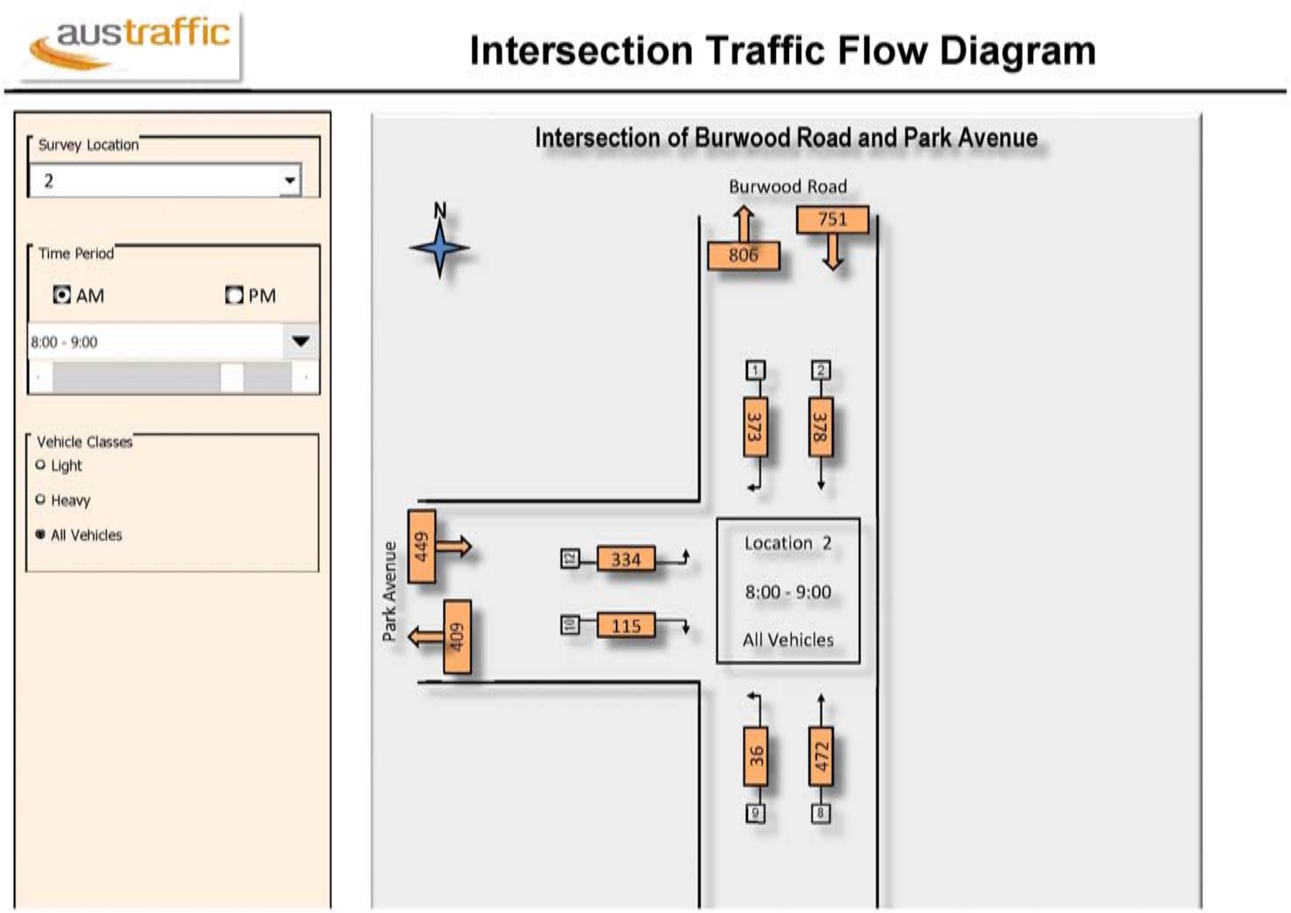
austraffic

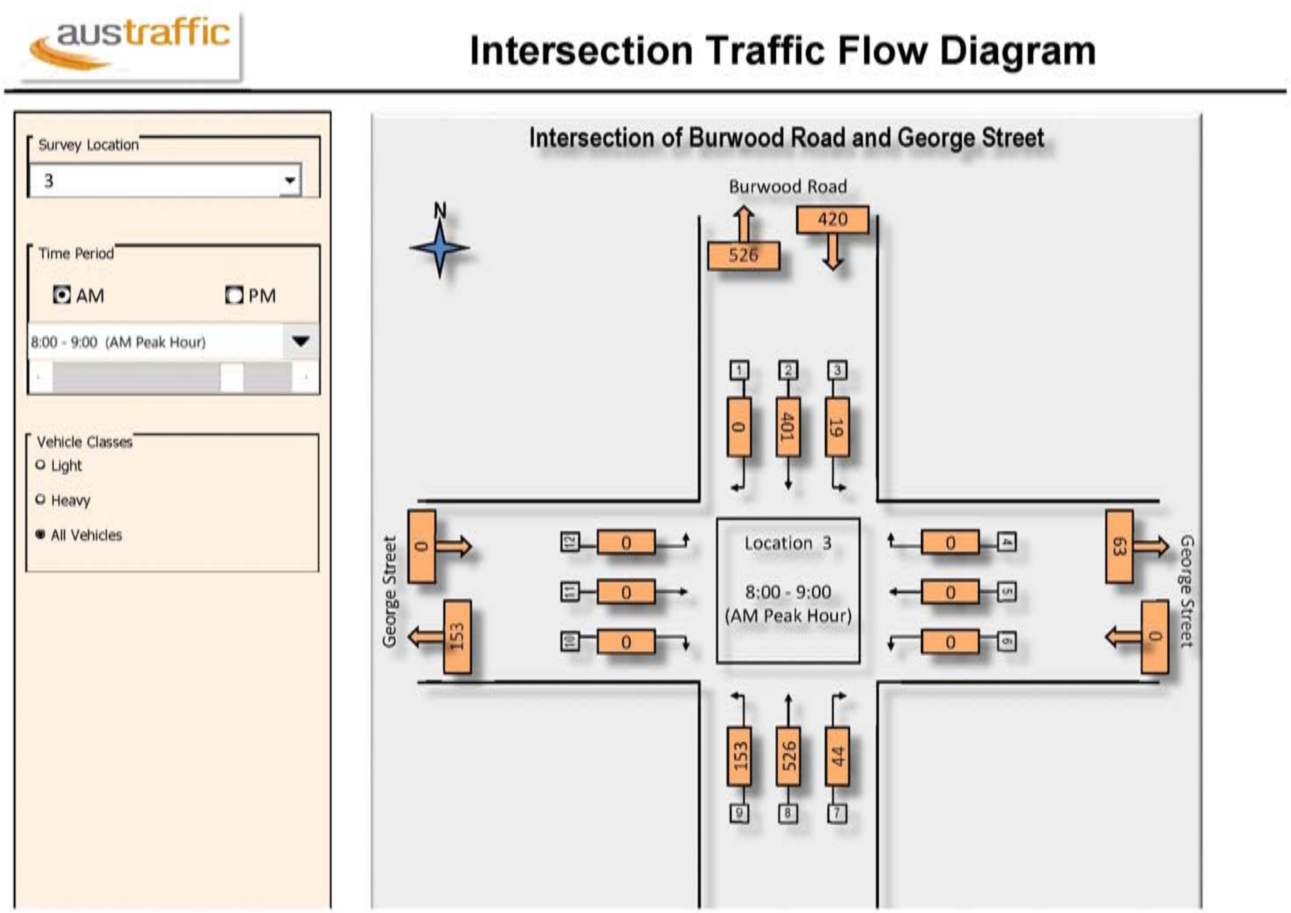
Intersection Traffic Flow Diagram

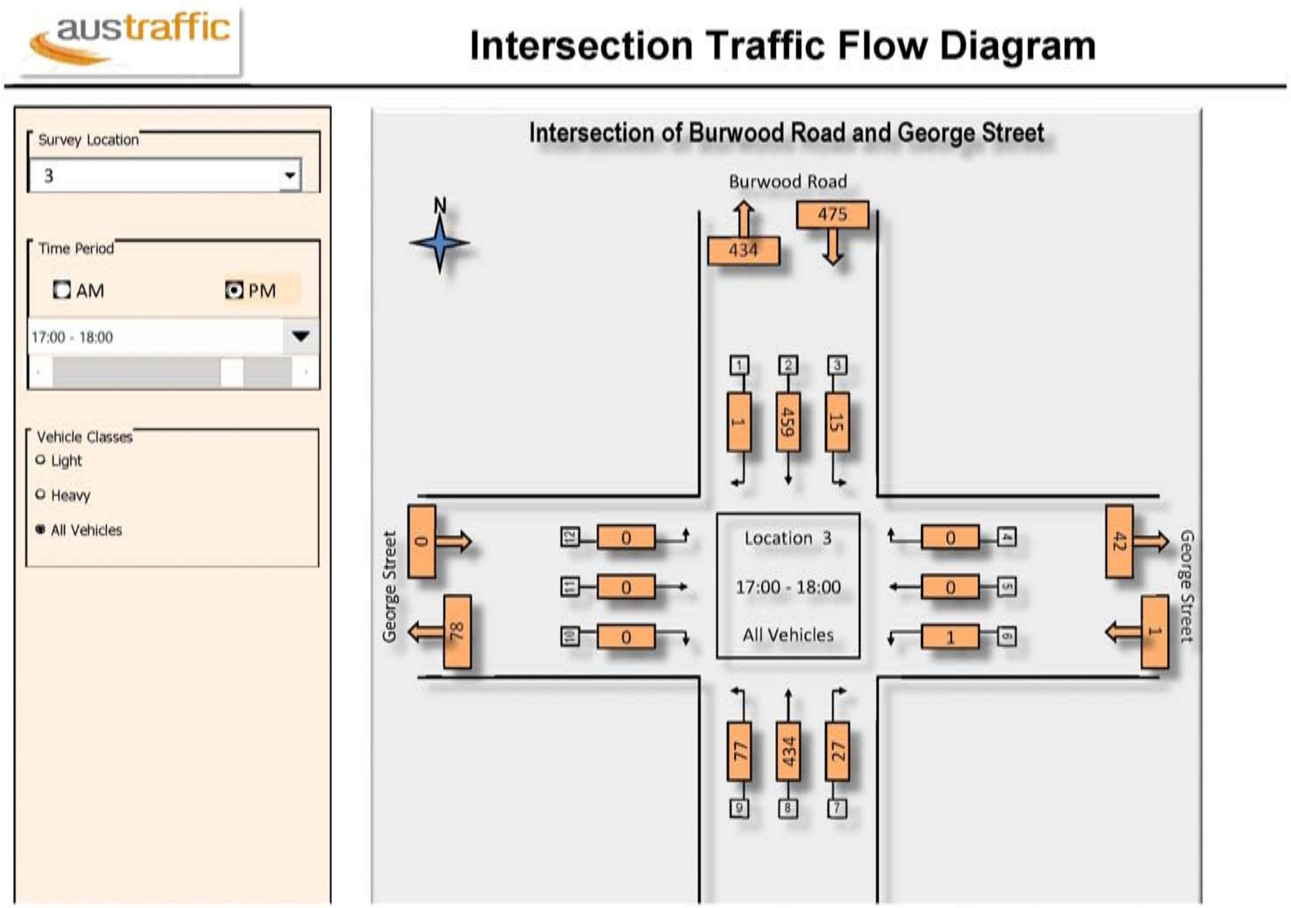


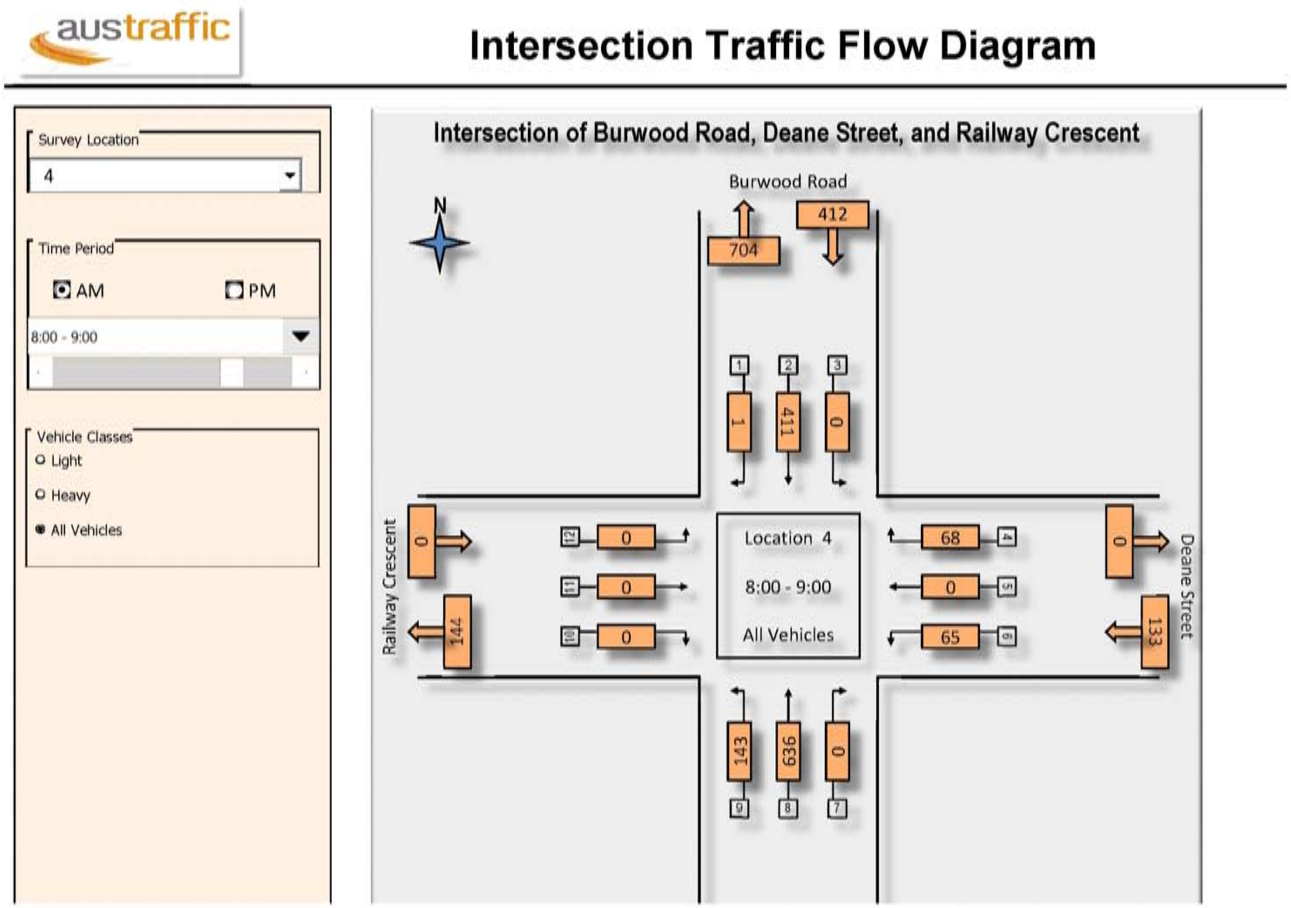

austraffic
Intersection Traffic Flow Diagram
Survey Location
1
Time Period
AM
PM
17:00 - 18:00
Vehicle Classes
Light
Heavy
All Vehicles
Intersection of Burwood Road and Wilga Street
Burwood Road
N
508
339
2
3
270
69
Location 1
17:00 - 18:00
All Vehicles
170
4
395
6
480
565
Wilga Street
338
411
8
7

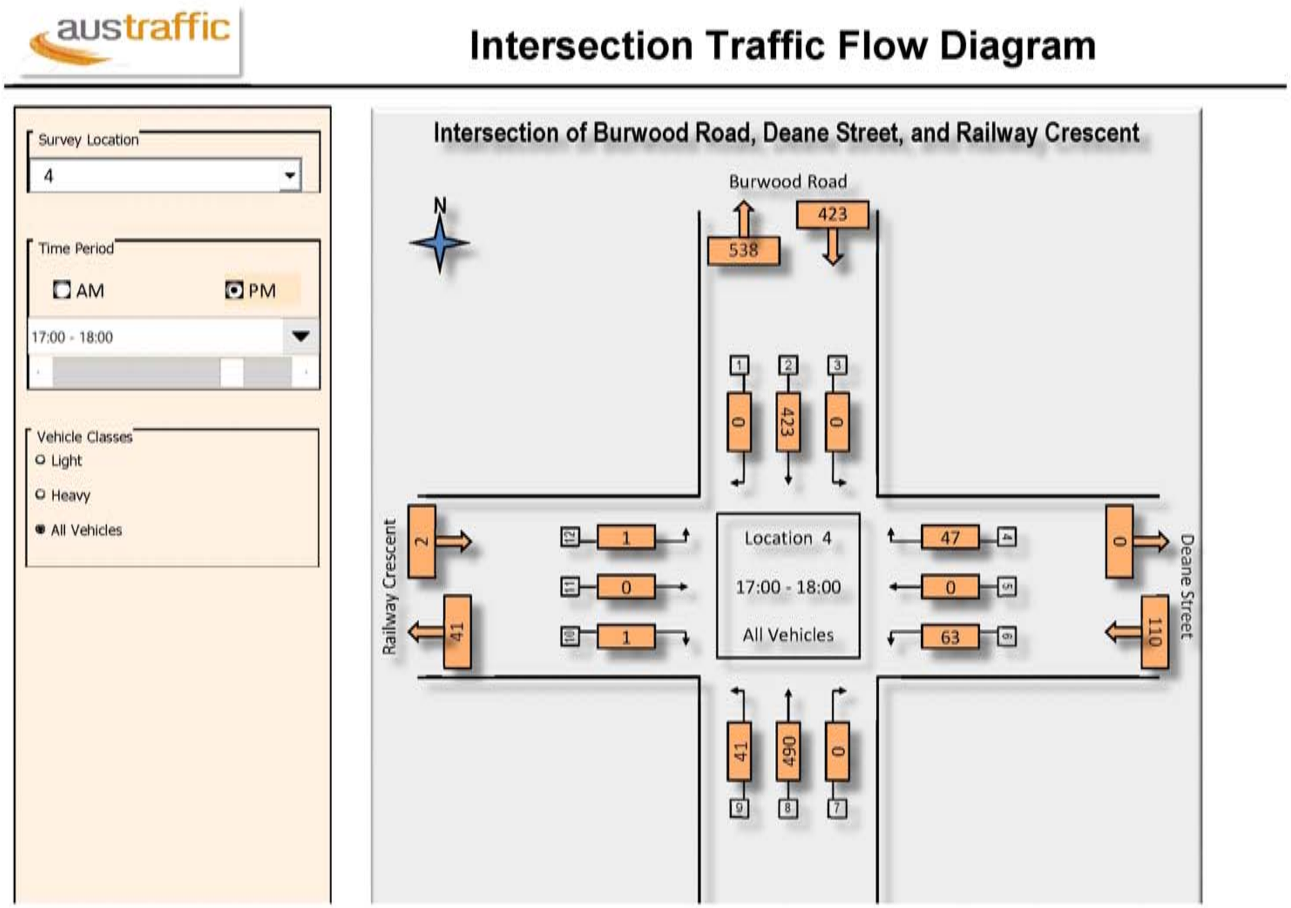
ROAD DELAY SOLUTIONS

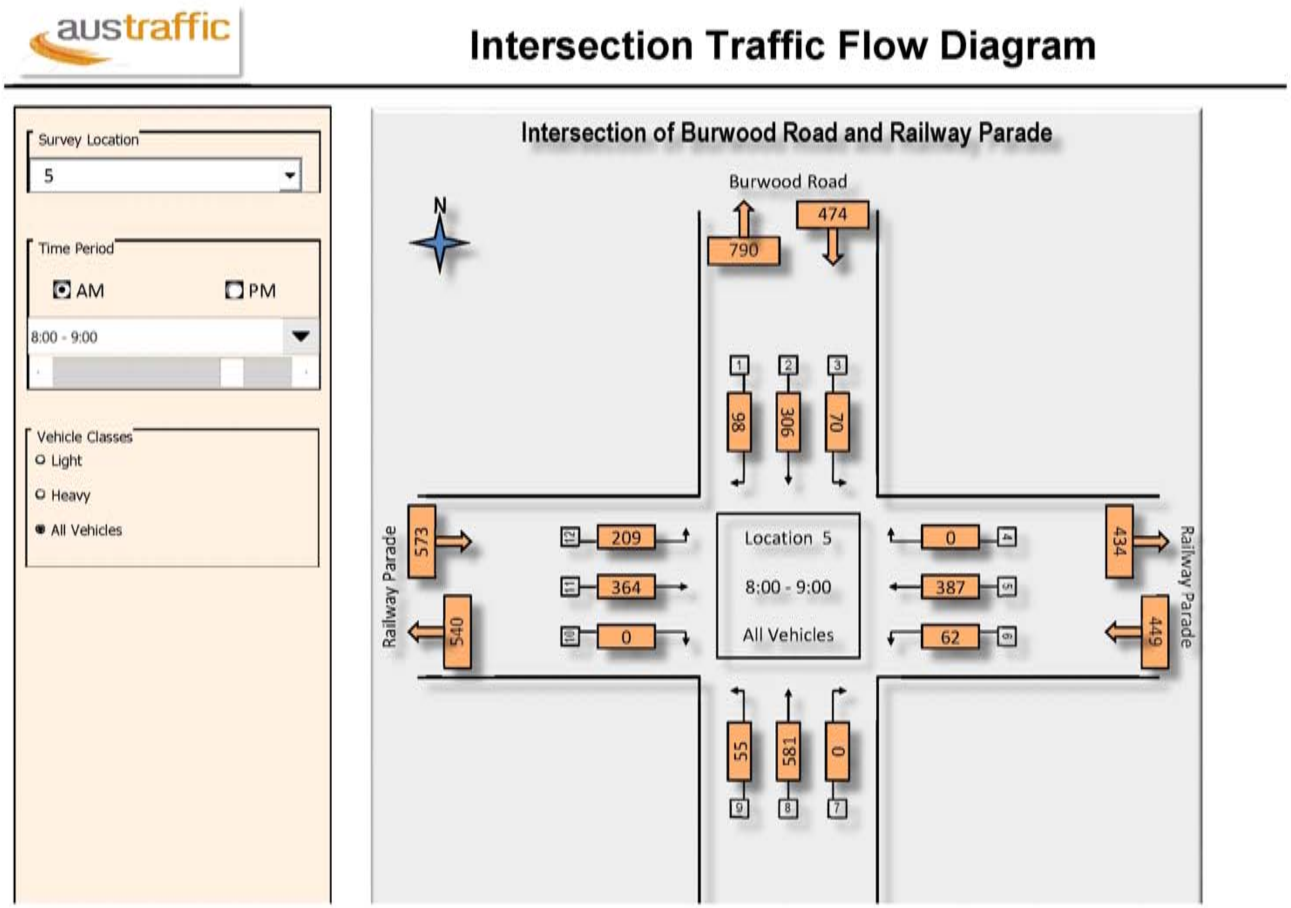



austraffic
Intersection Traffic Flow Diagram
Survey Location
3
Time Period
AM
PM
8:00 - 9:00 (AM Peak Hour)
Vehicle Classes
Light
Heavy
All Vehicles
Intersection of Burwood Road and George Street
Burwood Road
N
526
420
1
2
3
0
401
19
George Street
0
153
12
11
10
0
0
0
Location 3
8:00 - 9:00
(AM Peak Hour)
0
0
0
4
5
6
63
0
George Street
153
526
44
9
8
7


austraffic
Intersection Traffic Flow Diagram
Survey Location
3
Time Period
AM
PM
17:00 - 18:00
Vehicle Classes
Light
Heavy
All Vehicles
Intersection of Burwood Road and George Street
Burwood Road
N
434
475
1
2
3
1
459
15
George Street
0
78
12
11
10
0
0
0
Location 3
17:00 - 18:00
All Vehicles
0
0
1
4
5
6
42
1
George Street
77
434
27
9
8
7


austraffic
Intersection Traffic Flow Diagram
Survey Location
4
Time Period
AM
PM
8:00 - 9:00
Vehicle Classes
Light
Heavy
All Vehicles
Intersection of Burwood Road, Deane Street, and Railway Crescent
Burwood Road
704
412
N
1
2
3
1
411
0
Railway Crescent
0
144
12
11
10
0
0
0
Location 4
8:00 - 9:00
All Vehicles
68
0
65
4
5
6
Deane Street
0
133
143
636
0
9
8
7


austraffic
Intersection Traffic Flow Diagram
Survey Location
4
Time Period
AM
PM
17:00 - 18:00
Vehicle Classes
Light
Heavy
All Vehicles
Intersection of Burwood Road, Deane Street, and Railway Crescent
Burwood Road
538
423
N
1
2
3
0
423
0
Railway Crescent
2
41
12
11
10
1
0
1
Location 4
17:00 - 18:00
All Vehicles
47
0
63
4
5
6
0
110
Deane Street
41
490
0
9
8
7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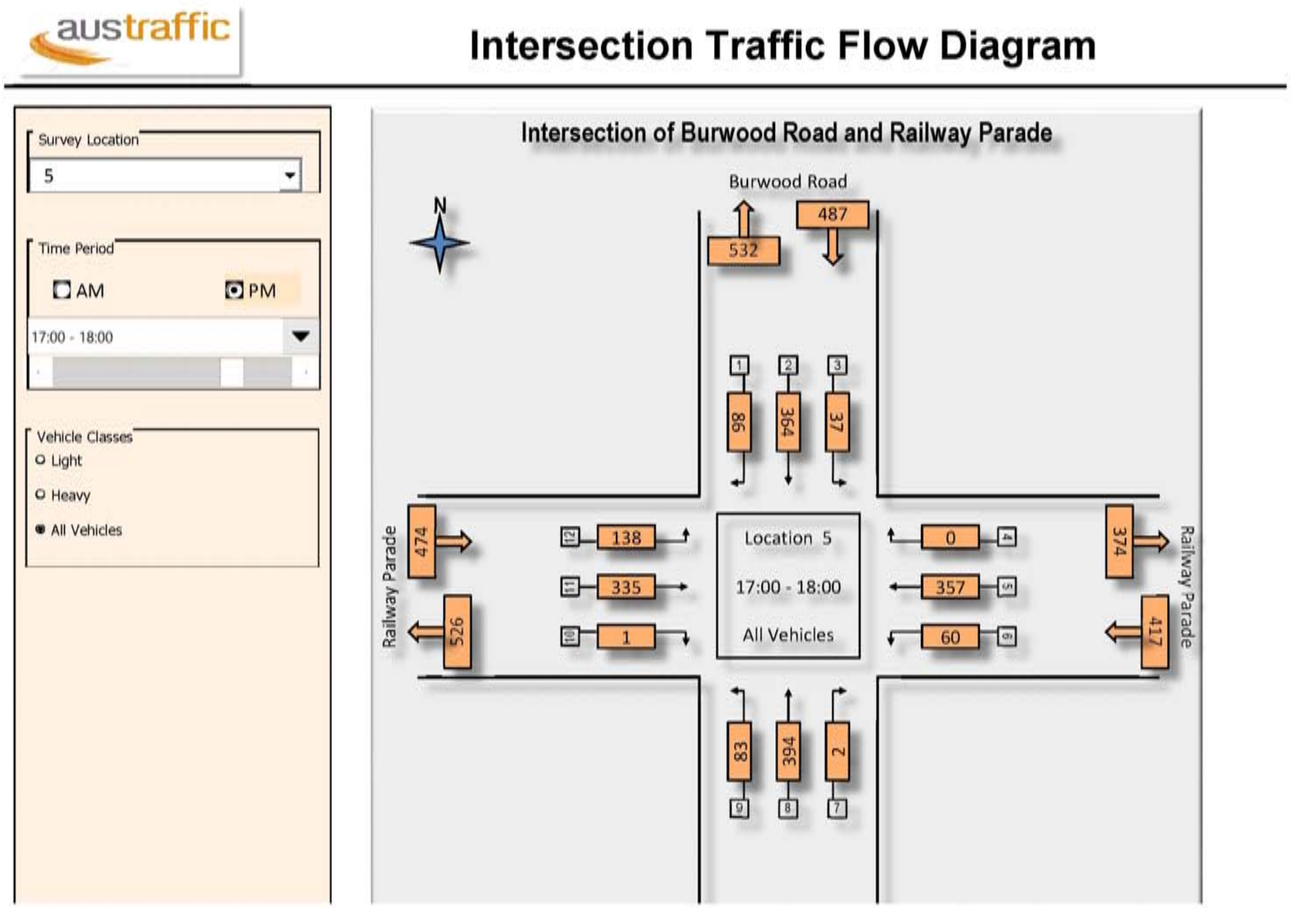
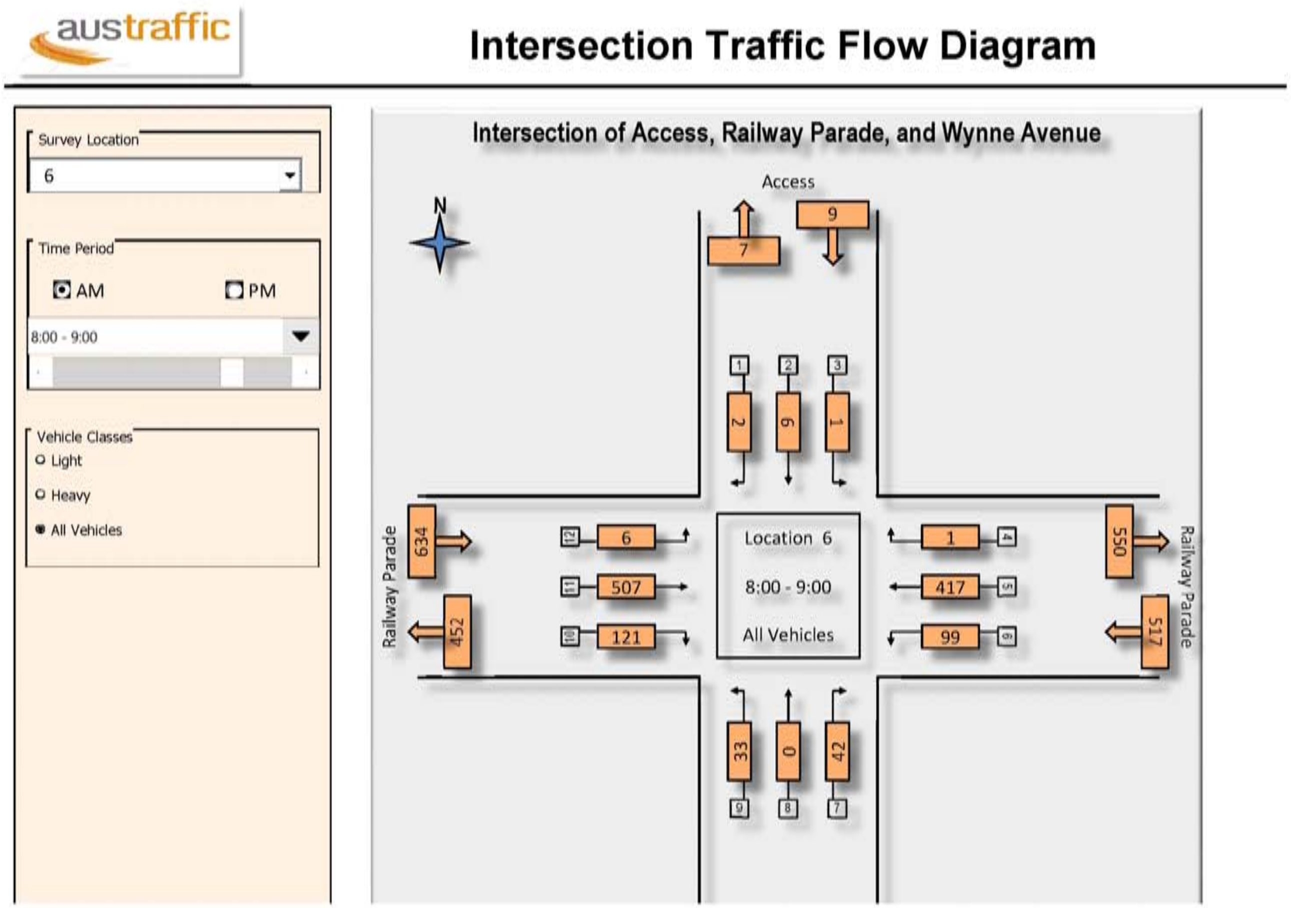
Intersection Traffic Flow Diagram
Survey Location
5
Time Period
AM
PM
8:00 - 9:00
Vehicle Classes
Light
Heavy
All Vehicles
Intersection of Burwood Road and Railway Parade
Burwood Road
N
790
474
1
2
3
98
306
70
Railway Parade
573
540
12
209
11
364
10
0
Location 5
8:00 - 9:00
All Vehicles
0
4
387
5
62
6
434
449
Railway Parade
55
581
0
9
8
7

ROAD DELAY SOLUTIONS

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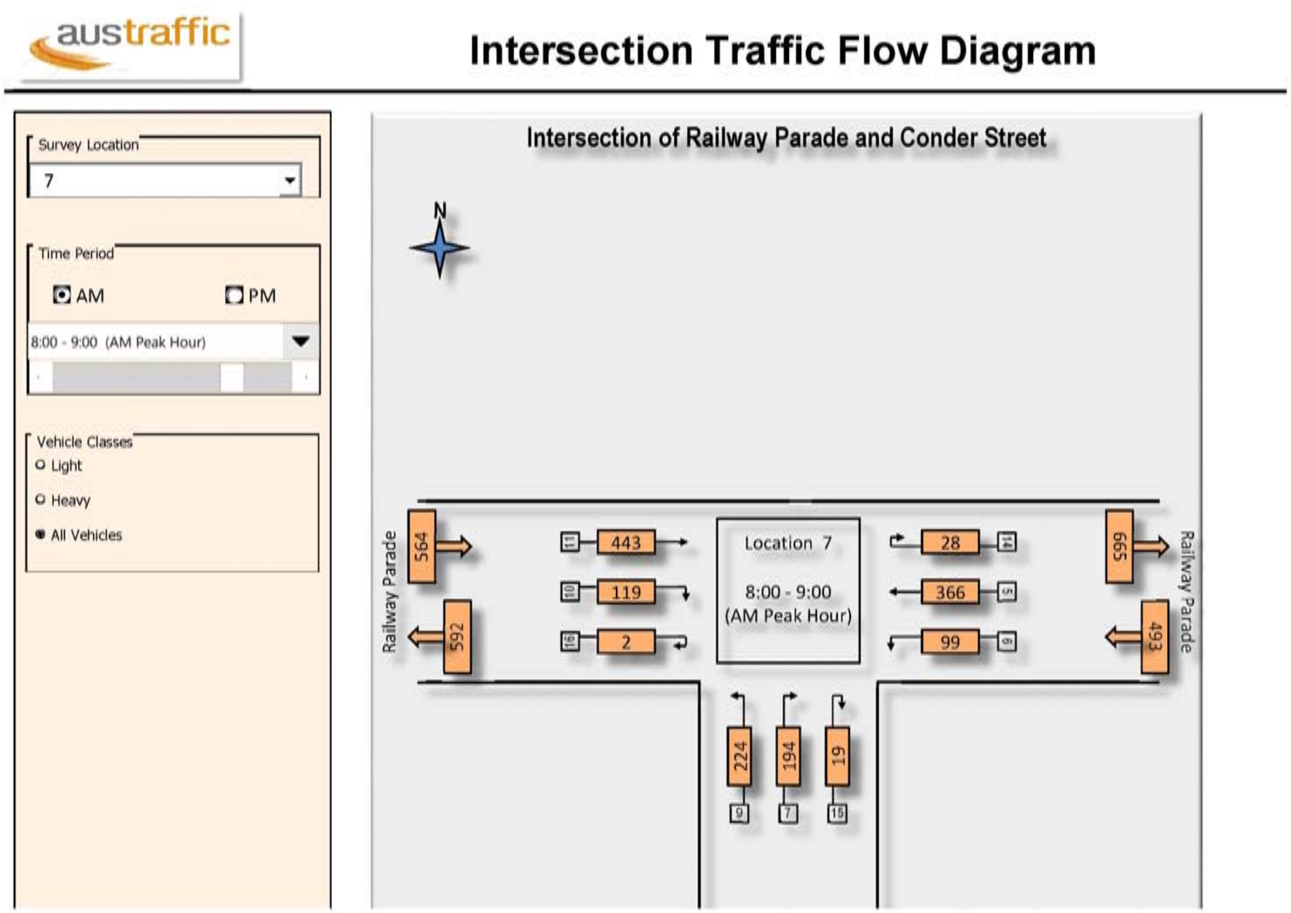
Intersection Traffic Flow Diagram
Survey Location
6
Time Period
AM
PM
8:00 - 9:00
Vehicle Classes
Light
Heavy
All Vehicles
Intersection of Access, Railway Parade, and Wynne Avenue
N
Access
7
9
1
2
3
2
9
1
Railway Parade
634
452
12
6
11
507
10
121
Location 6
8:00 - 9:00
All Vehicles
1
4
417
5
99
6
550
517
Railway Parade
33
0
42
9
8
7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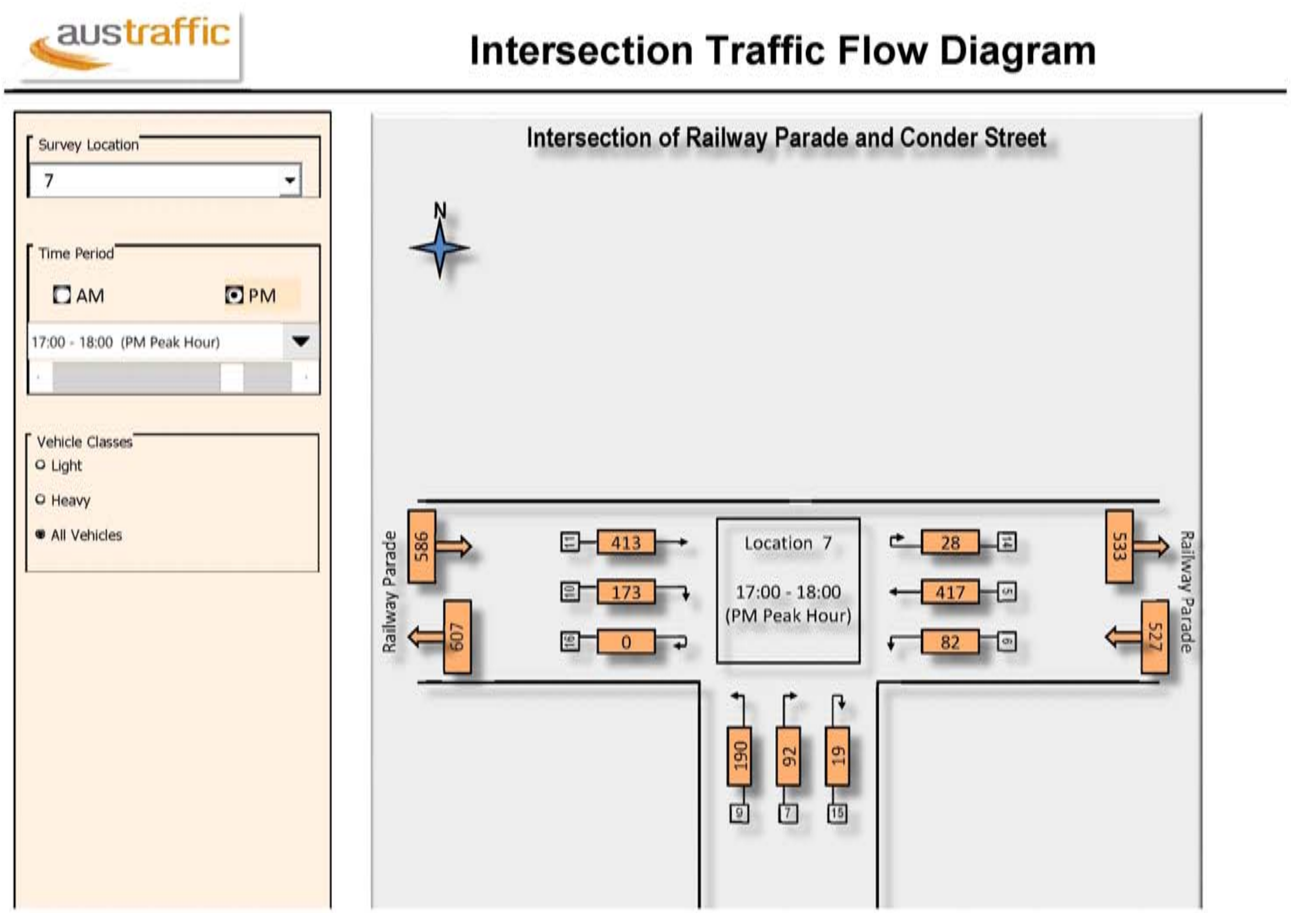
Intersection Traffic Flow Diagram
Survey Location
7
Time Period
AM
PM
8:00 - 9:00 (AM Peak Hour)
Vehicle Classes
Light
Heavy
All Vehicles
Intersection of Railway Parade and Conder Street
N
Railway Parade
564
592
11
443
10
119
16
2
Location 7
8:00 - 9:00
(AM Peak Hour)
28
14
366
5
99
6
665
493
Railway Parade
224
9
194
7
19
15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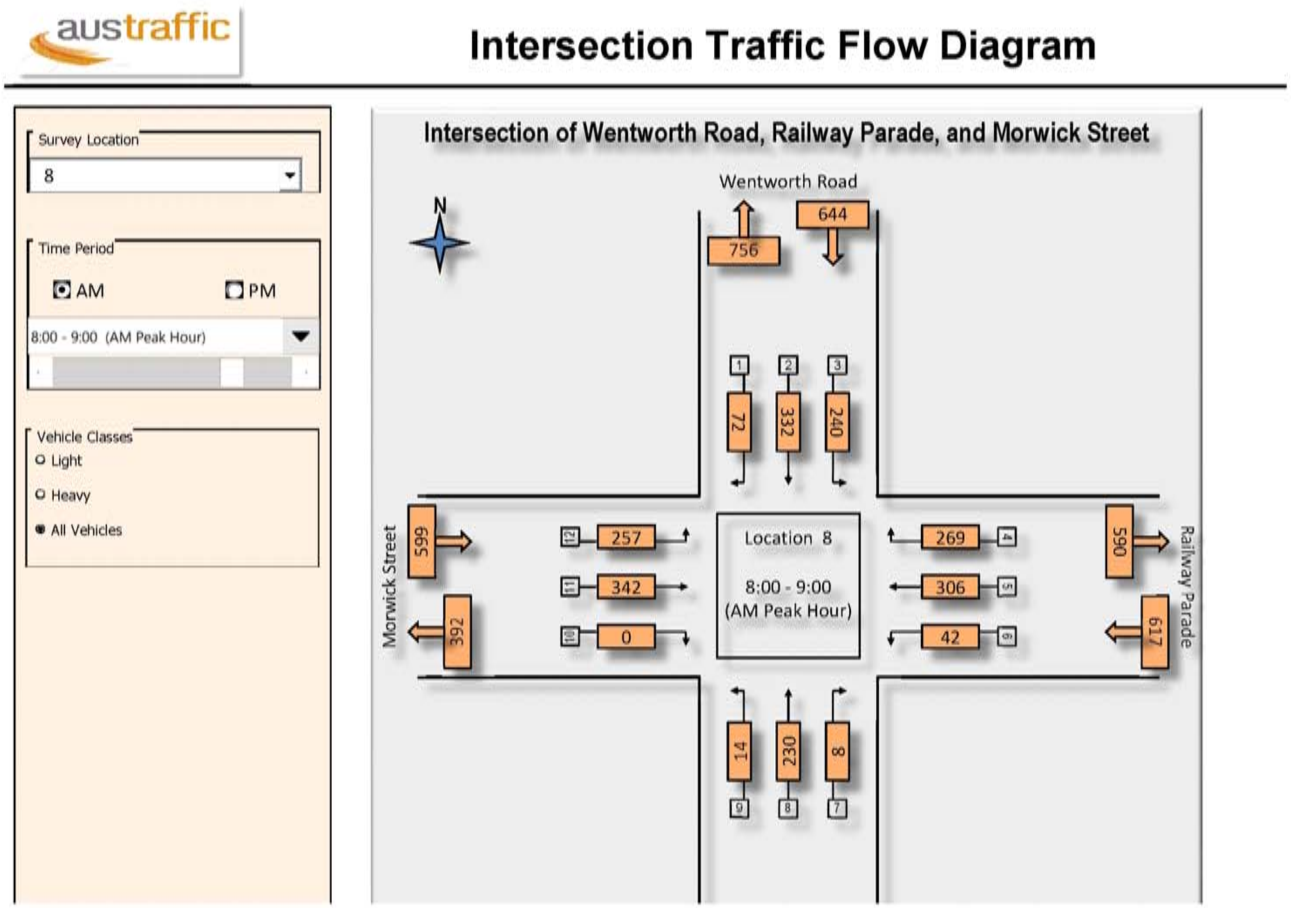
Intersection Traffic Flow Diagram
Survey Location
7
Time Period
AM
PM
17:00 - 18:00 (PM Peak Hour)
Vehicle Classes
Light
Heavy
All Vehicles
Intersection of Railway Parade and Conder Street
N
Railway Parade
586
607
413
173
0
Location 7
17:00 - 18:00
(PM Peak Hour)
28
417
82
533
527
Railway Parade
190
92
19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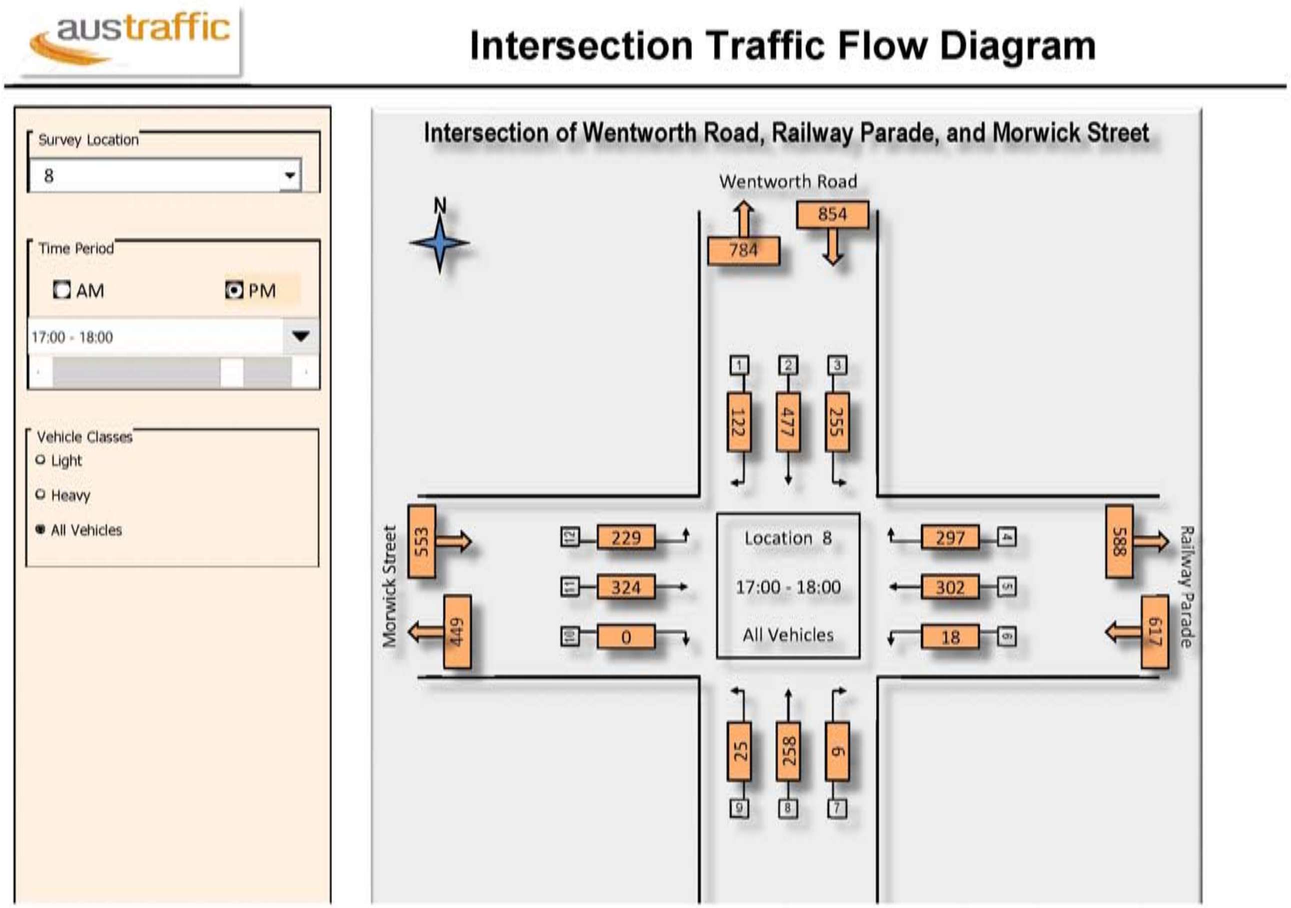
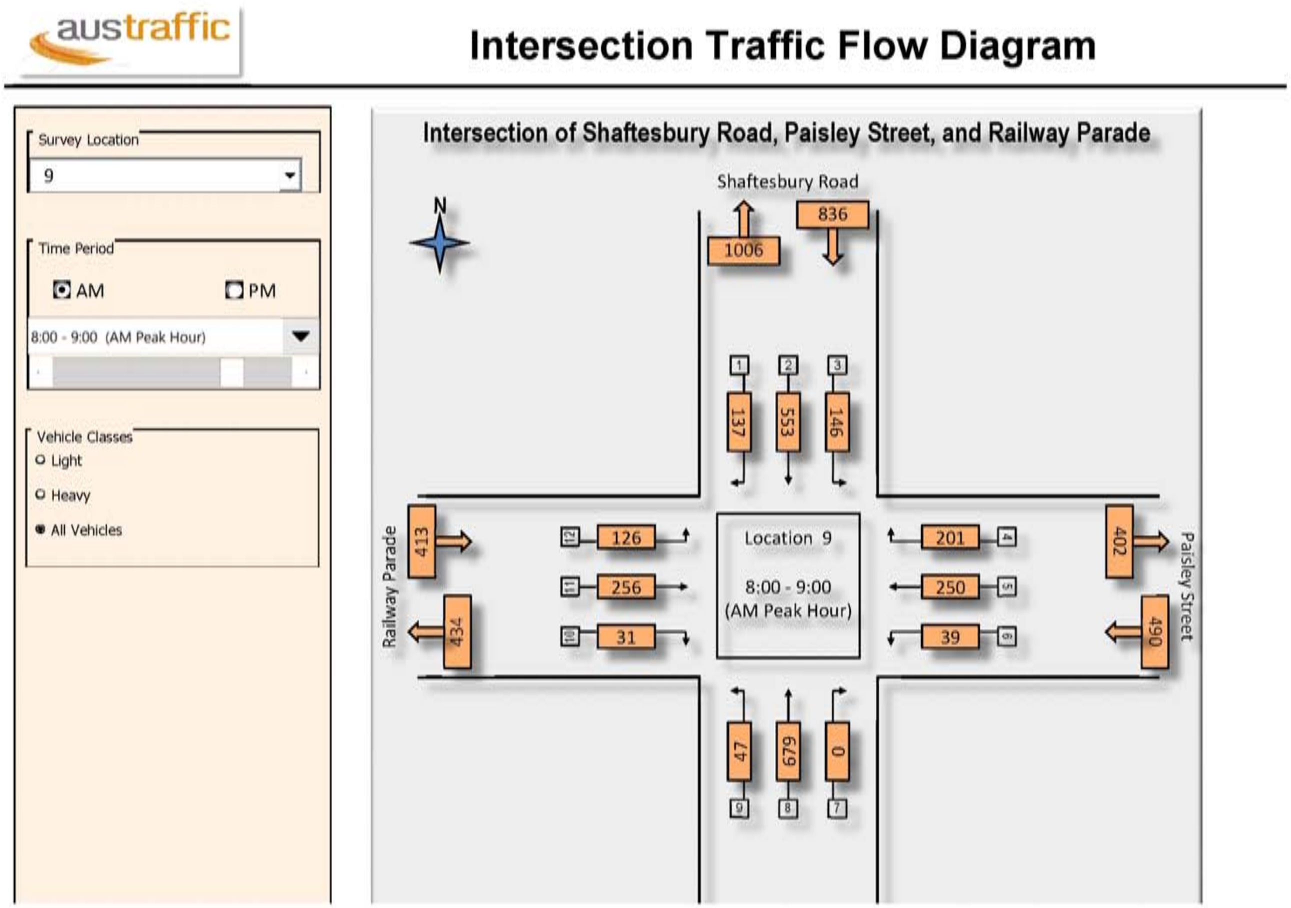
Intersection Traffic Flow Diagram
Survey Location
8
Time Period
AM
PM
8:00 - 9:00 (AM Peak Hour)
Vehicle Classes
Light
Heavy
All Vehicles
Intersection of Wentworth Road, Railway Parade, and Morwick Street
Wentworth Road
N
756
644
72
332
240
Morwick Street
599
392
257
342
0
Location 8
8:00 - 9:00
(AM Peak Hour)
269
306
42
590
617
Railway Parade
14
230
8

ROAD DELAY SOLUTIONS

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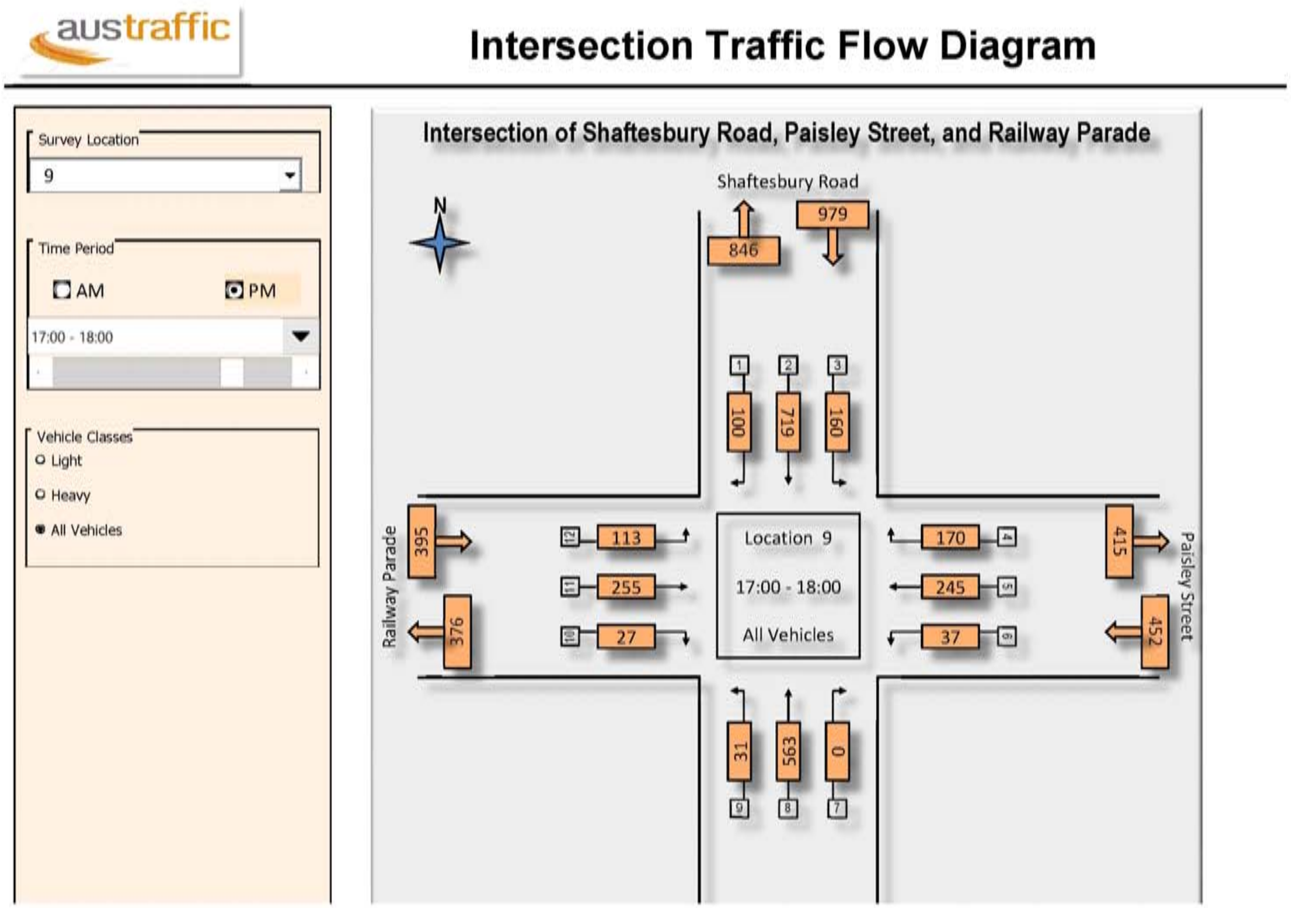
Intersection Traffic Flow Diagram
Survey Location
9
Time Period
AM
PM
8:00 - 9:00 (AM Peak Hour)
Vehicle Classes
Light
Heavy
All Vehicles
Intersection of Shaftesbury Road, Paisley Street, and Railway Parade
Shaftesbury Road
N
1006
836
137
553
146
Railway Parade
413
434
126
256
31
Location 9
8:00 - 9:00
(AM Peak Hour)
201
250
39
402
490
Paisley Street
47
679
0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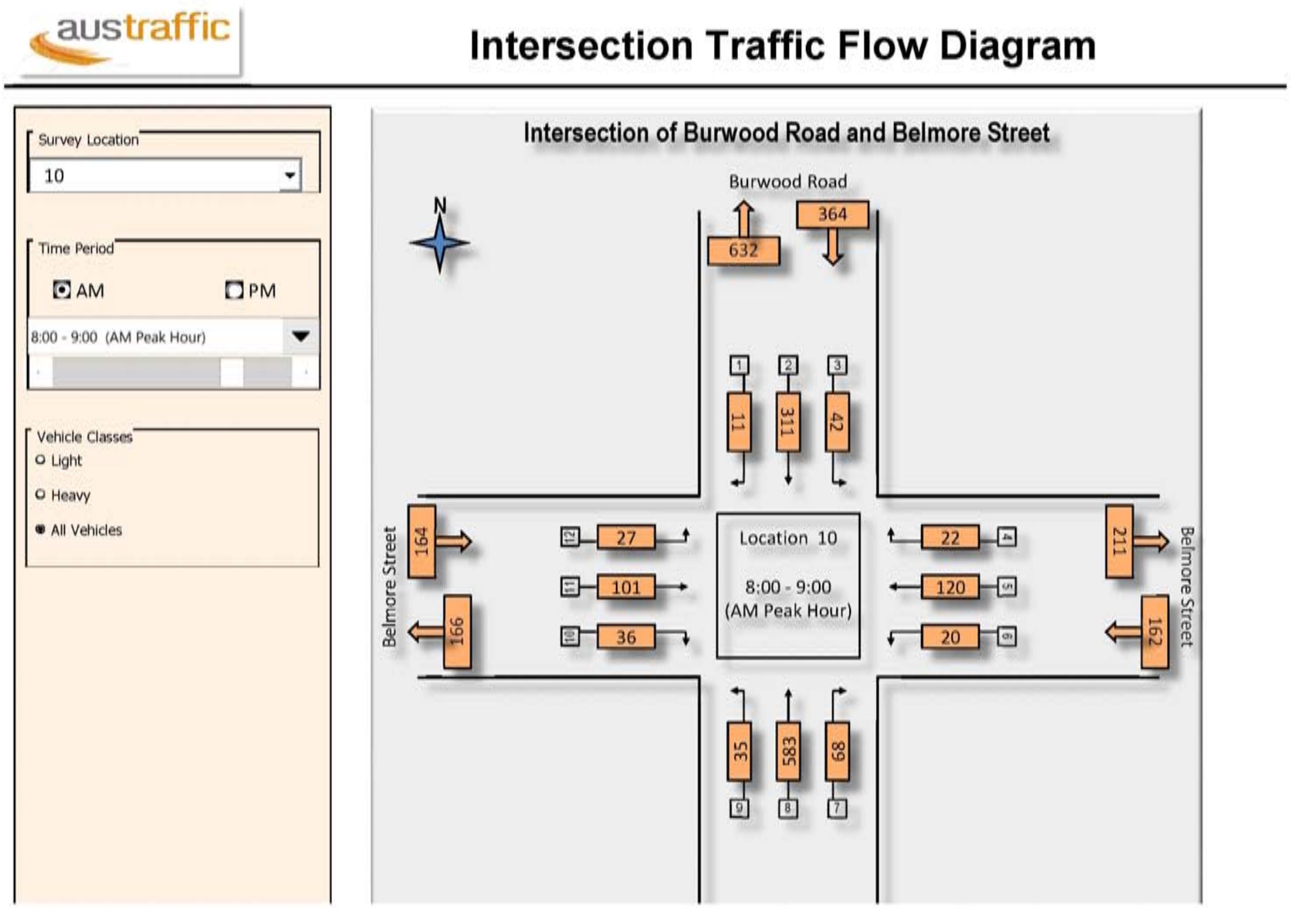
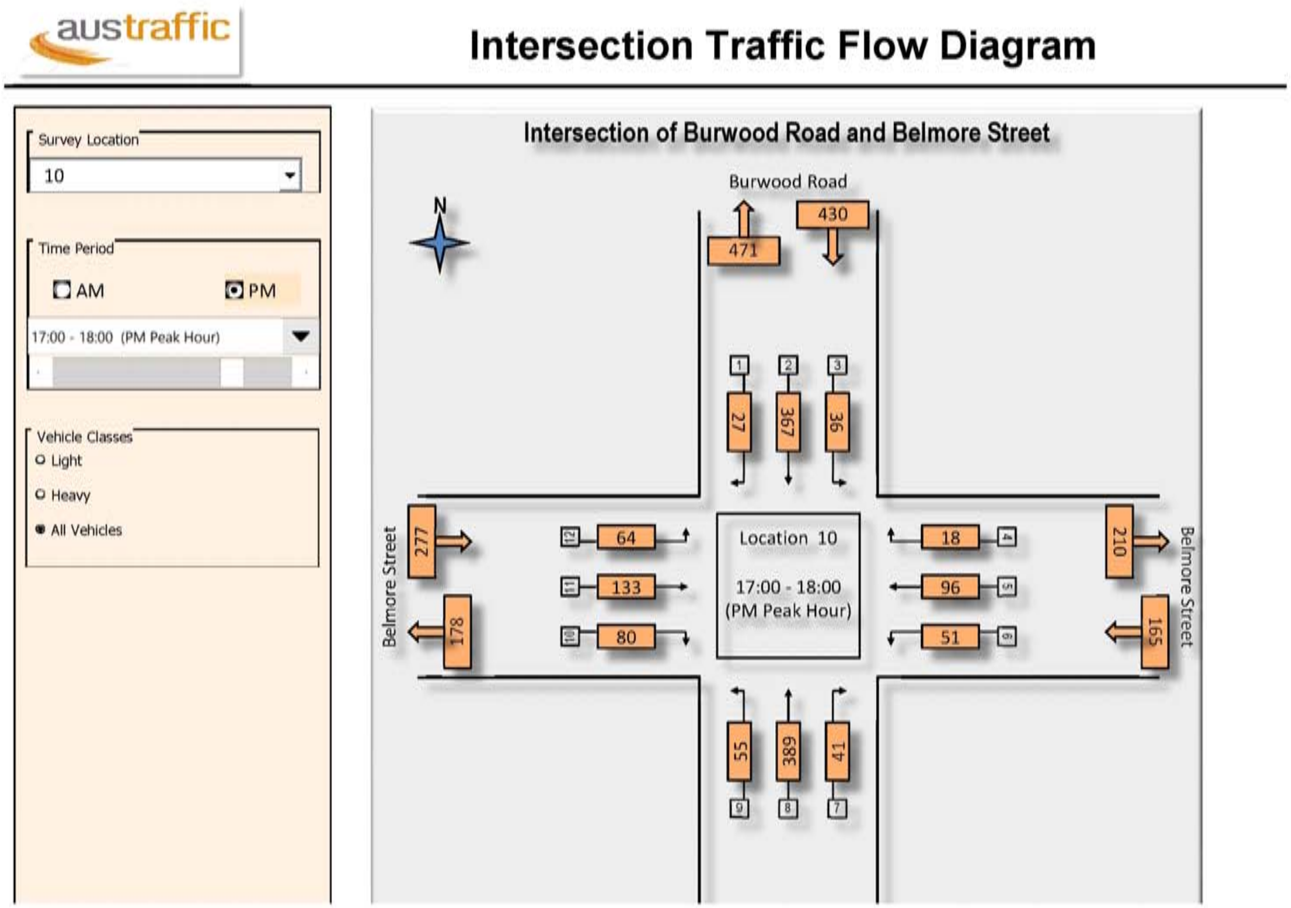
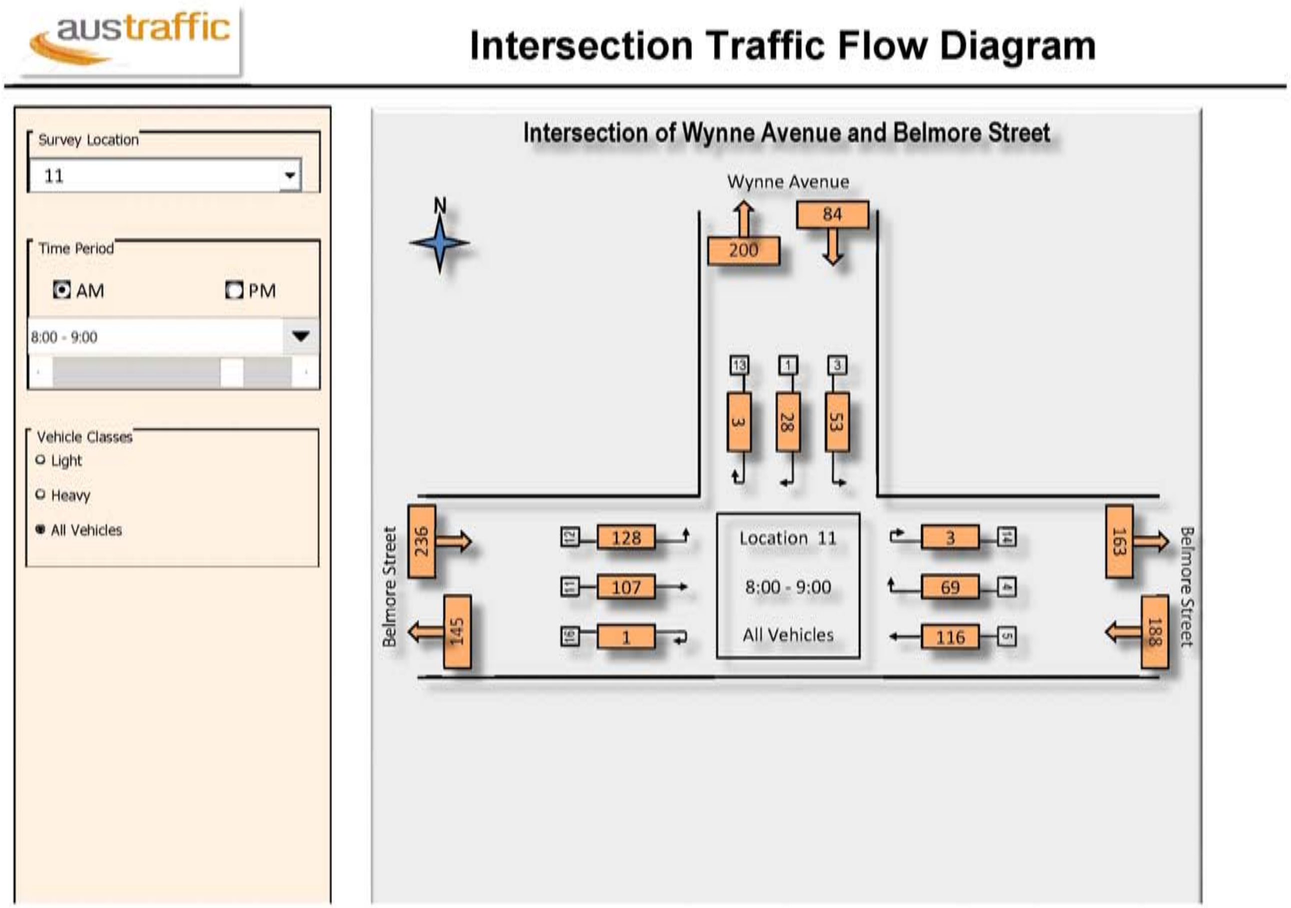
Intersection Traffic Flow Diagram
Survey Location
9
Time Period
AM
PM
17:00 - 18:00
Vehicle Classes
Light
Heavy
All Vehicles
Intersection of Shaftesbury Road, Paisley Street, and Railway Parade
Shaftesbury Road
N
846
979
1
2
3
100
719
160
Railway Parade
395
376
12
113
11
255
10
27
Location 9
17:00 - 18:00
All Vehicles
170
4
245
5
37
6
415
452
Paisley Street
31
563
0
9
8
7

ROAD DELAY SOLUTIONS



ROAD DELAY SOLUTIONS

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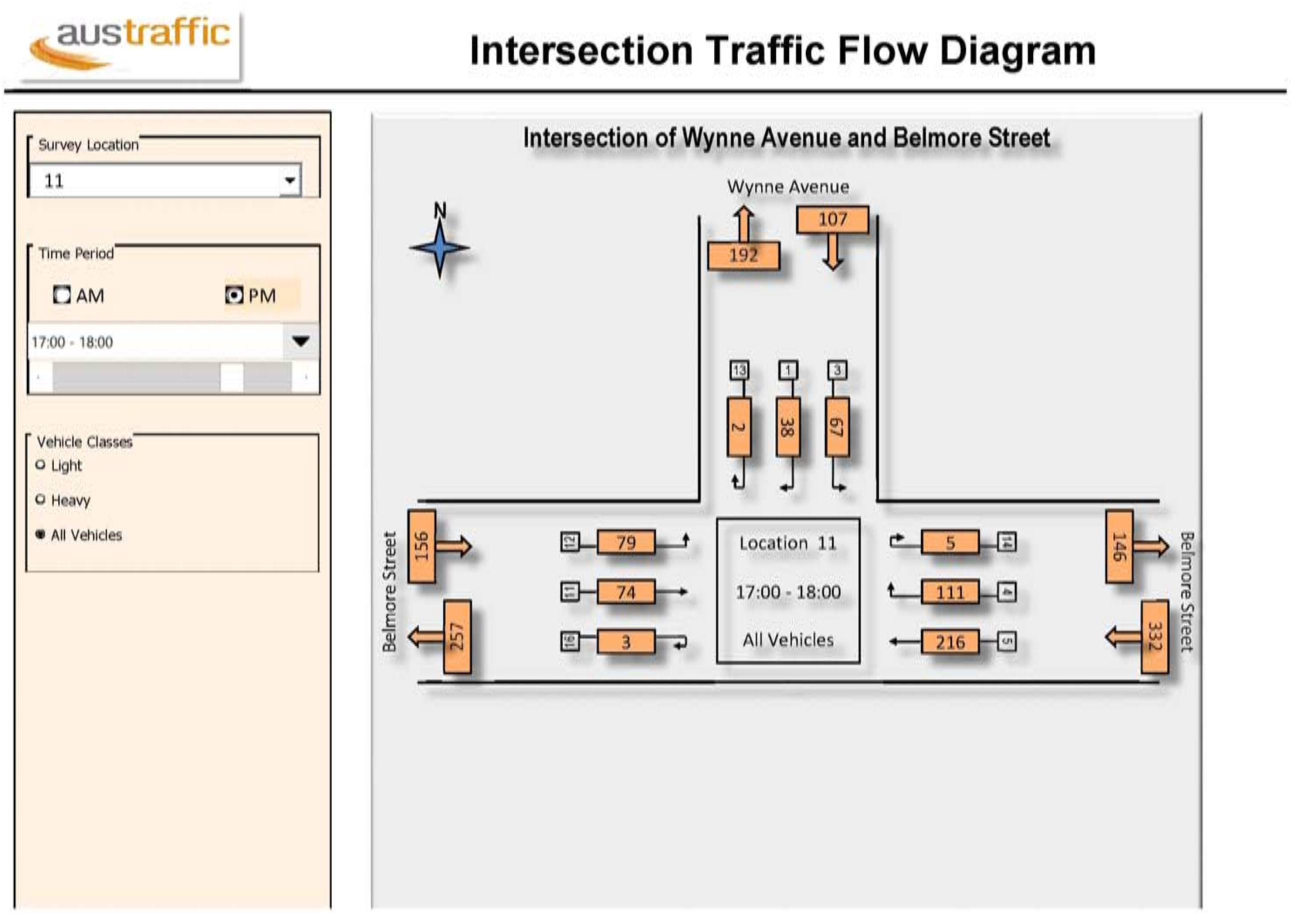
Intersection Traffic Flow Diagram
Survey Location
11
Time Period
AM
PM
8:00 - 9:00
Vehicle Classes
Light
Heavy
All Vehicles
Intersection of Wynne Avenue and Belmore Street
Wynne Avenue
N
200
84
13
1
3
3
28
53
Belmore Street
236
145
12
128
11
107
10
1
Location 11
8:00 - 9:00
All Vehicles
3
14
69
4
116
5
163
188
Belmore Street



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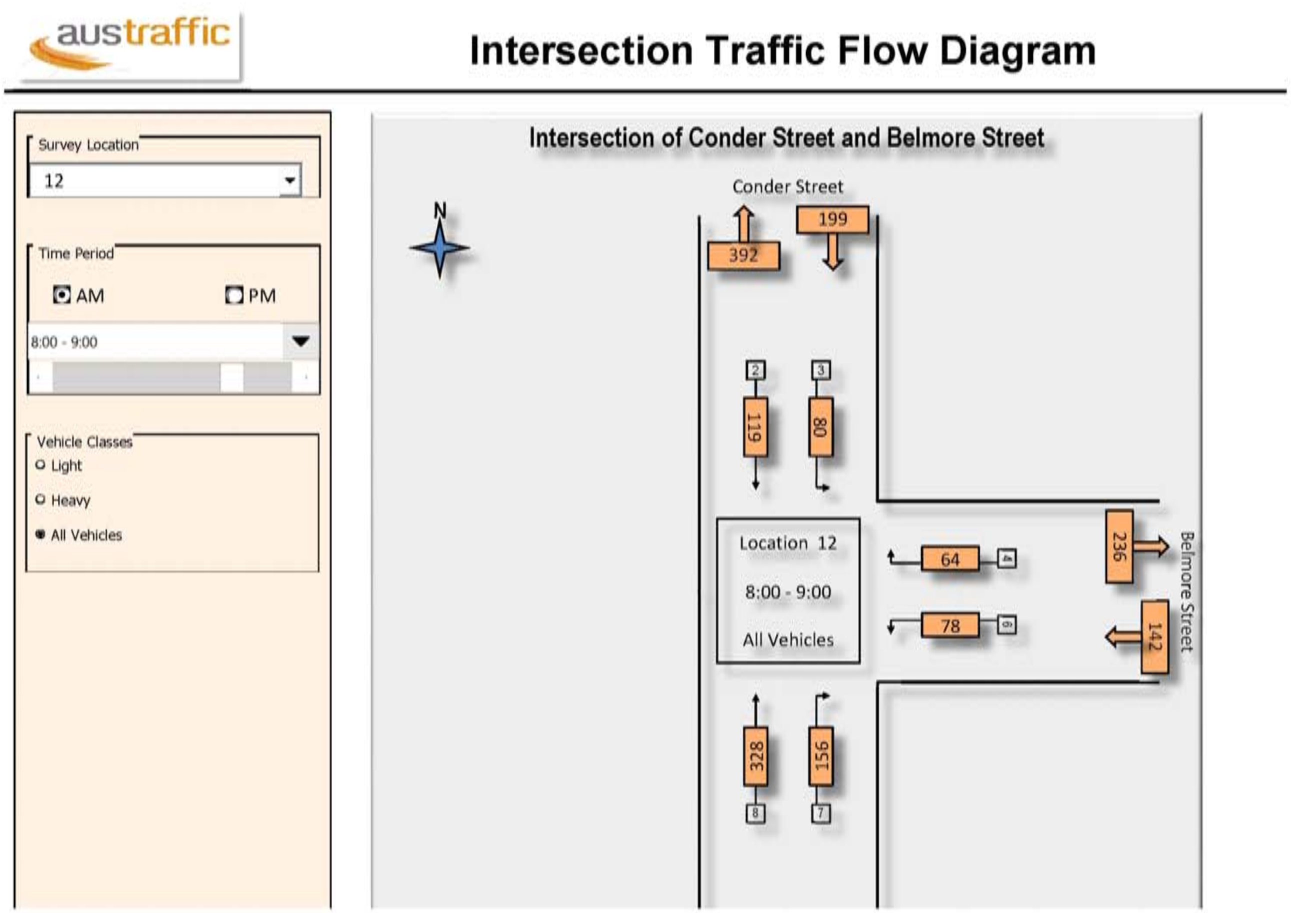
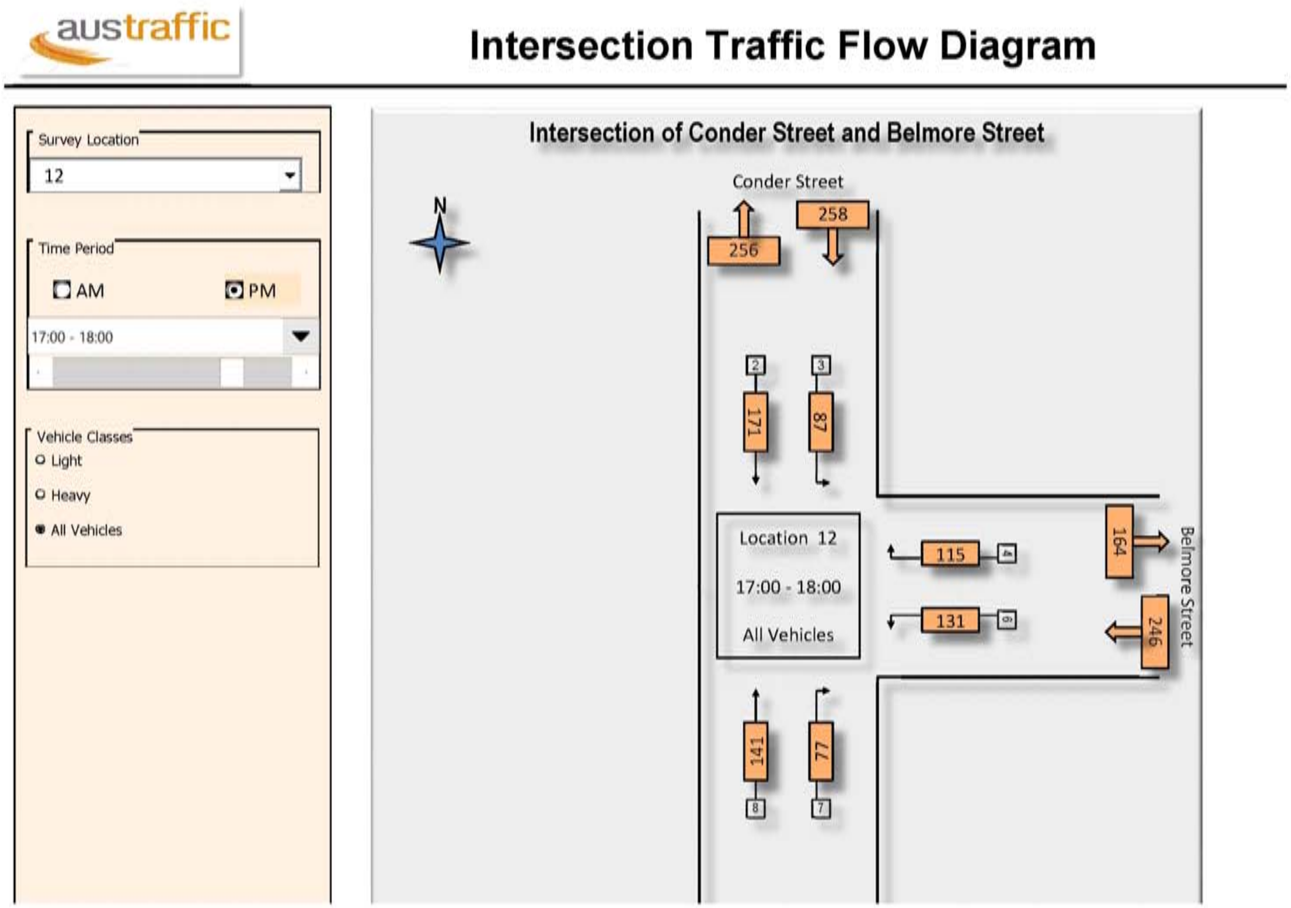
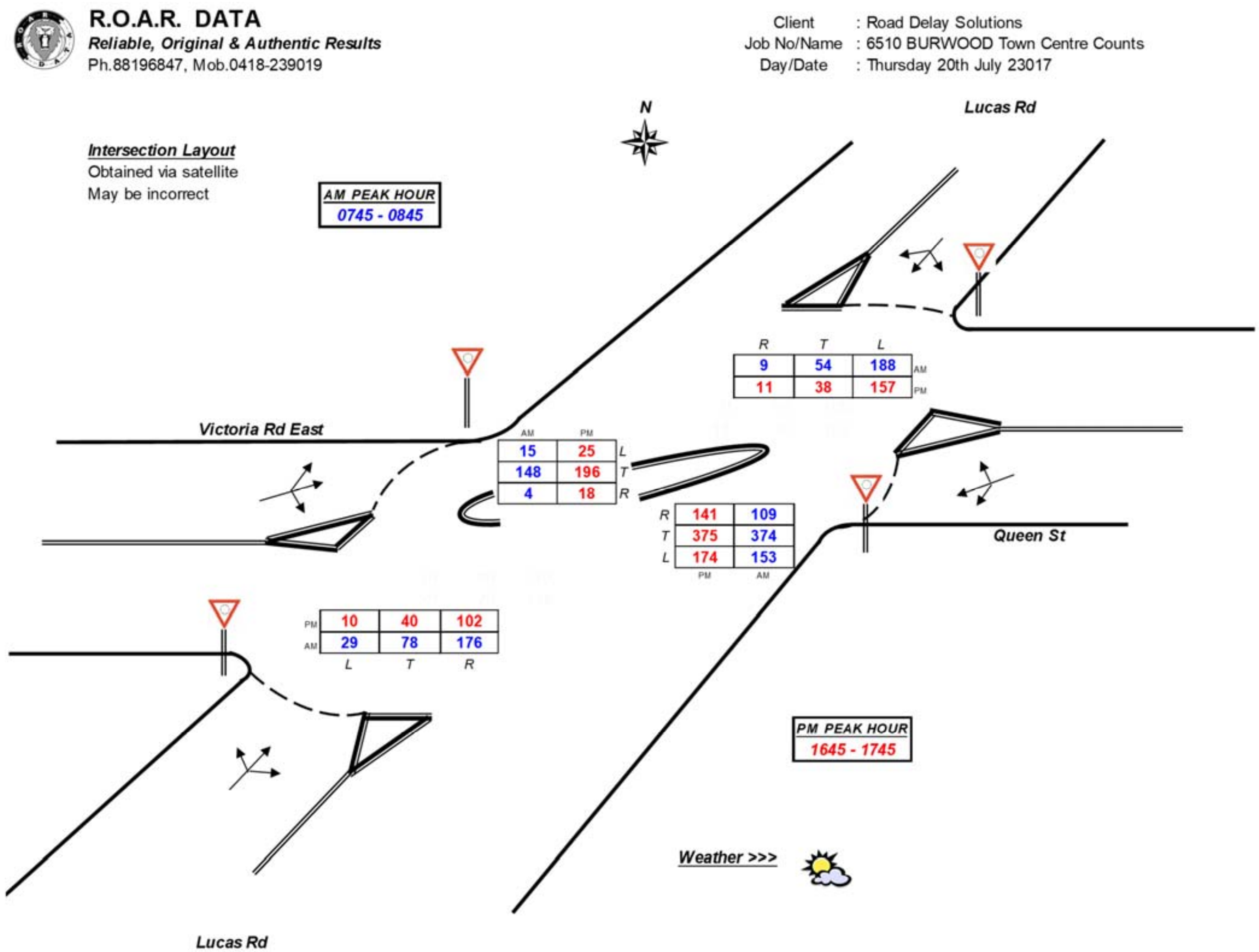
Intersection Traffic Flow Diagram
Survey Location
11
Time Period
AM
PM
17:00 - 18:00
Vehicle Classes
Light
Heavy
All Vehicles
Intersection of Wynne Avenue and Belmore Street
Wynne Avenue
N
192
107
13
1
3
2
38
67
Belmore Street
156
257
12
79
11
74
16
3
Location 11
17:00 - 18:00
All Vehicles
5
14
111
4
216
5
146
332
Belmore Street


austraffic
Intersection Traffic Flow Diagram
Survey Location
12
Time Period
AM
PM
8:00 - 9:00
Vehicle Classes
Light
Heavy
All Vehicles
Intersection of Conder Street and Belmore Street
Conder Street
N
392
199
2
3
119
80
Location 12
8:00 - 9:00
All Vehicles
64
4
78
6
236
142
Belmore Street
328
156
8
7


austraffic
Intersection Traffic Flow Diagram
Survey Location
12
Time Period
AM
PM
17:00 - 18:00
Vehicle Classes
Light
Heavy
All Vehicles
Intersection of Conder Street and Belmore Street
Conder Street
N
256
258
2
3
171
87
Location 12
17:00 - 18:00
All Vehicles
115
4
131
6
164
246
Belmore Street
141
77
8
7



R.O.A.R. DATA
Reliable, Original & Authentic Results
Ph.88196847, Mob.0418-239019
Client : Road Delay Solutions
Job No/Name : 6510 BURWOOD Town Centre Counts
Day/Date : Thursday 20th July 23017
N
Lucas Rd
Intersection Layout
Obtained via satellite
May be incorrect
AM PEAK HOUR
0745 - 0845
R T L
AM 9 54 188
PM 11 38 157
Victoria Rd East
AM PM
15 25 L
148 196 T
4 18 R
R 141 109
T 375 374
L 174 153
PM AM
Queen St
PM 10 40 102
AM 29 78 176
L T R
PM PEAK HOUR
1645 - 1745
Weather >>>
Lucas Rd

ROAD DELAY SOLUTIONS

R.O.A.R. DATA

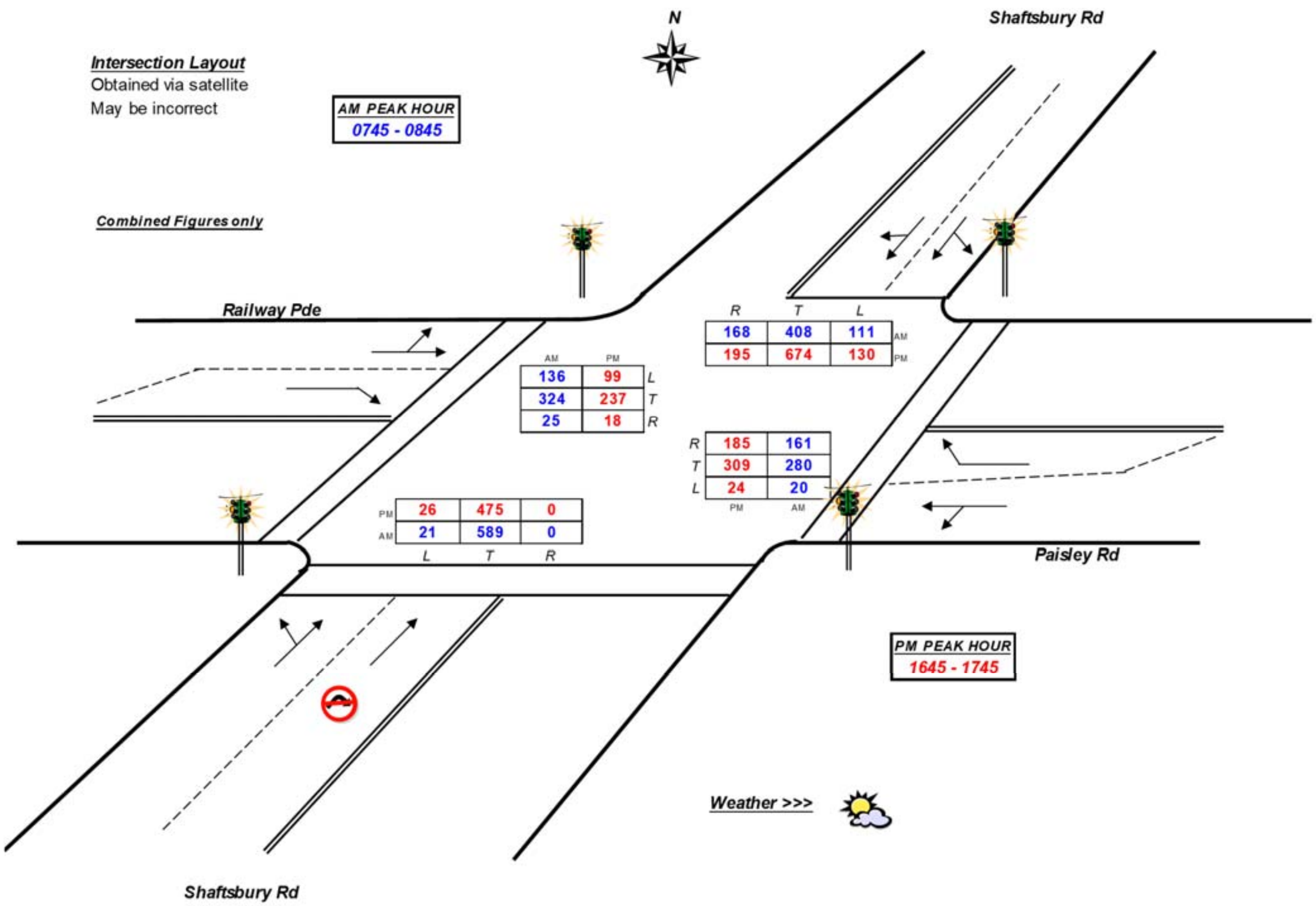
Reliable, Original & Authentic Results

Ph.88196847, Mob.0418-239019

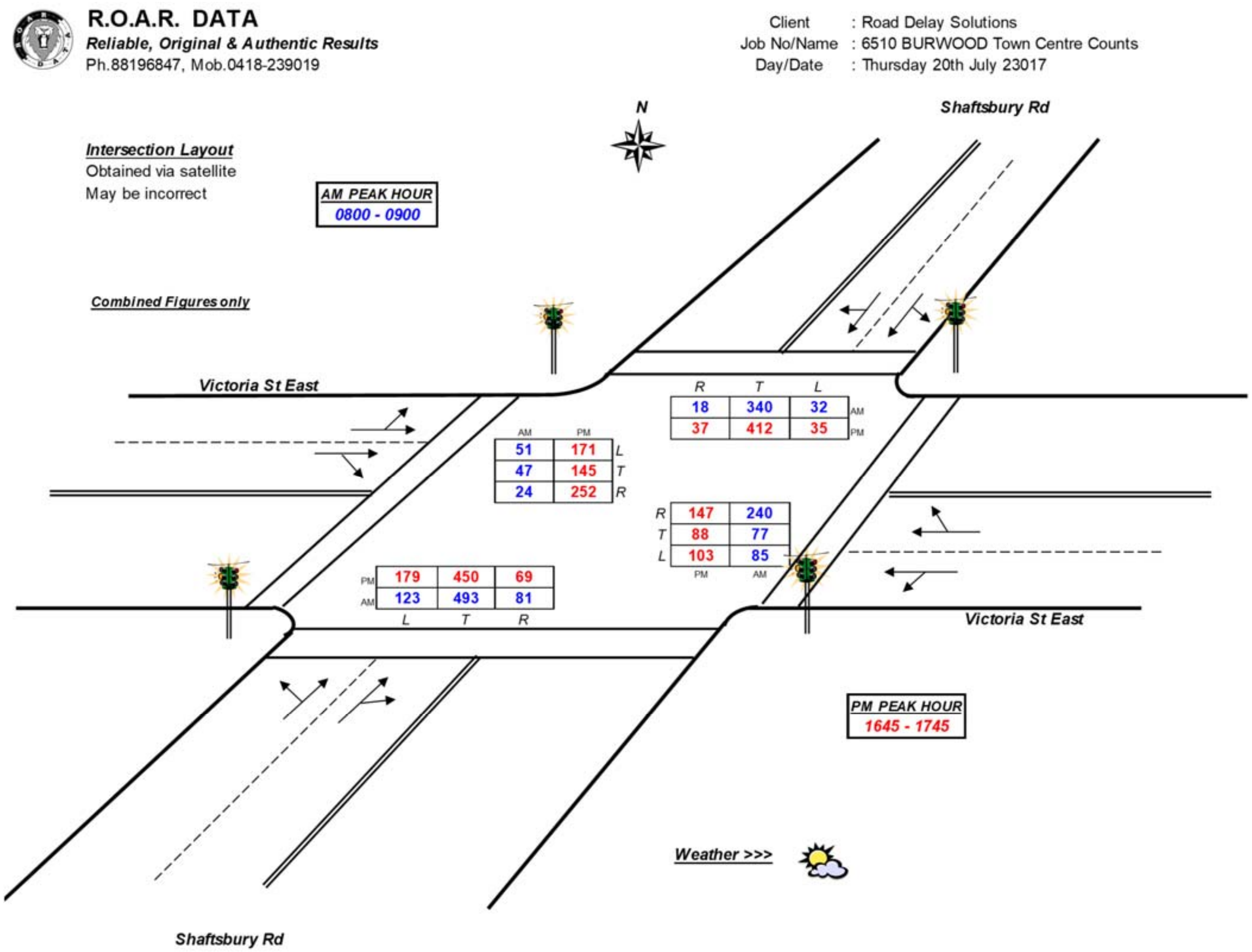
Client : Road Delay Solutions
Job No/Name : 6510 BURWOOD Town Centre Counts
Day/Date : Thursday 20th July 23017

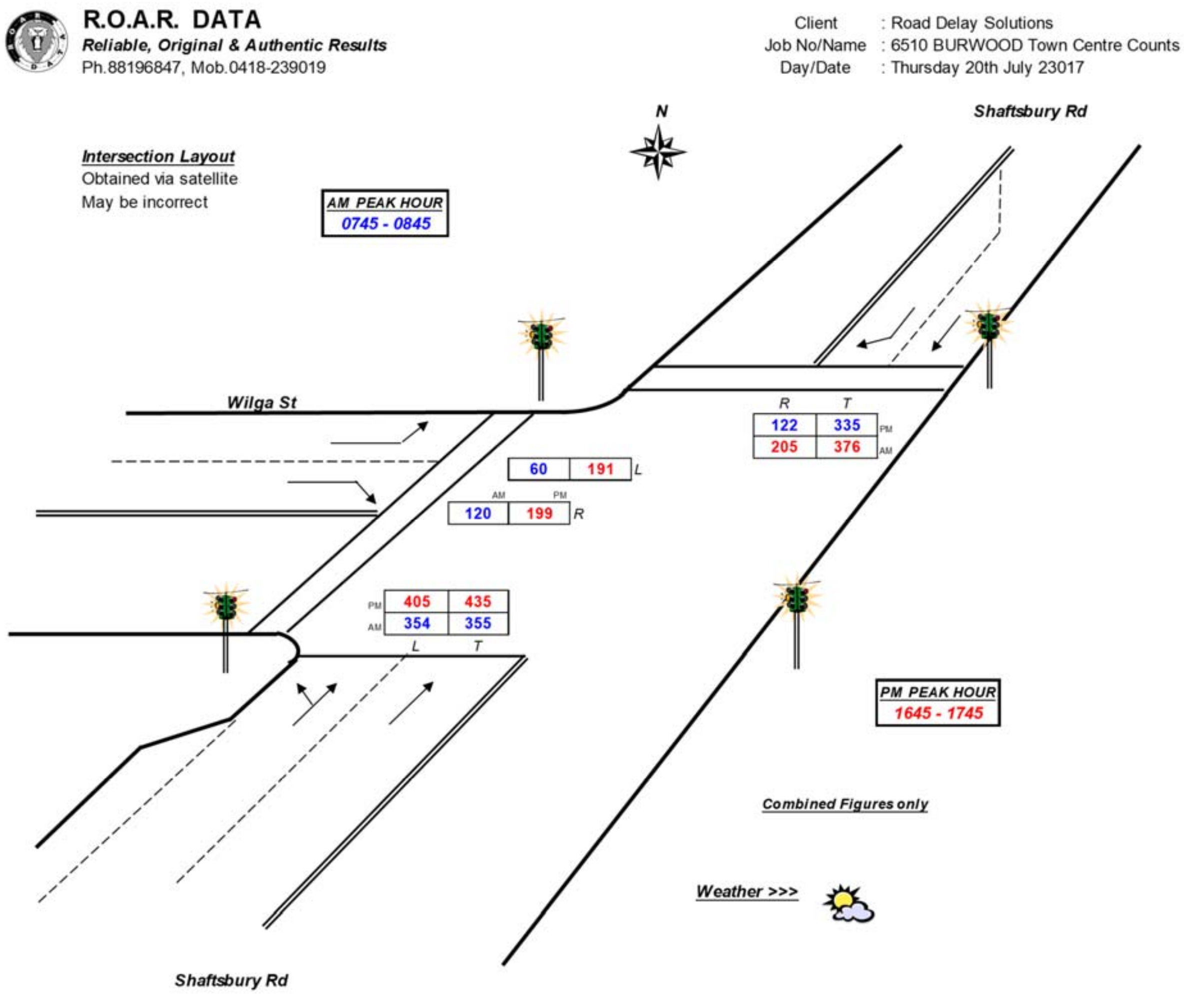
Intersection Layout
Obtained via satellite
May be incorrect

Combined Figures only



ROAD DELAY SOLUTIONS




R.O.A.R. DATA
Reliable, Original & Authentic Results
Ph.88196847, Mob.0418-239019
Client : Road Delay Solutions
Job No/Name : 6510 BURWOOD Town Centre Counts
Day/Date : Thursday 20th July 23017
N
Shaftsbury Rd
Intersection Layout
Obtained via satellite
May be incorrect
AM PEAK HOUR
0745 - 0845
Wilga St
R T
122 335 PM
205 376 AM
60 191 L
AM PM
120 199 R
PM 405 435
AM 354 355
L T
PM PEAK HOUR
1645 - 1745
Combined Figures only
Weather >>>
Shaftsbury Rd

APPENDIX B – PERFORMANCE INDICATORS

Level of Service (LoS)

Intersection performance is best measured by the indicators of Level of Service (LoS), Average Vehicle Delay (AVD) and the Degree of Saturation (DS) during peak hours.

This is defined as the assessment of a qualitative effect of factors influencing vehicle movement through the intersection. Factors such as speed, traffic volume, geometric layout, delay and capacity are qualified and applied to the specific intersection control mode, as shown in *Table 1*.

The measure of average delay assessed for traffic signal operation is over all movements. For roundabouts and priority controlled intersections, the critical criterion for assessment is the movement with the highest delay per vehicle.

Simillarly, Network and Route performance is best assessed by the Average Vehicle Delay (AVD) and LoS.

The Network performance is an index based on the operation of traffic within a given road network of linked intersections controlled by like and/or differing control methods. As with intersections, the LoA is rated between 'A' being good to 'F' being completely unsatisfactory and highly congested raaaequiring mitigation treatment. The Route LoS may be the result of a single intersection within the network or a group of intersections. It is the engineer's or planner's responsibility to analyse and determine the critical factors impacting the network operation.

The Route performance again is an indexed value based on the AVD along a defined path. The LoS between 'A' and 'F' is derived from the AVD and reported after consideration of each lanes operation under the specific control method at each intersection in the network.

Average Vehicle Delay (AVD)

The AVD is a measure of the operational performance of a road network or an intersection. AVD is determined globally over a road network or within a cordon during an assignment model run. The AVD exhibited on comparable network models, for analogous peak periods, forms the basis of comparing the operational performance of the road network.

AVD is used in the determination of intersection Level of Service. Generally, the total delay incurred by vehicles through an intersection is averaged to give an indicative delay on any specific approach. Longer delays do occur but only the average over the peak hour period is reported.

Degree of Saturation (DS)

The DS of an intersection is generally taken as the highest ratio of traffic volume on an approach compared with its theoretical capacity, and is a measure of the utilisation of available green time.

The DS reported is generally of a critical movement through the intersection rather than the DS of the intersection unless equal saturation occurs on all approaches.

For intersections controlled by traffic signals, generally both queue length and delay increase rapidly as DS approaches 1.0. An intersection operates satisfactorily when its DS is kept below 0.875. When the DS exceeds 0.9, extensive queues can be expected.

Table 11 Performance Indicators by Control Method

Intersection Control	Performance Measure [Unit]
Sign or Priority Control	Delay of critical movement(s) [seconds/vehicle]
	Average Vehicle Delay [seconds/vehicle]
	Queue length of critical movement(s) [metres]
Traffic Signal Control	Delay of critical movement(s) [seconds/vehicle]
	Degree of Saturation [ratio of vehicles to capacity]
	Average Vehicle Delay [seconds/vehicle]
	Cycle Length [seconds]
	Queue length of critical movement(s) [metres]
Roundabout Control	Delay of critical movement(s) [seconds/vehicle]
	Degree of Saturation[ratio of vehicles to capacity]
	Average Vehicle Delay [seconds/vehicle]
	Queue length of critical movement(s) [metres]

Table 12 Qualified Level of Service by Differing Control Methods

LOS	AVD secs	Traffic Signals and Roundabout	Give Way and Stop Sign Priority Control
A	1 to 14	Good operation.	Good operation
B	14 to 28	Good operation with acceptable delays and spare capacity.	Good operation with acceptable delays and spare capacity.
C	28 to 42	Satisfactory.	Satisfactory but accident study and operational analysis required.
D	42 to 56	Operating near capacity.	Near capacity. Acceptable LOS for new developments. Accident study and operational analysis required.
E	56 to 70	Unsatisfactory. Traffic signals incidence will cause excessive delays. Requires additional capacity. Roundabouts require alternative control mode.	At capacity. Requires alternative control mode.
F	>70	Unsatisfactory. Over capacity and unstable operation.	Over capacity. Unstable and unsafe operation.