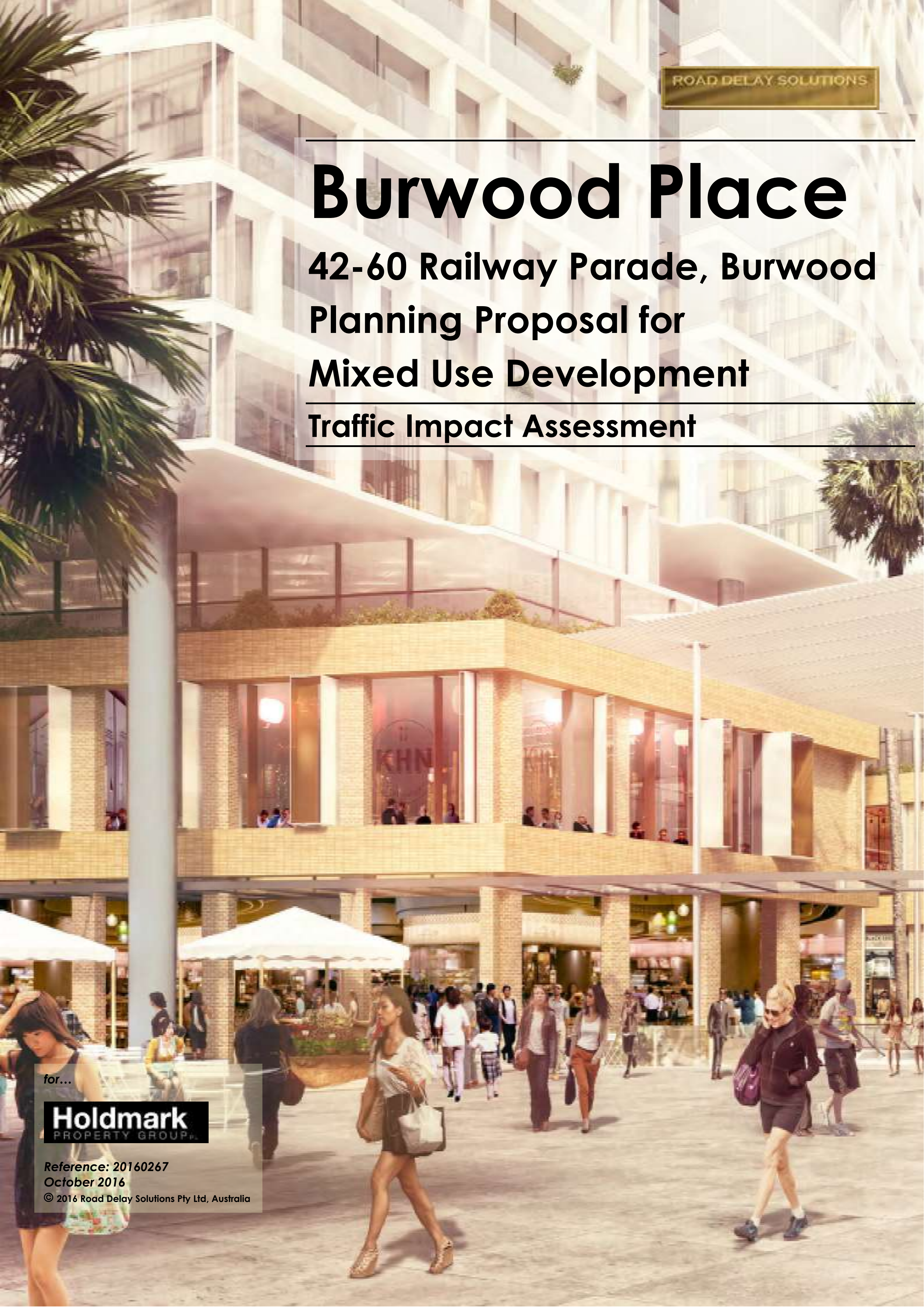

ROAD DELAY SOLUTIONS

Burwood Place

42-60 Railway Parade, Burwood
Planning Proposal for Mixed Use Development

Traffic Impact Assessment

for…

Holdmark
PROPERTY GROUP

Reference: 20160267
October 2016

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DOCUMENT STATUS

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Date	24 October 2016...

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Cover Art provided by Architectus/Cox depicting the intended integration with Burwood Town Centre's cosmopolitan form

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TABLES

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EXECUTIVE SUMMARY

Road Delay Solutions has been engaged by *Holdmark Property NSW 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 42-50 and 52-60 Railway Parade, Burwood, commonly known as '*Burwood Plaza*'.

The PP was lodged with Burwood Council on 28 September 2015, proposing a mixed use development.

Council, at the Council meeting on 24 May 2016, resolved to forward the PP to the Department of Planning and Environment (DPE) for a Gateway Determination, subject to minor amendments. However Council officers (on advice from DPE) declined to forward the PP in the absence of a TIA.

This TIA has therefore been commissioned at the request of Council officers, in order to assess the traffic impacts associated and to recommend infrastructure upgrades in support of the proposed development.

Road Delay Solutions has undertaken extensive consultation with both Council officers and Council's external consultants 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 Burwood Place development on the Burwood Town Centre road network. Extensive mesoscopic and operational modelling has analysed the following three traffic scenarios, namely…

- → *2026 Base Year Model ('Do Nothing'),*
- → *2026 Section 94 Infrastructure Model, and*
- → *2026 Burweood Place Development Model.*

The assessment of these scenarios 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 benign on the town centre's road network.

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 Burwood Place development to year 2026.

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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,*
- → *Introduction of a partial closure of Wynne Avenue to accommodate a single trafficable lane in each direction, south of Railway Parade for a distance of some 81m,*
- → *The introduction of site specific access from Railway Parade, Wynne Avenue and Belmore Street,*
- → *The introduction of traffic signal control at the intersections of…*
    - *Railway Parade and Conder Street,*
    - *Belmore Street and Wynne Avenue,*
    - *Belmore Street and Conder Street, and*
    - *Burwood Road and Victoria Street East.*

If the aforementioned measures are implemented, the impact of traffic generation associated with the Burwood Place development will be effectively and satisfactorily managed while reducing the impedence of pedestrian traffic.

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THE SITE

The subject site is located at 42-60 Railway Parade, Burwood and is located 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 LGAs in the state and has a relatively high population density.

Situated on both sides of Wynne Avenue and fronting Railway Parade, the site is only some 170m west of both the Burwood Railway Station and bus interchange.

The eastern segment, at 42-50 Railway Parade, is occupied by Burwood Plaza which provides some 13,000m^2 retail. Vehicle entry to Burwood Plaza is catered for from Wynne Avenue with egress onto Belmore Street. The Plaza loading docks are accessible from Wynne Avenue.

The western segment, at 52-60 Railway Parade, is occupied by two commercial office buildings which provide some 17,100m^2. Access to the western site is provided from Wynne Avenue.

In addition there is a public car park on the west site, south of the commercial buildings.

Figure ES 1 ***Burwood Plaza Site in Context***

Source *vimeo.com, 2016*

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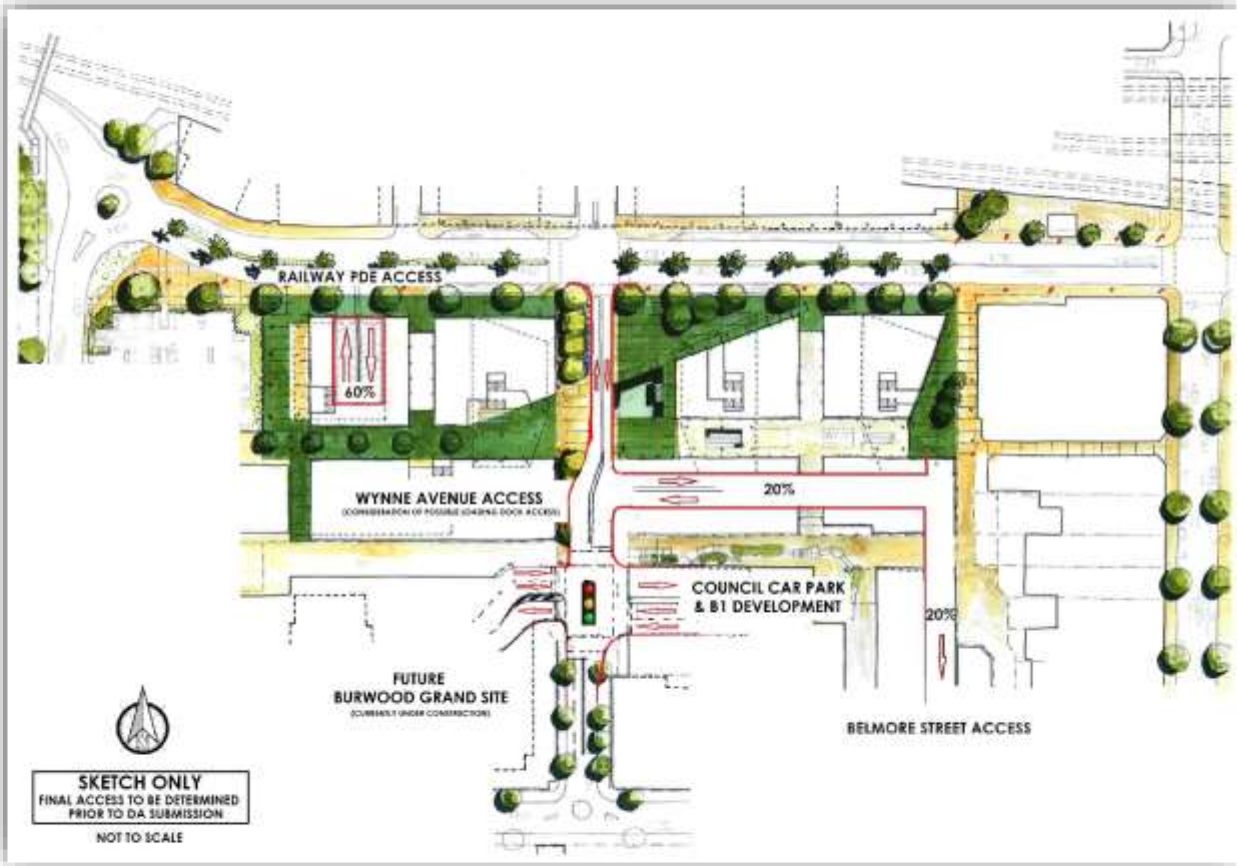
PROPOSED DEVELOPMENT

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

- *1,044 residential apartments,*
- *100 Hotel styled serviced apartments,*
- *28,477m² retail GFA (19,400m² GLFA) inclusive of supermarket GFA 4,200m² (2,900m² GLFA), and*
- *15,092m² (12,075m² GLFA) of commercial floor space. and*
- *A resultant FSR of some 9.9:1 for the site.*

Figure ES 2 The Development Footprint

Source Architectus/Cox, 2016



There is also potential for any development, at Development Application stage, to reconfigure Wynne Avenue. This could include a reduction in the carriageway width to one (1) lane in each direction on the section of Wynne Avenue for a distance of some 81m immediately south of Railway Parade, to permit the introduction of a cosmopolitan thouroughfare (*widened footway areas*) and reinforced pedestrian mobility and continuity at the podium level within the site.

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The closure (or partial closure) will permit the travel of vehicles both northbound and southbound while providing accessibility to the proposed entry/exit driveway on Wynne Avenue.

Vehicular access to the site is currently under consideration from three (3) locations…

- → *Railway Parade servicing some 60% of development,*
- → *Wynne Avenue servicing some 20% of development, and*
- → *Belmore Street servicing some 20% of development.*

Access for resident, tenant and and publicly accessible visitor and retail spaces will be separated and clearly defined within the development by the use of underground car parking. Internal ramps will connect the parking levels.

The approximate 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 model.

The internal layout and function of the car park provisions and access locations are yet to be finalised.

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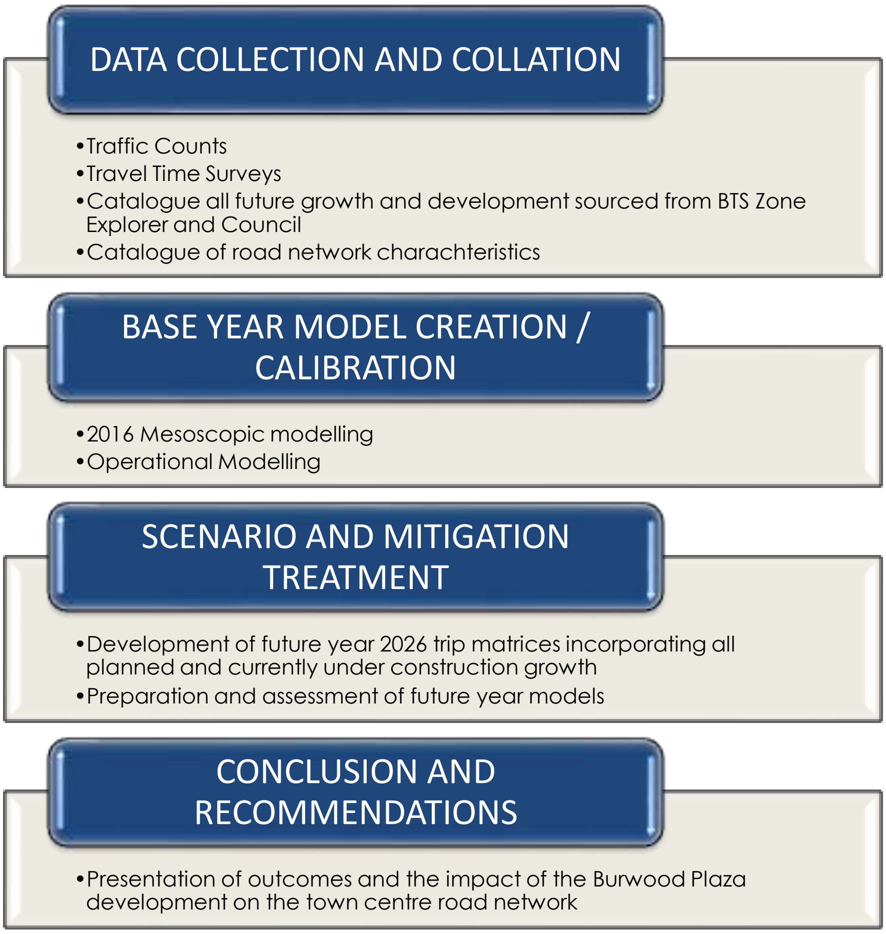
THE ASSESSMENT PROCESS

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, 2016



4.1 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.

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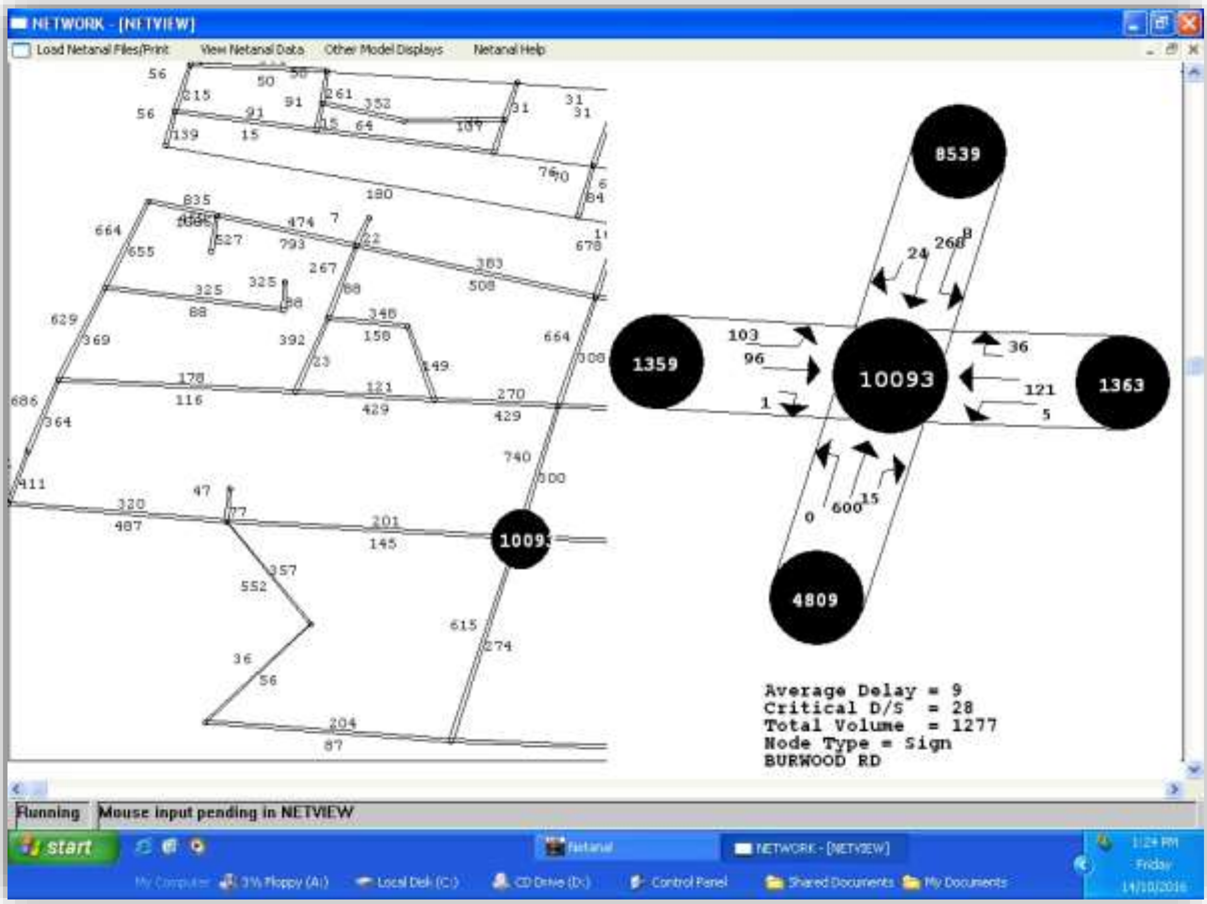
Figure ES 4 The Netanal Mesoscopic Model

Source Road Delay Solutions, 2016



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THE 2016 EXISTING SITUATION

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 George Street and Belmore Street, currently operate 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.

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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.

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Figure ES 5 2016 Existing Conditions Summary

Source Road Delay Solutions, 2016

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GROWTH FORECASTS

Investigations into the traffic impacts associated with the Burwood Place 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 2011, 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…

- → *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 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.

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Figure ES 6 Adopted Forecast Growth Projections

Source BTS, 2016

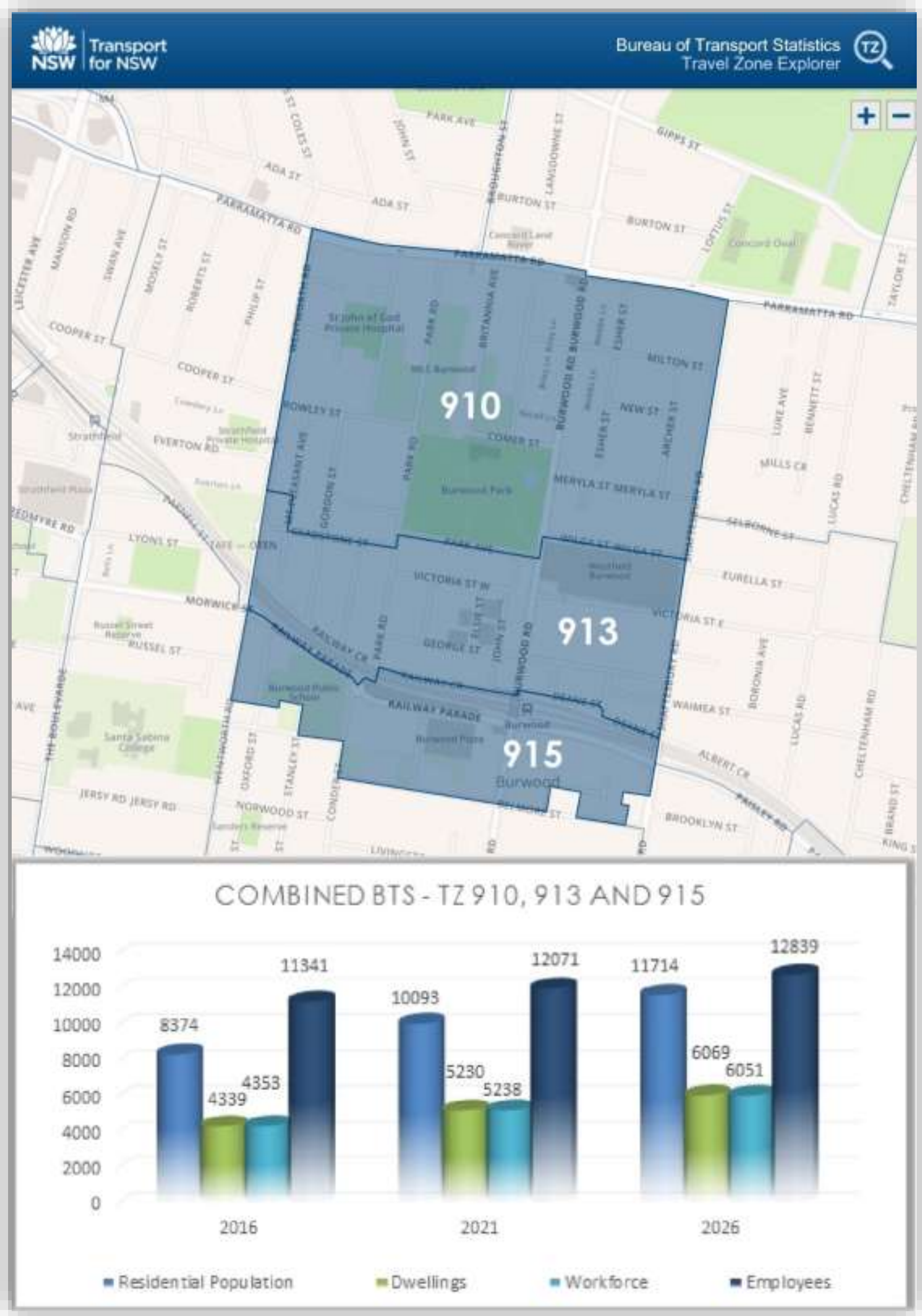

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Figure ES 7 ***Burwood Council Approved and Planned Developments***

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.*

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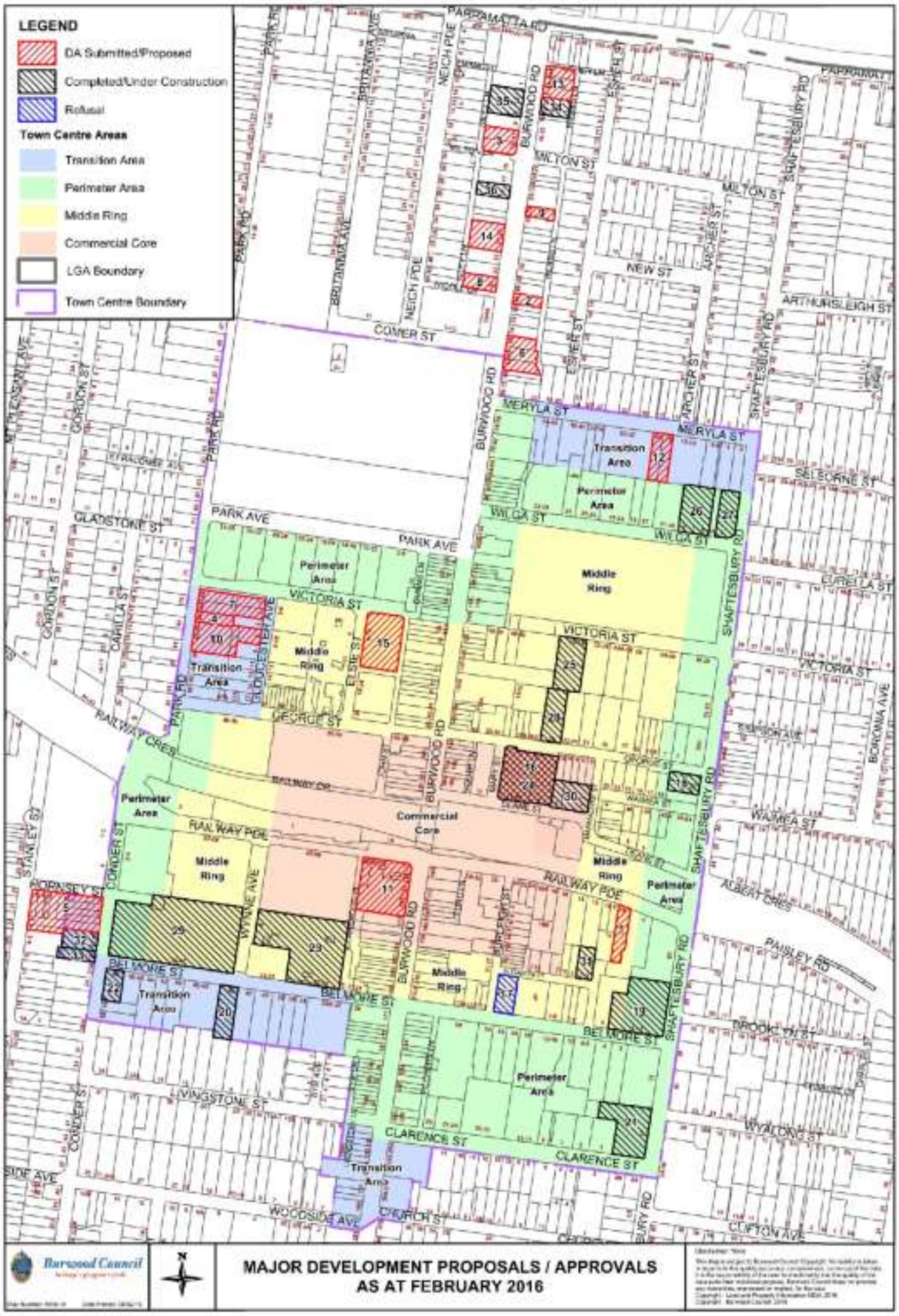
Figure ES 8 Burwood Town Centre Development Opportunity

Source Burwood Council, 2016



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6.1 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 Burwood Place development will generate 9,912 vehicle trips daily, with some 3,200 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.

6.2 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 2011, while the retail traffic distribution has been determined by a catchment analysis of simillar operations.

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Figure ES 9 ***Proposed Vehicle Generation***

Source *Road Delay Solutions, 2016*

BURWOOD PLAZA 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	1,044	1,044	1.52	0.19	0.15	0.1	198	157	104	159	40	31	125	57	47
Serviced Apartments#	100	100	3	0.4	0.4	0.4	40	40	20	32	8	8	32	16	4
Retail Specialty Shops*	17,460	24,277	0.3403	0.059	0.059	0.075	1030	1030	1310	464	567	567	464	720	589
Supermarket*	3,100	4,200	0.3403	0.059	0.059	0.075	183	183	233	82	101	101	82	128	105
Commercial	12,075	15,092	0.11	0.016	0.012	0.001	193	145	12	29	164	123	22	7	5
TOTAL			9,912				1645	1555	1678	766	879	830	725	929	750

**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.*

The retail GLFA excludes common areas such as walkways, garbage storage, unoccupied lobby areas and the shared loading dock provisions.

 # The hotel style serviced apartments have adopted the casual accommodation vehicle generation rate prescribed by the RMS of 0.4 trips per apartment during the peak periods given the proximity to Burwood Railway Station.

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THE FUTURE YEAR MODELS

The future year 2026 models were run against three different infrastructure scenarios to understand and compare the impacts associated with the Burwood Place 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 Burwood Plaza development traffic, and*
- → *2026 Development Model – The 2026 Section 94 road network including proposed infrastructure and traffic generation from the Burwood Place development.*

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7.1 2026 Base Year 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 developed to understand the likely traffic impacts the general metropolitan growth, and the planned Burwood town centre developments, 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, 2016

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 reported growth on Shaftesbury Road and Wentworth 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 routes of Shaftesbury Road and Wentworth Road remain viable options.

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.

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7.2 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, 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 Burwood Plaza (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.

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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 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.

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 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.

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7.3 2026 Plaza Development Model

The third scenario model of the Year 2026 includes the impacts of the Burwood Plaza Development.

The Plaza 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 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 within the town centre.*

The major input parameters incorporated in the 2026 Plaza 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,*

→ *The introduction of traffic generation associated with the Burwood Plaza development, via the proposed access locations on Railway Parade, Belmore Street and Wynne Avenue, 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 Plaza development.

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Figure ES 12 2026 Plaza Development Model – Road Network Treatment Options

Source Road Delay Solutions, 2016

Identifier	Proposed Road Network Component	Priority in Relation to Plaza Development	Reasoning
1	Widening of pedestrian crossings to 5m at select locations	Low	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.
4	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.
5	Retention of current intersection configuration and phasing on Burwood Road at Belmore Street	Medium	Retention of the RT movement for all vehicle classes at Railway Parade negates the need for a dedicated RT phase from Burwood Road, SB, in Burwood Road.
6	Introduction of a partial closure of Wynne Avenue, south of Railway Parade	Low	The partial closure, or narrowing, of Wynne Avenue is proposed to consolidate continuity and pedestrian mobility at the podium level, between the two Burwood Plaza development sites.
7	Introduction of priority sign controlled development access in Railway Parade	High	Required to provide access to the Burwood Plaza development. No RT from development site onto Railway Parade to be permitted.
8	Introduction of traffic signal controlled development access in Wynne Avenue	High	Required to provide access to the Burwood Plaza development and manage the movement of pedestrian across the driveway and Wynne Avenue. Possible loading dock access to also be considered prior to DA.
9	Introduction of priority sign controlled development access in Belmore Street	High	Necessary to provide access to the development.
9	Signalisation of the Railway Parade intersection with Conder Street	Medium	Signalisation will formalise pedestrian movements, efficiently manage traffic movements and allow buses to perform a 'U' turn movement to access the bus layover on the northern side of Railway Parade, adjacent to Burwood Central.
10	Signalisation of Burwood Road intersection at Victoria Street East. Buses Only RT movement from Burwood Road NB	Low	Necessary to formalise both bus and pedestrian movements. Intended to reduce the incidence of 'J' walking across Burwood Road.
11	Traffic signalisation of the Belmore Street intersection with Conder Street	Medium	Treatment will effectively manage vehicle and pedestrian movements.
12	Traffic signalisation of the Belmore Street intersection with Wynne Avenue	Medium	Treatment will effectively manage vehicle and pedestrian movements.

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Butrwood Plaza currently generates some 940 vehicle trips per hour during the one (1) hour morning and evening commuter peak periods. With the proposed mixed use development the subsequent, calculated ,vehicle generation is 1,645vph during the morning AM peak and 1,555vph during the PM.

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 indicates that with the addition of the Burwood Plaza traffic generation, Burwood Road traffic volumes do not rise significantly. However, traffic vehicle volume increases do occur on Shaftesbury Road and Wentworth Road.

The model results would suggest that residents of the proposed Plaza development will opt for the less congested alternate, parallel, routes to avoid congestion and reduce travel times to their elected destinations, should they be outside the cordon of the town centre. This was evident from select link analysis of the development traffic generation movements.

The vehicular growth reported on Burwood Road is consistent with that reported between the years 2000 and 2016.

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MITIGATION MEASURES

8.1 Widening of Pedestrian Crossings

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

- *Victoria Road East,*
- *Dean 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.

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.

8.2 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 of 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.

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With the Burwood railway station only 170m from the Burwood Place 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.

8.3 Burwood Road and Belmore Street

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

8.4 Wynne Avenue Partial Closure

A partial closure, or narrowing, of Wynne Avenue is proposed to consolidate continuity and pedestrian mobility at the podium level, between the two Burwood Place development sites. The partial closure is to take the form of widened footway provisions, the restriction of one (1) trafficable lane each way in Wynne Avenue, south of Railway Parade, for a distance of some 81m and the introduction of a 20km/h speed limit.

Sidra network modelling of Conder Street with both the Belmore Street and Railway Parade intersections and the Belmore Street and Wynne Avenue intersection do not indicate any significant deterioration with the changed travel patterns associated with the Wynne Avenue partial closure. While the impact to traffic volumes on Burwood Road is reported as negligible.

8.5 Railway Parade Access

The proposed sign controlled access from Railway Parade has been found to operate at a good LoS 'A' for all peak periods. The intersection is proposed to incorporate…

- → *Sign priority control,*
- → *Modification of the central median in Railway Parade to allow for a single lane right turn movement from Railway Parade, eastbound, into the site,*
- → *Location a minimum of 60m east from the Conder Street intersection,*
- → *Clearly identified multiple lane entry for the differing uses within the site, and*
- → *Employment of a right turn ban from the site onto Railway Parade.*

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The access is anticipated, at this time, to cater for some 60% of the development's traffic generation and be located a minimum of 60m from Conder Street to provide satisfactory sight distance and queueing capacities.

The final configuration, traffic composition and location will be determined during the DA design stage in consultation with Council and any key stakeholders.

8.6 Wynne Avenue Access

Discussions are currently underway as to the viability of a possible access to the development from Wynne Avenue. Modelling reports an intersection LoS 'A' at the location when servicing some 20% of the Plaza development's traffic generation.

The site may also be considered for the introduction of a loading dock as pedestrian activity is currently low and no significant increase is foreseen at the site.

8.7 Belmore Street Access

Historically recognised as an access location to the former Plaza, the right of carriageway is currently under consideration for use by neighbouring development. Single lane egress is proposed.

With an anticipated 20% of development traffic generation utilising the site, modelling indicates an intersection LoS 'A' during the peak periods.

8.8 Railway Parade and Conder Street

The introduction of traffic signal control is proposed under Council's Section 94 Infrastructure Plan.

The signalisation of the site will formalise pedestrian movements and effectively manage the increasing vehicle activity. The future signalised pedestrian crossings at the site should be designed 5m wide to increase the throughput and reduce the delay of pedestrians per phase.

Of critical note when introducing traffic signals at the aite is the inclusion of a 'U' turn provision for buses only in Railway Parade, westbound. Current bus lay over provisions on the northern side of Railway Parade, adjacent to Burwood Central, necessitate the need for a 'U' turn facility for buses only. Modelling of the site has reported an intersection LoS 'D' with the 'U' turn movement occurring during the intergreen period, prior to 'A' phase. The movement is to be controlled by use of an exclusive 20m long bus lane and bus lantern display.

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8.9 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 to enable access to bus layover provisions in Victoria Street East, adjacent to Westfields.

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.

8.10 Belmore Street and Conder Street

The introduction of traffic signal control at the site is proposed under Counci'ls Section 94 Infrastructure Plan.

The signals will provide improved management and formalisation of vehicle movements and pedestrian demands.

The site reports an intersection LoS 'B' during each of the three (3) modelled peak hour periods.

8.11 Belmore Street and Wynne Avenue

The removal of the existing roundabout and introduction of traffic signal control at the site is proposed under Counci'ls Section 94 Infrastructure Plan.

Once again, the introduction of traffic signals will provide improved management and formalisation of vehicle movements and pedestrian demands while returning a satisfactory LoS.

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CONCLUSION

Road Delay Solutions has been engaged by *Holdmark Property NSW Pty Ltd* to undertake the preparation of a Traffic Impact Assessment in support of the Planning Proposal for a mixed use development at 42-50 and 52-60 Railway Parade, Burwood, commonly known as '*Burwood Plaza*'.

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 Burwood Plaza redevelopment 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 and Wentworth Road provide viable through traffic avenues 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 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 Burwood Place 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,*
- → *Introduction of a partial closure of Wynne Avenue to accommodate a single trafficable lane in each direction, south of Railway Parade for a distance of some 81m,*
- → *The introduction of site specific access from Railway Parade, Wynne Avenue and Belmore Street,*
- → *The introduction of traffic signal control at the intersections of…*
    - *Railway Parade and Conder Street,*
    - *Belmore Street and Wynne Avenue,*
    - *Belmore Street and Conder Street, and*
    - *Burwood Road and Victoria Street East.*

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In conclusion, with the introduction of the aforementioned management measures, the impact of traffic generation associated with the Burwood Place development will be effectively managed while reducing the impedence of 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 within the Burwood Town Centre.

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Figure ES 13 Burwood Town Centre Intersection Operational Performance

Source *Road Delay Solutions, 2016*

BURWOOD TOWN CENTRE SIDRA NETWORK MODELLING												
	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
Burwood Road and Victoria Street East												
DS										0.535	0.521	0.567
AVD *(sec)*										16.4	18.8	19.5
LOS										B	B	B
Burwood Road, Deane Street and Railway Crescent												
DS	0.531	0.368	0.416	0.887	0.437	0.44	0.493	0.56	0.488	0.673	0.319	0.398
AVD *(sec)*	9.7	12.8	6.9	15.2	12.8	13.8	6.1	6.1	7.7	8.2	7.3	6.5
LOS	A	A	A	B	A	A	A	A	A	A	A	A
Burwood Road and Railway Parade												
DS	0.899	0.863	0.661	1.022	0.845	0.938	0.761	0.64	0.79	1.064	1.021	0.894
AVD *(sec)*	33.8	32.5	24.9	49	27.8	39.4	28.6	25.3	32.8	54	46.1	37.6
LOS	C	C	B	D	B	C	C	B	C	D	D	C
Burwood Road and Belmore Street												
DS	0.859	1.004	0.703	0.96	0.709	0.931	0.757	0.683	0.898	0.916	0.895	0.946
AVD *(sec)*	27.8	25.1	17.5	36.6	21.6	30.9	24.4	23.2	28.6	27.2	32.3	33.7
LOS	B	B	B	C	B	C	B	B	C	B	C	C
Railway Parade and Wynne Avenue												
DS	0.402	0.348	0.376	0.335	0.388	0.384	0.403	0.347	0.479	0.443	0.422	0.465
AVD *(sec)*	14	14.6	19.2	15.9	16.5	13.1	25.6	24.1	26.6	18.7	22	20.5
LOS	A	B	B	B	B	A	B	B	B	B	B	B
Railway Parade and Conder Street												
DS	0.569	0.513	0.498	0.519	0.548	0.538	0.904	0.927	0.96	0.878	0.893	0.885
AVD *(sec)*	8.3	7.7	7.6	7.5	7.3	7	33.8	21.3	34.9	32.6	33.6	36.9
LOS	A	A	A	A	A	A	C	B	C	C	C	C
Belmore Street and Wynne Avenue												
DS	0.2	0.258	0.29	0.196	0.254	0.25	0.307	0.359	0.422	0.495	0.373	0.451
AVD *(sec)*	6	6.1	6.2	6.3	6.9	6.3	19.8	26.5	23.1	17.8	17.6	18.8
LOS	A	A	A	A	A	A	B	B	B	B	B	B
Belmore Street and Conder Street												
DS	0.241	0.2	0.24	0.239	0.252	0.258	0.557	0.47	0.614	0.898	0.457	0.621
AVD *(sec)*	4.1	3.8	4.1	13.1	4	4.4	20.5	23.9	24.4	31	21.5	21.4
LOS	A	A	A	A	A	A	B	B	B	C	B	B
Railway Parade and Development Access												
DS										0.447	0.483	0.605
AVD *(sec)*										3	3.1	3.4
LOS										A	A	A
Belmore Street and Development Access												
DS										0.198	0.162	0.225
AVD *(sec)*										1.6	1.8	2.1
LOS										A	A	A
Wynne Avenue and Development Access												
DS										0.345	0.281	0.34
AVD *(sec)*										20	21.4	19.6
LOS										B	B	B

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Figure ES 14 Modelled Vehicle Projections

Source *Road Delay Solutions, 2016*

MESOSCOPIC MODEL HOURLY TRAFFIC VOLUME PROJECTIONS																					
	Model																				
Road Link	16AM28	26AMBASE	Variance 2026 Base Model minus Existing	26AMS94	Variance 2026 S94 Model minus Existing	26AMDV	Variance 2026 Plaza Model minus Existing	16PM23	26PMBASE	Variance 2026 Base Model minus Existing	26PMS94	Variance 2026 S94 Model minus Existing	26PMDV	Variance 2026 Plaza Model minus Existing	16AMWE17	26AMWEBA	Variance 2026 Base Model minus Existing	26AMWE94	Variance 2026 S94 Model minus Existing	26AMWEDV	Variance 2026 Plaza Model minus Existing
BURWOOD RD NB S DEANE ST	739	792	53	831	39	678	-61	534	569	35	611	77	447	-87	570	598	28	631	61	550	-20
BURWOOD RD SB S DEANE ST	474	516	42	439	-77	397	-77	403	439	36	463	60	307	-96	426	485	59	403	-23	343	-83
BURWOOD RD NB S RAILWAY PDE	609	652	43	688	36	664	55	407	433	26	456	49	381	-26	475	508	33	428	-47	363	-112
BURWOOD RD SB S RAILWAY PDE	340	368	28	313	-55	308	-32	290	347	57	348	58	226	-64	314	330	16	273	-41	259	-55
RAILWAY PDE EB E WYNNE AVE	490	492	2	458	-34	383	-107	497	528	31	505	8	464	-33	477	490	13	548	71	523	46
RAILWAY PDE WB E WYNNE AVE	385	420	35	581	161	508	123	485	521	36	459	-26	422	-63	512	568	56	747	235	647	135
RAILWAY PDE EB W CONDER ST	660	662	2	826	164	966	306	571	651	80	728	157	883	312	658	685	27	836	178	825	167
RAILWAY PDE WB W CONDER ST	546	587	41	1091	504	1226	680	646	710	64	674	28	726	80	489	508	19	707	218	844	355
CONDER ST NB N BELMORE ST	413	436	23	540	104	629	216	232	268	36	210	-22	292	60	260	299	39	275	15	340	80
CONDER ST SB N BELMORE ST	177	194	17	248	54	369	192	297	300	3	282	-15	556	259	230	236	6	327	97	447	217
CONDER ST NB S BELMORE ST	462	492	30	622	130	686	224	206	228	22	232	26	262	56	288	336	48	357	69	313	25
CONDER ST SB S BELMORE ST	189	202	13	269	67	364	175	350	352	2	373	23	573	223	220	228	8	389	169	485	265
BELMORE ST EB E CONDER ST	174	195	21	202	7	178	4	166	181	15	195	29	146	-20	248	268	20	271	23	170	-78
BELMORE ST WB E CONDER ST	138	147	9	141	-6	116	-22	246	274	28	263	17	193	-53	209	223	14	251	42	234	25
WYNNE AVE NB N BELMORE ST	184	197	13	193	-4	392	208	160	161	1	183	23	268	108	163	163	0	209	46	312	149
WYNNE AVE SB N BELMORE ST	24	22	-2	43	21	23	-1	119	129	10	154	35	83	-36	71	76	5	86	15	174	103
BELMORE ST EB W BURWOOD RD	204	221	17	259	38	270	66	370	403	33	417	47	268	-102	390	423	33	401	11	438	48
BELMORE ST WB W BURWOOD RD	246	258	12	265	7	429	183	250	273	23	264	14	349	99	255	267	12	303	48	406	151
RAILWAY PDE EB E BURWOOD RD	432	434	2	389	-45	390	-42	405	420	15	391	-14	425	20	428	449	21	388	-40	380	-48
RAILWAY PDE WB E BURWOOD RD	325	355	30	530	175	440	115	407	456	49	387	-20	368	-39	447	461	14	660	213	607	160
DEANE ST WB E BURWOOD RD	164	201	37	102	-99	140	-24	120	124	4	86	-34	105	-15	121	132	11	106	-15	113	-8
RAILWAY CRES W BURWOOD RD	146	158	12	167	9	165	19	56	61	5	54	-2	63	7	79	92	13	88	9	74	-5
WENTWORTH ROAD NB	367	464	97	321	-143	622	255	258	254	-4	210	-48	538	280	218	319	101	296	78	564	346
WENTWORTH ROAD SB	312	353	41	344	-9	638	326	662	767	105	722	60	989	327	465	559	94	527	62	782	317
SHAFTESBURY AVENUE NB	484	570	86	600	30	573	89	679	748	69	725	46	778	99	642	703	61	724	82	768	126
SHAFTESBURY AVENUE SB	442	505	63	476	-29	476	34	465	534	69	579	114	593	128	634	622	-12	729	95	681	47

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TRAFFIC IMPACT ASSESSMENT

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1. INTRODUCTION

1.1 Currently

Road Delay Solutions has been engaged by *Holdmark Property NSW Pty Ltd* to undertake the preparation of a Traffic Impact Assessment in support of the Planning Proposal for a mixed use development at 42-50 and 52-60 Railway Parade, Burwood, commonly known as '*Burwood Plaza*'.

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, Belmore Street, Livingstone Street and Clarence Street.

Plans for further development under the potential in the LEP, including the Burwood Place, 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 and businesses while catering for 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.

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

Source *Transport For NSW - BTS, 2016*

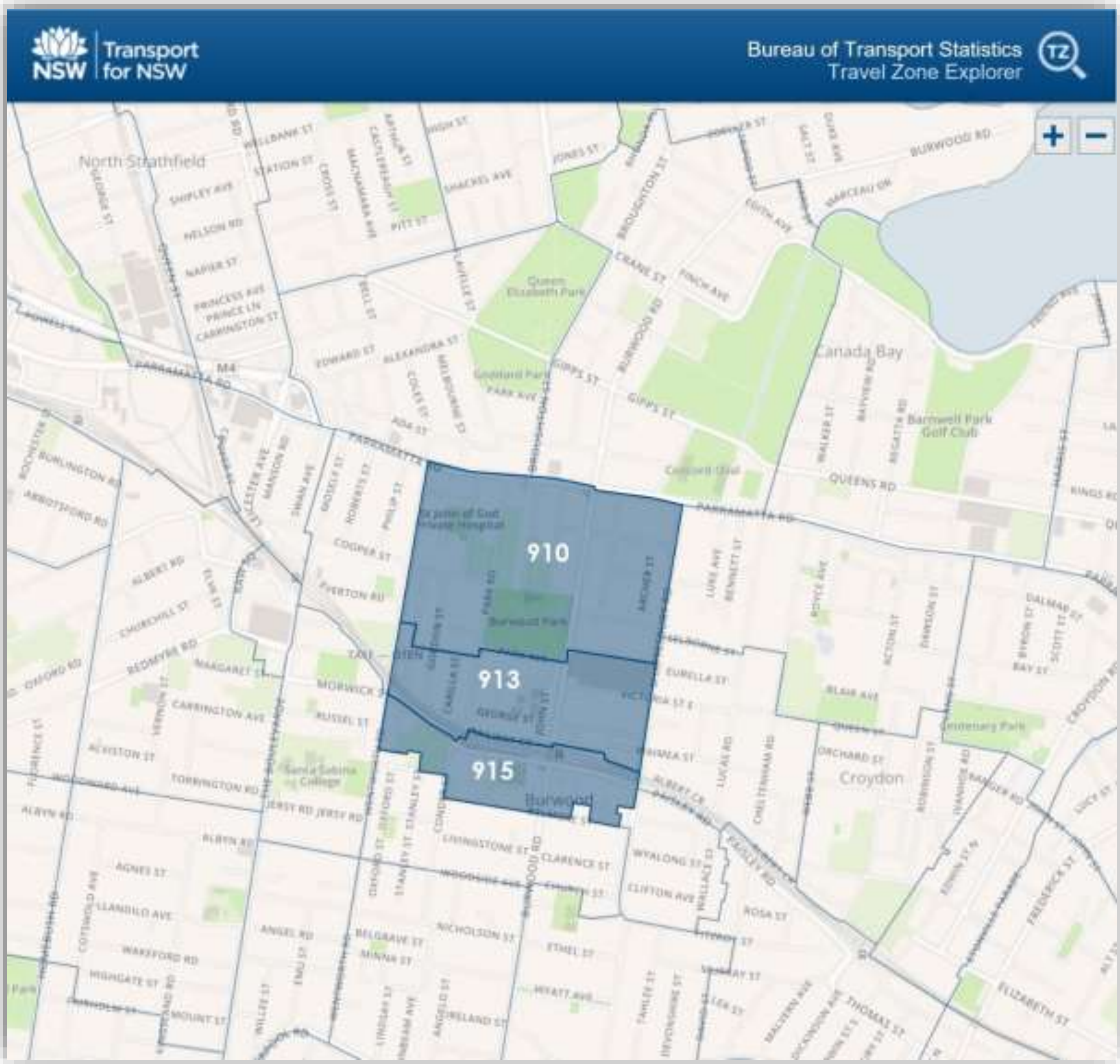

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Figure 2 ***Looking East on Railway Parade from Conder Street, Burwood***

Source *Google Street View, 2016*

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1.2 The Site

Buwood Plaza seamlessly integrates with the surrounding Burwood Town Centre commercial and retail activities. The site is segmented into two (2) major components.

Situated on both sides of Wynne Avenue and fronting Railway Parade, the Plaza is only some 170m west of Burwood Railway Station.

The eastern segment, at 42-50 Railway Parade, is occupied by Burwood Plaza which provides some 13,000m^2 retail. Vehicle entry to Burwood Plaza is catered for from Wynne Avenue with egress onto Belmore Street. The Plaza loading docks are accessible from Wynne Avenue.

The western segment, at 52-60 Railway Parade, is occupied by two commercial office buildings which provide some 17,100m^2. Access to the western site is provided from Wynne Avenue.

In addition there is a public car park on the west site, south of the commercial buildings.

Figure 3 ***Burwood Place Site in Context***

Source *vimeo.com, 2016*

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

- → *1,044 residential apartments,*
- → *100 Hotel styled serviced apartments,*
- → *28,477m² retail GFA (19,400m² GLFA) inclusive of supermarket GFA 4,200m² (2,900m² GLFA), and*
- → *15,092m² (12,075m² GLFA) of commercial floor space. and*
- → *A resultant FSR of some 9.9:1 for the site.*

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.

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Figure 4 ***The Assessment Process***

Source *Road Delay Solutions, 2016*

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

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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,*
- → *Railway Parade*
- → *Wynne Avenue,*
- → *Belmore Street,*
- → *Clarendon Place,*
- → *Conder Street, and*
- → *Hornsey 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 Railway Parade and Belmore Street with a 40km/hr speed limit through the town centre.

Railway Parade

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.

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There is a 40 kilometre per hour speed limit on Railway Parade generally, between Conder Street and Shaftesbury Road.

Wynne Avenue

Wynne Avenue connects Railway Parade with Belmore Street in the south. It provides for one traffic lane and one parking lane in each direction, clear of intersections. There are traffic signals at the intersection of Wynne Avenue with Railway Parade, and a roundabout at Wynne Avenue and Belmore Street.

Belmore Street

Belmore Street is to the south of the site. It provides access to commercial, retail and residential operations within the town centre. It caters for one traffic lane and one parking lane in each direction, clear of intersections.

The intersection of Belmore Street with Burwood Road is controlled by traffic signals.

Clarendon Place

Clarendon Place runs south from Railway Parade, on the eastern side of Burwood Plaza. It provides for two-way traffic and provides access to the rear of properties fronting Burwood Road.

There are marked pedestrian crossings in Clarendon Place at Railway Parade and at the Burwood Plaza pedestrian access.

Conder Street

Conder Street is west of the site, running south from Railway Parade on the western side of the town centre.

The intersection of Conder Street with Railway Parade is controlled by a roundabout. Conder Street provides for one traffic lane and one parking lane in each direction, clear of intersections.

Hornsey Street

Hornsey Street connects to Conder Street and provides access along the southern side of the council offices and community facilities. It provides access to parking areas south of the site and provides a pedestrian connection between Conder Street and Wynne Avenue.

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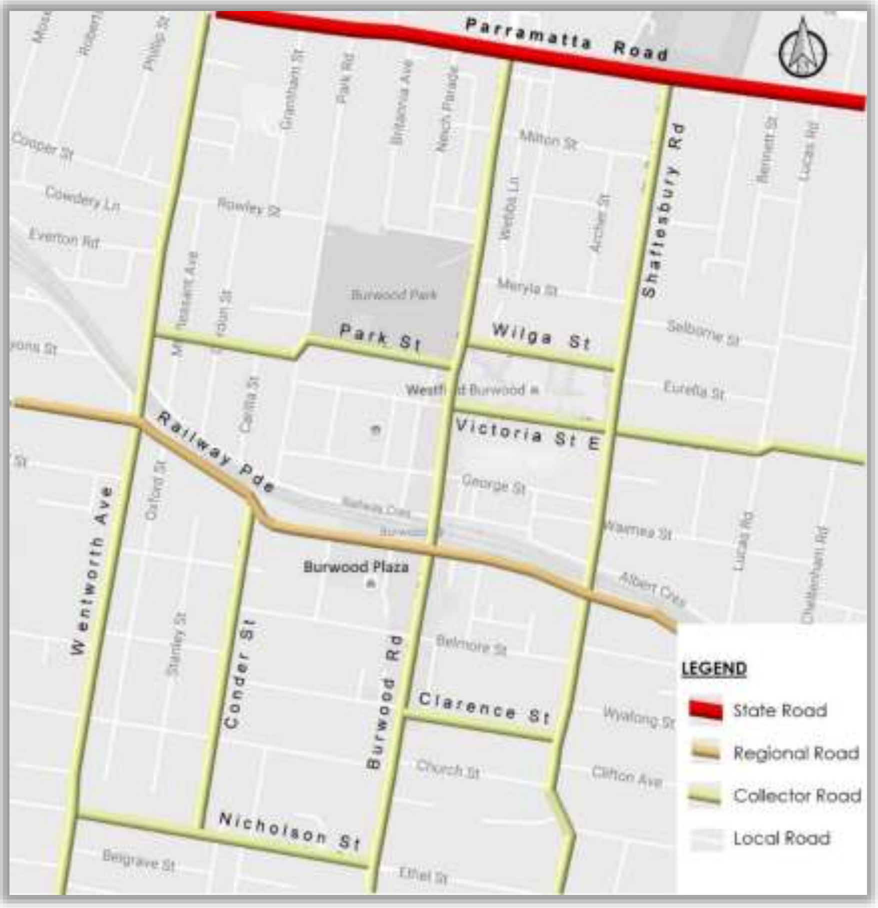
Figure 5 Road Hierarchy

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 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.*

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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).*

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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.

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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.

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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*

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Figure 7 ***Burwood Road J-Walking***

Source *Road Delay Solutions, 2016*

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Figure 8 ***City Rail Network***

Source *Transport Sydney Trains, 2016*

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Figure 9 ***Intercity Rail Network***

Source *Transport Sydney Trains, 2016*

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

Source *Transport Sydney Trains, 2016*

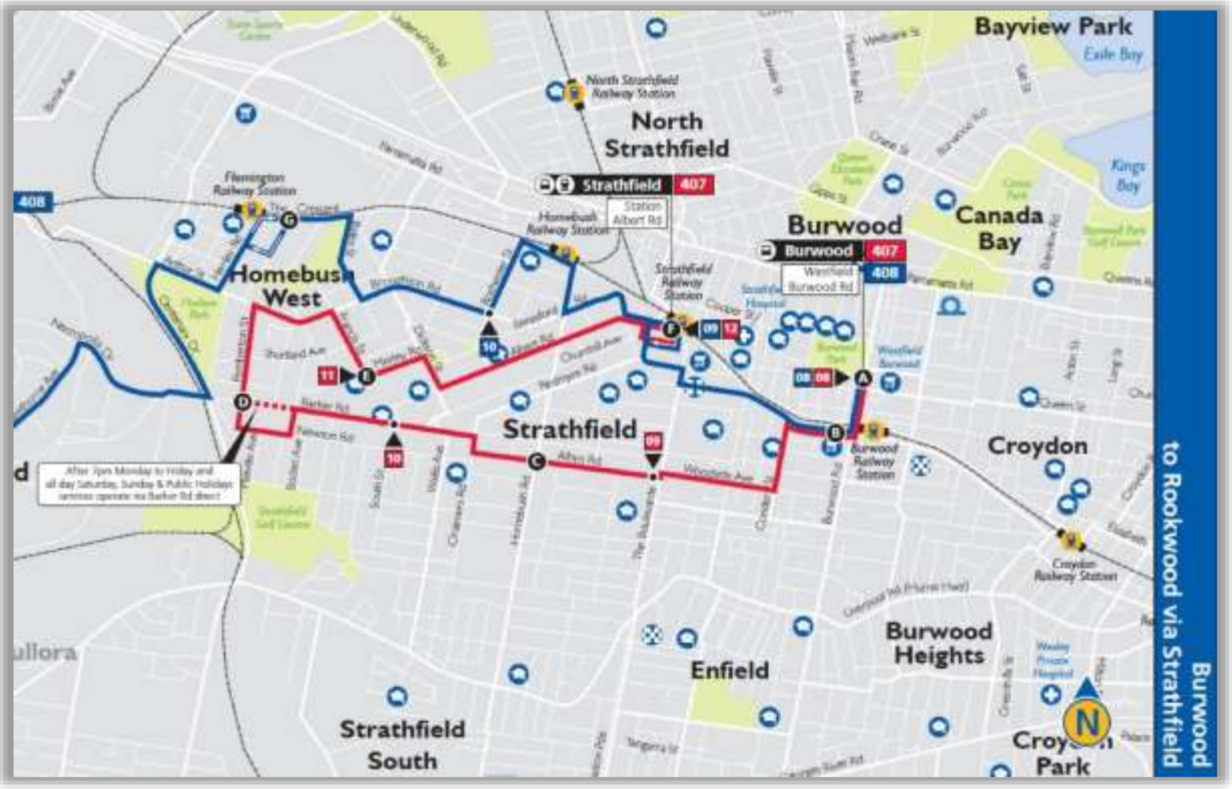

Figure 11 ***Bus Network Route 461***

Source *Transport Sydney Trains, 2016*

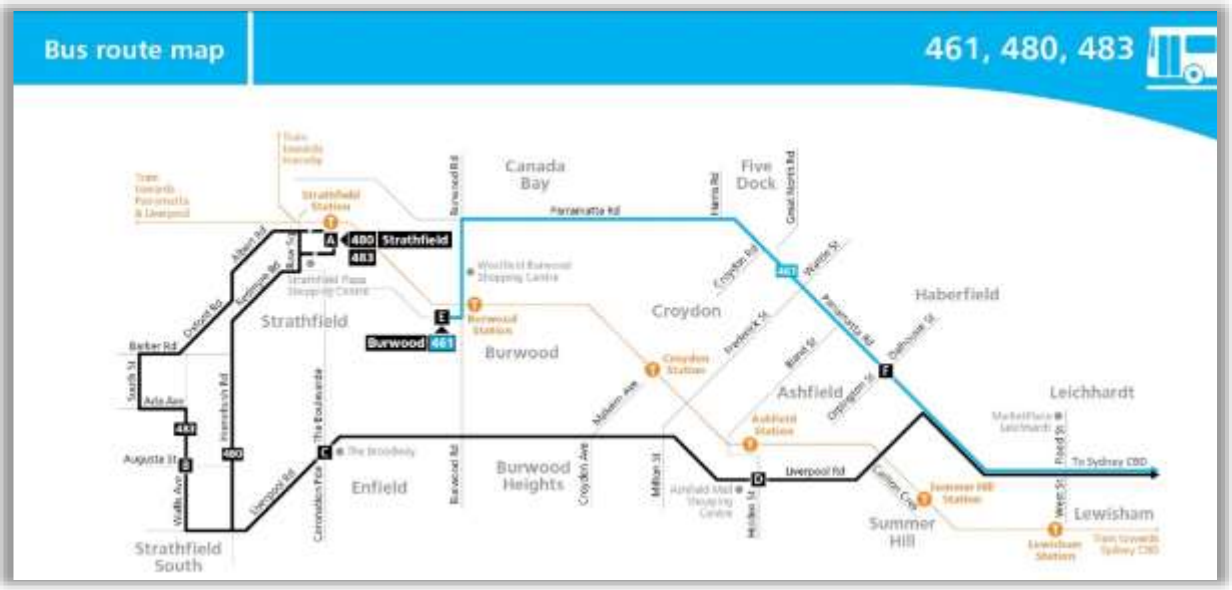

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Figure 12 ***Bus Network Route 415***

Source *Transport Sydney Trains, 2016*

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

Source *Transport Sydney Trains, 2016*

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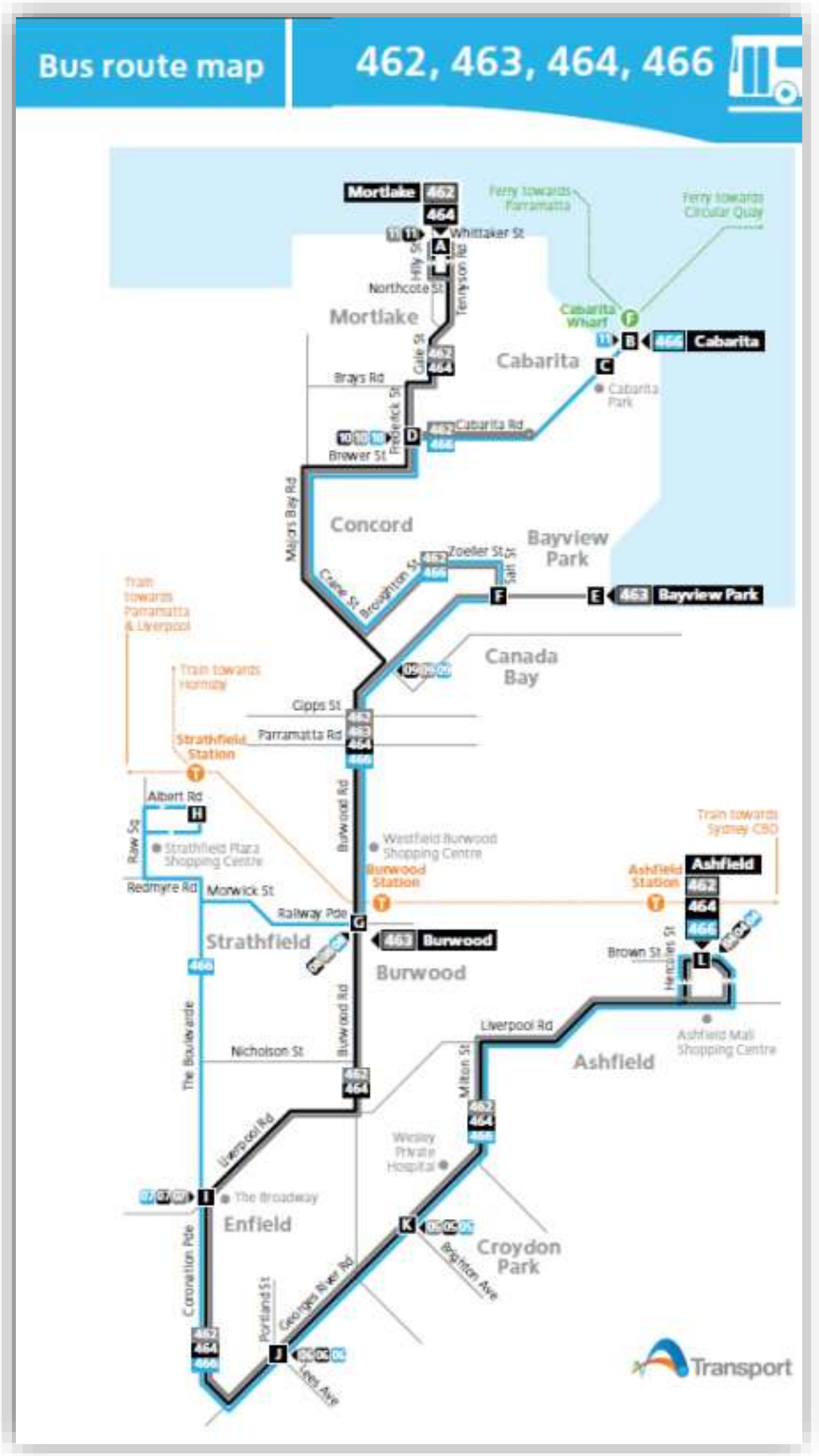
Figure 14 ***Bus Network Route 463 and 466***

Source *Transport Sydney Trains, 2016*



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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*

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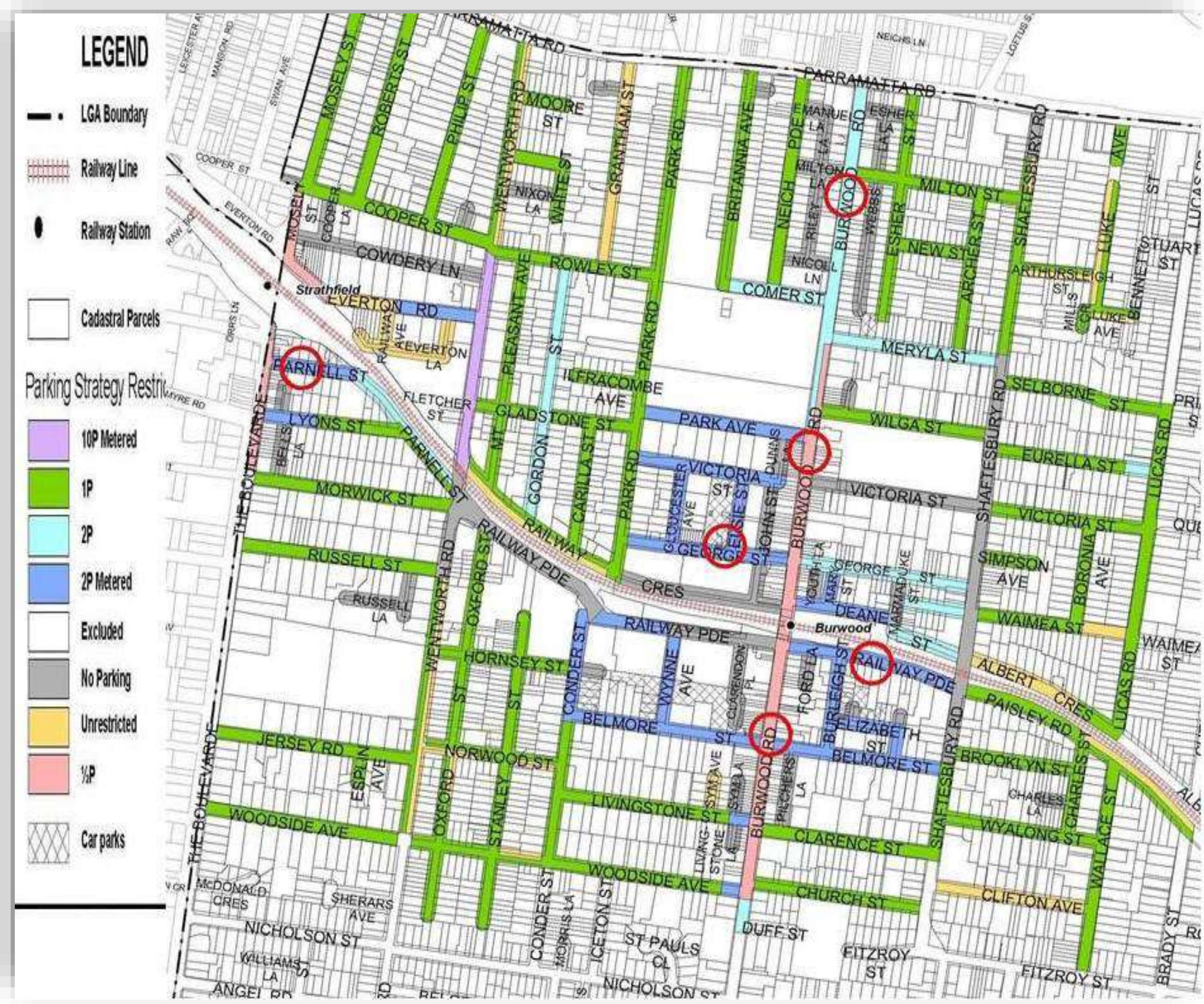
A catalogue of the available parking choice is presented in the following figure.

Figure 15 ***Burwood Town Centre Parking***

Source *'Parking Behaviour of Burwood Town Centre', Alex Karki, 2015*



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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),*
- *Origin and destination to confirm traffic patterns (Road Delay Solutions, 2016),*
- *Travel time surveys along Burwood Road (Road Delay Solutions, 2016),*
- *Parking occupancy rates (Road Delay Solutions, 2016),*
- *Bus routes and frequency (State Buses, 2016),*
- *Train routes and frequency (Sydney Trains, 2016),*
- *Road network catalogue (Road Delay Solutions, 2016), and*
- *Traffic signal operation data (RMS, 2000, 2005, 2016).*

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*, 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 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,*

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9. *Shaftesbury Road, Railway Parade and Paisley Street,*
10. *Burwood Road and Belmore Street,*
11. *Belmore Street and Wynne Avenue, and*
12. *Belmore Street and Conder Street.*

Figure 16 ***Traffic Count Locations***
Source *Road Delay Solutions, 2016*

Appendix A presents the traffic survey data utilised in the coding and calibration of the base year 2016 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.

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3.3 Travel Time Surveys

Travel time data was collected along Burwood Road, between Wilga Avenue 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 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.*

Figure 17 ***Travel Time Corridors***

Source *Google Maps, 2016*

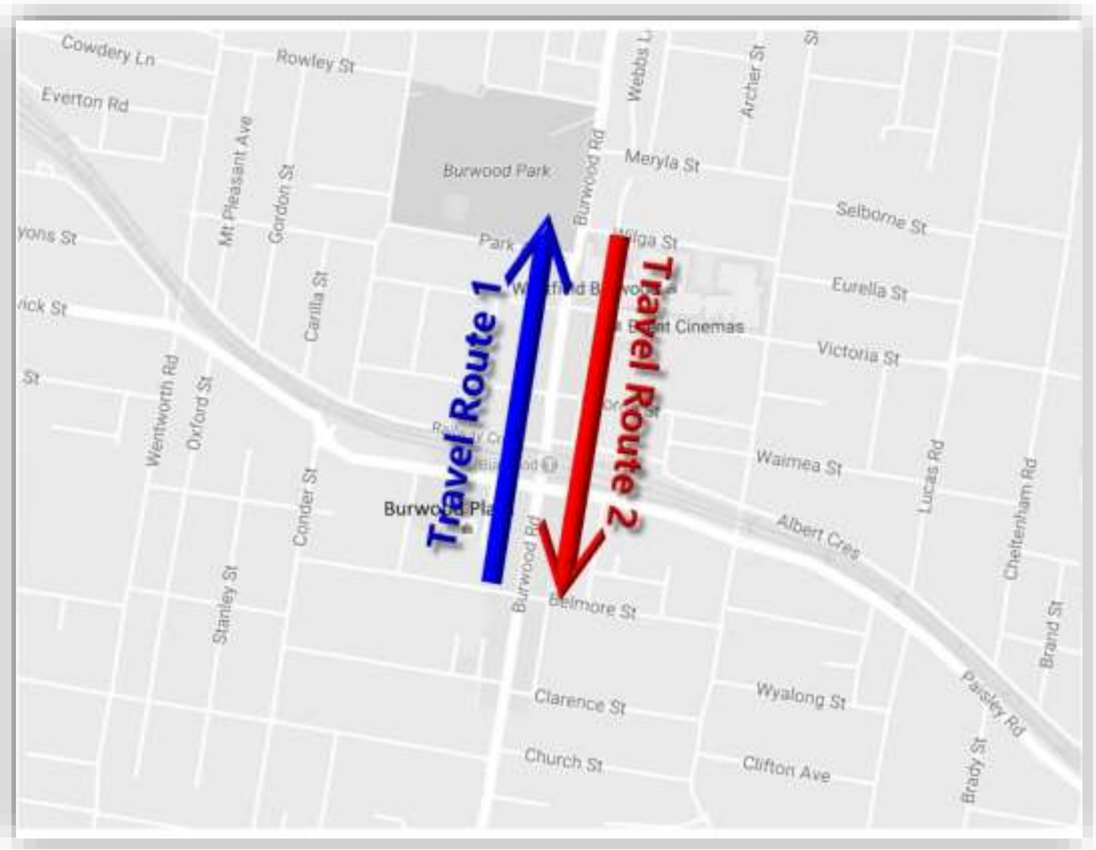

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Table 1 ***2016 Calibrated Travel Route 1***

Source *Road Delay Solutions, 2016*

ROUTE	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	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	-5.81%
RAILWAY CRESCENT	1.03	14.56	0.99	15.00	0.25	-5.81%
GEORGE STREET	1.07	17.94	1.08	17.74	0.32	-5.81%
VICTORIA STREET EAST	1.18	21.36	1.18	21.44	0.42	-5.81%
PARK AVENUE	1.71	17.89	1.62	19.00	0.51	-5.81%
WILGA STREET	1.78	18.88	1.68	20.03	0.56	-5.81%
TOTALS	1.78	17.08	1.68	17.62		-5.62%

ROUTE	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	0.76	11.84	0.71	12.50	0.15	-5.81%
RAILWAY CRESCENT	1.03	14.56	0.96	15.47	0.25	-5.81%
GEORGE STREET	1.07	17.94	1.05	18.25	0.32	-5.81%
VICTORIA STREET EAST	1.18	21.36	1.15	21.99	0.42	-5.81%
PARK AVENUE	1.71	17.89	1.59	19.36	0.51	-5.81%
WILGA STREET	1.78	18.88	1.65	20.39	0.56	-5.81%
TOTALS	1.78	17.08	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.

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Table 2 ***2016 Calibrated Travel Times Route 2***

Source *Road Delay Solutions, 2016*

ROUTE	AVG SURVEYED TIME (minutes)	AVG SURVEYED SPEED km/hr	MODEL 16AM28 TIME (minutes)	MODEL 16AM28 SPEED km/hr	Distance km	TIME Diff %
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	AVG SURVEYED TIME (minutes)	AVG SURVEYED SPEED km/hr	MODEL 16PM23 TIME (minutes)	MODEL 16PM23 SPEED km/hr	Distance km	TIME Diff %
Start Node = 10096 WILGA STREET						
PARK AVENUE	0.31	9.68	0.28	12.50	0.05	-5.81%
VICTORIA STREET EAST	0.39	21.54	0.4	15.00	0.14	-5.81%
GEORGE STREET	0.61	23.61	0.5	17.74	0.24	-5.81%
RAILWAY CRESCENT	0.85	21.88	0.7	21.44	0.31	-5.81%
RAILWAY PARADE	1.52	16.18	1.38	19.00	0.41	-5.81%
BELMORE STREET	1.87	17.97	1.74	20.03	0.56	-5.81%
TOTALS	1.87	18.48	1.74	17.62		-6.95%
ROUTE	AVG SURVEYED TIME (minutes)	AVG SURVEYED SPEED km/hr	MODEL 16WE17 TIME (minutes)	MODEL 16WE17 SPEED km/hr	Distance km	TIME Diff %
Start Node = 10096 WILGA STREET						
PARK AVENUE	0.27	11.11	0.28	10.00	0.05	-5.81%
VICTORIA STREET EAST	0.43	19.53	0.4	21.10	0.14	-5.81%
GEORGE STREET	0.62	23.23	0.5	29.14	0.24	-5.81%
RAILWAY CRESCENT	0.8	23.25	0.73	26.88	0.31	-5.81%
RAILWAY PARADE	1.48	16.62	1.41	17.90	0.41	-5.81%
BELMORE STREET	1.74	19.31	1.76	19.34	0.56	-5.81%
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.

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.

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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, 2016*

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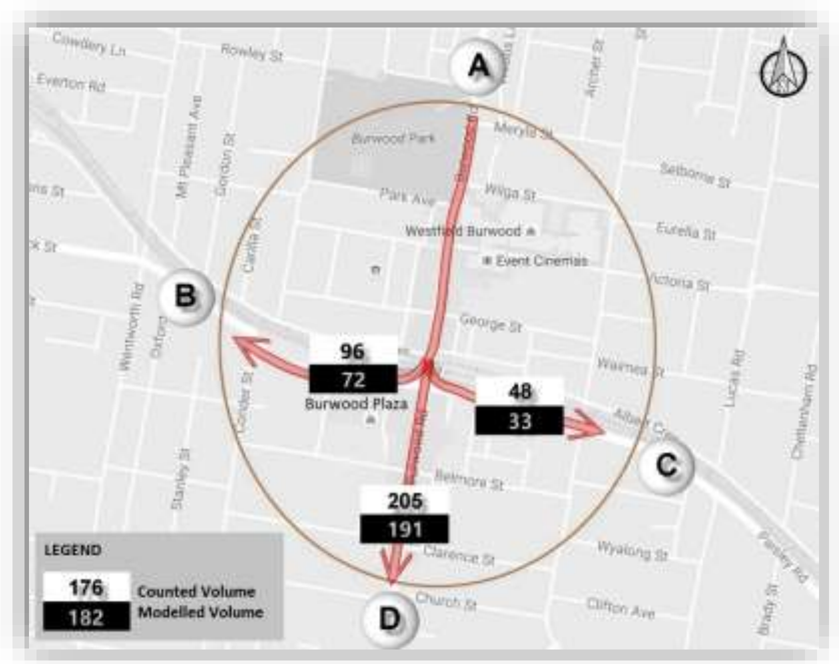
Figure 19 Northbound O/D Survey

Source Road Delay Solutions, July 2016

Figure 20 Southbound O/D Survey

Source Road Delay Solutions, July 2016



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3.5 Vehicle Growth to 2016

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, 2016

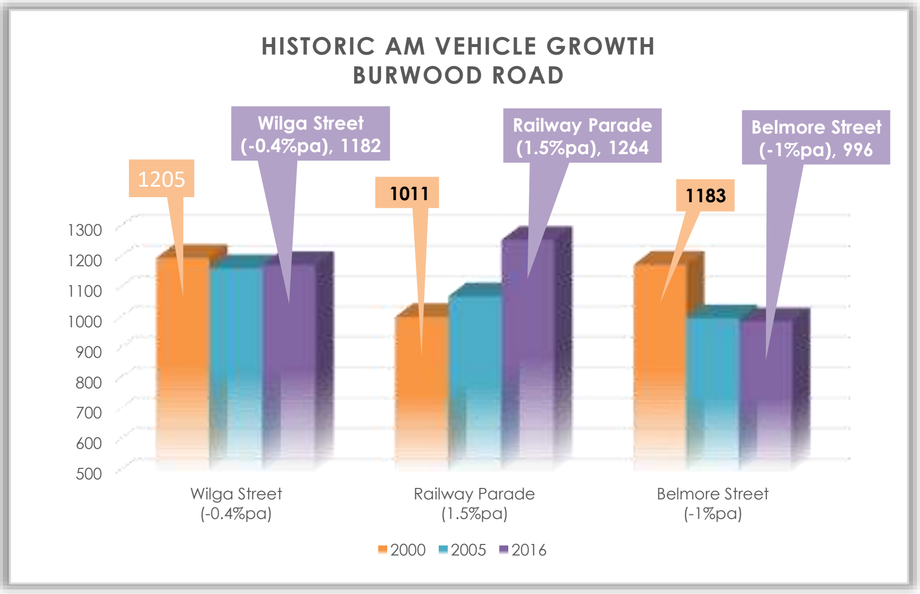
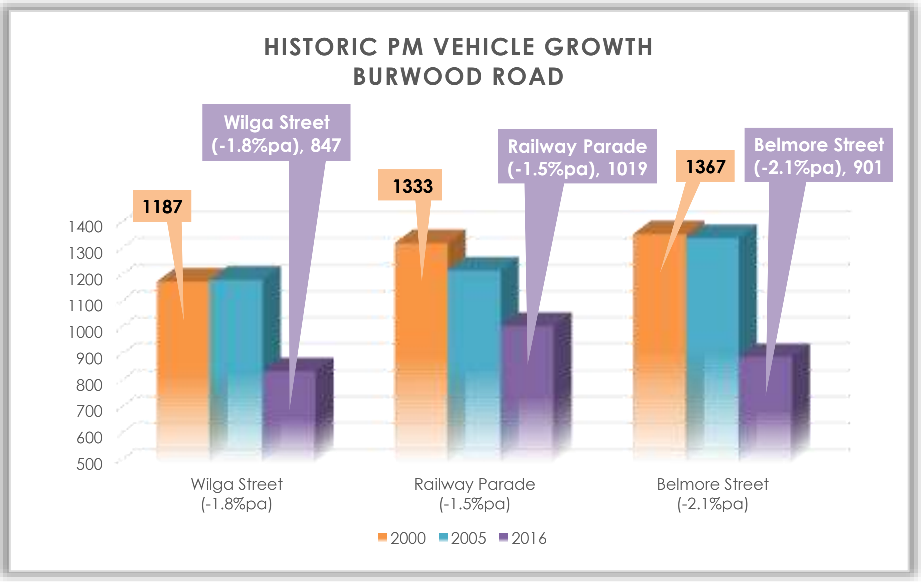


Figure 22 +PM Vehicle Growth

Source Road Delay Solutions, 2016



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All indicators suggest that there has been a negative vehicle growth within the town centre over the past 16 years between year 2000 and 2016.

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 170m between the Burwood Place 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. Therefore, the maximum walk distance to a station has been adopted as 800 metres within the model.

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

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

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 Burwood Place 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 plaza development. The full traffic generation of 1,605vph during the AM commuter peak and 1,515vph during the PM has been incorporated into the model trip matrices to provide a conservative '*worst case*' assessment.

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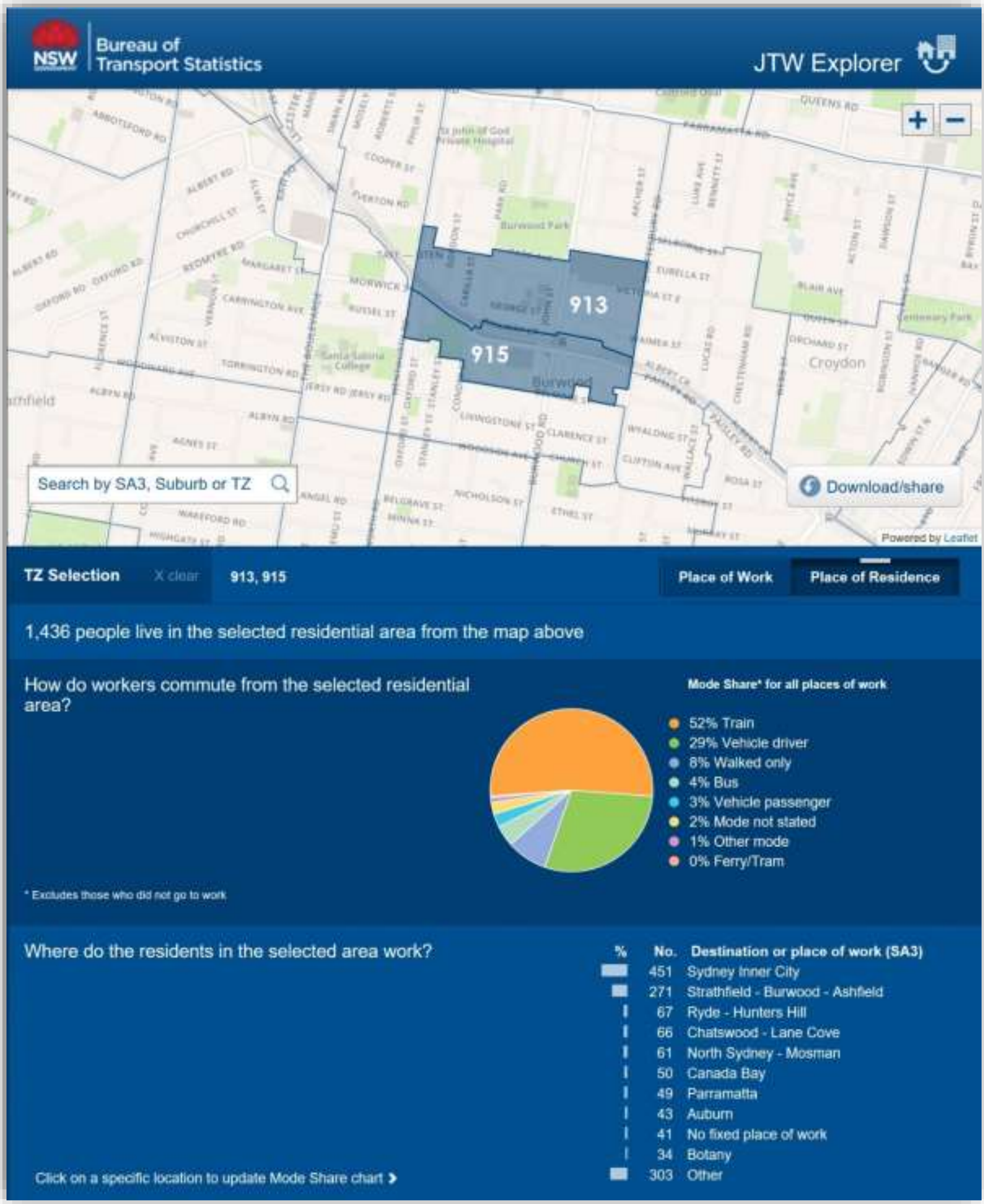
Figure 23 ***Burwood Town Centre JTW Mode Share***

Source *BTS JTW Exporer, 2016*



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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.

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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.

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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.*

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- **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%. hen 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.

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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.

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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.

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5 2016 MODEL CALIBRATION

5.1 General

This section provides a concise framework for the verification, validation and calibration of the base year 2016 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.

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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.*

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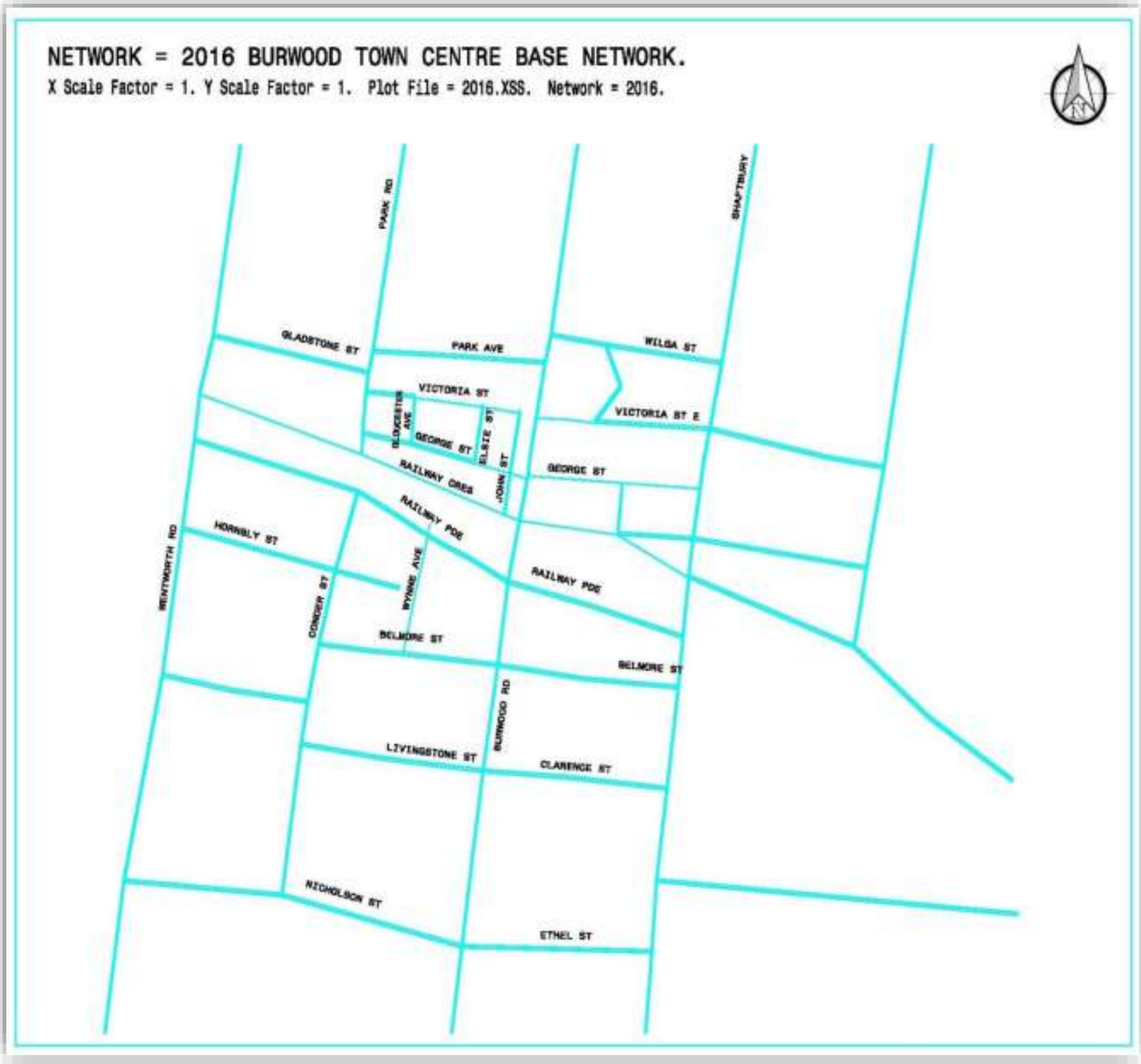
Figure 24 ***Mesoscopic Road Network Cordon***

Source *Road Delay Solutions, 2016*



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5.3 2016 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 base 2016 trip matrices were originally developed and published by the *TDC* in October 2012. 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 2016 trip matrices, conform with those published by *TDC* and have been further advanced through numerous calibration processes throughout the Sydney Metropolitan area.

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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*'.

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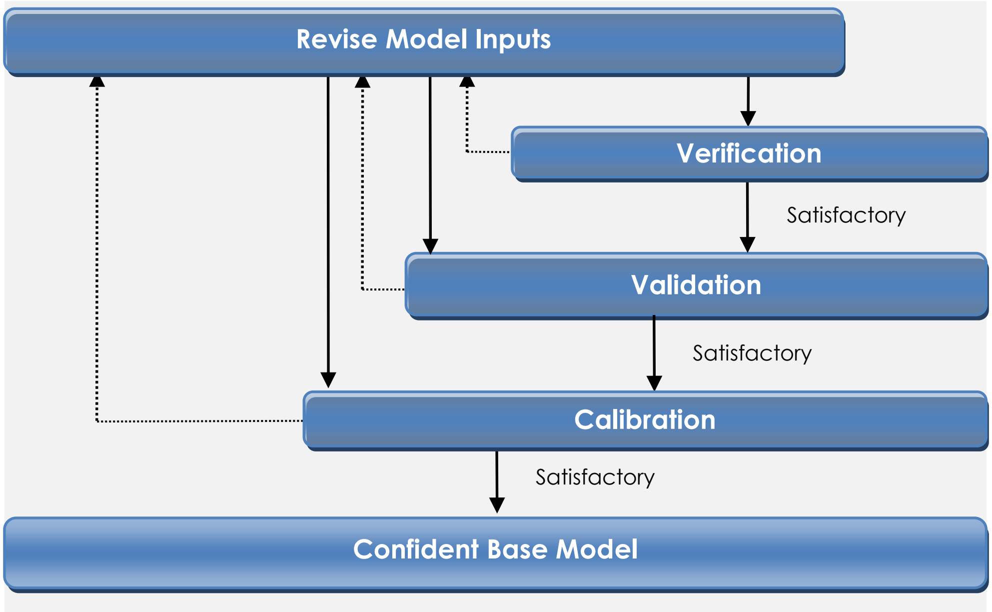
Figure 25 **_The Correctness Procedure_**

Source *Road Delay Solutions, 2016*



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.

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Figure 26 The GEH Statistic

Source Road Delay Solutions, 2016

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

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, 2016

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

A target 60% of the modelled volumes in the calibration summary should have 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.

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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 3 2016 GEH Calibrated Turn Results

Source Road Delay Solutions, 2016

Accuracy	AM Peak Turns		PM Peak Turns	WE Peak Turns
GEH >= 10	0%		0%	0%
GEH >= 5 <= 10	4%		6%	11%
GEH < 5	96%		94%	89%

An R-squared value, in excess of 0.987 was achieved for the AM, PM and WE modelled peak periods.

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.

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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.

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5.7 2016 AM Peak Calibration Synopsis

Calibration Summary for Model 16AM28

Network = 2016 Trip Table = 16AM28

2016 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	608	115	23	5
WILGA ST EB	10096	4020	365	374	9	2	0
WILGA ST WB	4020	10096	506	554	48	9	2
PARK AVE EB	8542	10097	449	479	30	7	1
PARK AVE WB	10097	8542	409	379	-30	-7	2
BURWOOD RD NB S PARK A	4800	10097	508	577	69	14	3
BURWOOD RD SB S PARK A	10097	4800	493	591	98	20	4
BURWOOD RD SB N GEORGE	4800	8541	420	534	114	27	5
GEORGE ST EB	8541	8540	63	100	37	59	4
GEORGE ST WB W BURWOOD	8541	8506	153	141	-12	-8	1
RAILWAY CRES WB	8544	1365	144	146	2	1	0
DEANE ST WB	8543	8544	133	164	31	23	3
BURWOOD RD NB N RAILWA	10094	8544	779	739	-40	-5	1
RAILWAY PDE EB W BURWO	8544	10094	573	474	-99	-17	4
RAILWAY PDE WB E BURWO	8522	10094	409	325	-84	-21	4
RAILWAY PDE EB E BURWO	10094	8522	434	432	-2	-0	0
BURWOOD RD NB S RAILWA	8539	10094	636	609	-27	-4	1
BURWOOD RD SB S RAILWA	10094	8539	368	340	-28	-8	1
BURWOOD CENTRAL NB	8533	848	7	6	-1	-14	0
BURWOOD CENTRAL SB	848	8533	9	21	12	133	3
RAILWAY PDE EB W WYNNE	8554	8533	573	479	-94	-16	4
RAILWAY PDE WB W WYNNW	8533	8554	452	488	36	8	2
RAILWAY PDE EB W CONDE	1361	8554	564	660	96	17	4
RAILWAY PDE WB W CONDE	8554	1361	592	546	-46	-8	2
CONDER ST NB	8557	8525	437	413	-24	-5	1
CONDER ST SB	8554	8525	218	226	8	4	1
BELMORE ST EB W BURWOO	8523	8539	164	204	40	24	3
BELMORE ST WB W BURWOO	8539	8523	196	246	50	26	3
BELMORE ST WB E BURWOO	8228	8539	162	218	56	35	4
BELMORE ST EB E BURWOO	8539	8228	211	177	-34	-16	2
WYNNE AVE NB N BELMORE	8555	8524	200	184	-16	-8	1
WYNNE AVE SB N BELMORE	8533	8524	84	136	52	62	5
CONDER ST NB S BELMORE	8559	8557	484	462	-22	-5	1
CONDER ST SB N BELMORE	8525	8557	199	177	-22	-11	2
BELMORE ST WB E CONDER	8555	8557	142	138	-4	-3	0

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BELMORE ST EB E CONDER	8557	8555	236	174	-62	-26	4

Summary of GEH Calibration Validation

	Counts	%
GEH <= 5 Target = > 60%	36	100
GEH <= 7 Target = > 80%	36	100
GEH <= 10 Target = > 95%	36	100
GEH <= 12 Target = 100%	36	100
GEH > 12 Target = 0%	0	0
Total Counts	36	

Mean, Mean Absolute Difference (MAD) & +/- 10% MAD Analysis - Model 16AM28

Date = 08-30-2016. Time = 13:57:31

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	-4.63	13.68	3.68	28
0501 to 1000	1.97	10.97	0.97	8
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	-2.09	12.64	2.64	36
Total of Counts 0501 to Maximum Range	1.97	10.97	0.97	8

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5.8 2016 PM Peak Calibration Synopsis

Calibration Summary for Model 16PM23

Network = 2016 Trip Table = 16PM23

2016 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	478	39	9	2
WILGA ST EB	10096	4020	480	544	64	13	3
WILGA ST WB	4020	10096	565	544	-21	-4	1
PARK AVE EB	8542	10097	499	518	19	4	1
PARK AVE WB	10097	8542	365	444	79	22	4
BURWOOD RD NB S PARK A	4800	10097	415	465	50	12	2
BURWOOD RD SB S PARK A	10097	4800	485	496	11	2	0
BURWOOD RD SB N GEORGE	4800	8541	475	414	-61	-13	3
GEORGE ST EB	8541	8540	42	62	20	48	3
GEORGE ST WB W BURWOOD	8541	8506	78	81	3	4	0
RAILWAY CRES WB	8544	1365	41	56	15	37	2
DEANE ST WB	8543	8544	110	120	10	9	1
BURWOOD RD NB N RAILWA	10094	8544	532	534	2	0	0
RAILWAY PDE EB W BURWO	8544	10094	474	403	-71	-15	3
RAILWAY PDE WB E BURWO	8522	10094	417	407	-10	-2	0
RAILWAY PDE EB E BURWO	10094	8522	374	405	31	8	2
BURWOOD RD NB S RAILWA	8539	10094	479	407	-72	-15	3
BURWOOD RD SB S RAILWA	10094	8539	325	290	-35	-11	2
BURWOOD CENTRAL NB	8533	848	16	20	4	25	1
BURWOOD CENTRAL SB	848	8533	18	22	4	22	1
RAILWAY PDE EB W WYNNE	8554	8533	523	495	-28	-5	1
RAILWAY PDE WB W WYNNE	8533	8554	624	662	38	6	1
RAILWAY PDE EB W CONDE	1361	8554	586	571	-15	-3	1
RAILWAY PDE WB W CONDE	8554	1361	607	646	39	6	2
CONDER ST NB	8557	8525	301	232	-69	-23	4
CONDER ST SB	8525	8557	255	297	42	16	3
BELMORE ST EB W BURWOO	8523	8539	327	370	43	13	2
BELMORE ST WB W BURWOO	8539	8523	178	250	72	40	5
BELMORE ST WB E BURWOO	8228	8539	265	331	66	25	4
BELMORE ST EB E BURWOO	8539	8228	210	213	3	1	0
WYNNE AVE NB N BELMORE	8555	8524	192	160	-32	-17	2
WYNNE AVE SB N BELMORE	8524	8555	107	119	12	11	1
CONDER ST NB S BELMORE	8559	8557	218	206	-12	-6	1
CONDER ST SB N BELMORE	8525	8557	218	297	79	36	5
BELMORE ST WB E CONDER	8555	8557	246	246	0	0	0

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BELMORE ST EB E CONDER	8557	8555	164	166	2	1	0
BELMORE ST EB W WYNNE	8557	8555	156	166	10	6	1

Summary of GEH Calibration Validation

	Counts	%
GEH <= 5 Target = > 60%	37	100
GEH <= 7 Target = > 80%	37	100
GEH <= 10 Target = > 95%	37	100
GEH <= 12 Target = 100%	37	100
GEH > 12 Target = 0%	0	0
Total Counts	37	

Mean, Mean Absolute Difference (MAD) & +/- 10% MAD Analysis - Model 16PM23

Date = 08-29-2016. Time = 00:03:36

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	-3.78	12.43	2.43	31
0501 to 1000	-0.44	4.16	0.00	6
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	-2.80	10.02	0.02	37
Total of Counts 0501 to Maximum Range	-0.44	4.16	0.00	6

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5.9 2016 WE Peak Calibration Synopsis

Calibration Summary for Model 16AMWE17
Network = 2016 Trip Table = 16AMWE17
2016 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	472	75	19	4
WILGA ST EB	10096	4020	577	568	-9	-2	0
WILGA ST WB	4020	10096	601	545	-56	-9	2
PARK AVE EB	8542	10097	504	573	69	14	3
PARK AVE WB	10097	8542	339	330	-9	-3	0
BURWOOD RD NB S PARK A	4800	10097	364	442	78	21	4
BURWOOD RD SB S PARK A	10097	4800	565	618	53	9	2
BURWOOD RD SB N GEORGE	4800	8541	412	455	43	10	2
GEORGE ST EB	8541	8540	68	107	39	57	4
GEORGE ST WB W BURWOOD	8541	8506	83	93	10	12	1
RAILWAY CRES WB	8544	1365	57	79	22	39	3
DEANE ST WB	8543	8544	82	121	39	48	4
BURWOOD RD NB N RAILWA	10094	8544	534	570	36	7	2
RAILWAY PDE EB W BURWO	8544	10094	416	426	10	2	0
RAILWAY PDE WB E BURWO	8522	10094	424	447	23	5	1
RAILWAY PDE EB E BURWO	10094	8522	322	428	106	33	5
BURWOOD RD NB S RAILWA	8539	10094	492	475	-17	-3	1
BURWOOD RD SB S RAILWA	10094	8539	361	314	-47	-13	3
BURWOOD CENTRAL NB	8533	848	15	16	1	7	0
BURWOOD CENTRAL SB	848	8533	9	22	13	144	3
RAILWAY PDE EB W WYNNE	8554	8533	522	542	20	4	1
RAILWAY PDE WB W WYNNE	8533	8554	475	512	37	8	2
RAILWAY PDE EB W CONDE	1361	8554	563	658	95	17	4
RAILWAY PDE WB W CONDE	8554	1361	573	489	-84	-15	4
CONDER ST NB	8557	8525	317	260	-57	-18	3
CONDER ST SB	8554	8525	224	193	-31	-14	2
BELMORE ST EB E WYNNE	8555	8523	164	202	38	23	3
BELMORE ST WB W BURWOO	8539	8523	172	255	83	48	6
BELMORE ST WB E BURWOO	8228	8539	162	234	72	44	5
BELMORE ST EB E BURWOO	8539	8228	211	186	-25	-12	2
WYNNE AVE NB N BELMORE	8555	8524	232	163	-69	-30	5
WYNNE AVE SB N BELMORE	8524	8555	84	71	-13	-15	1
CONDER ST NB S BELMORE	8559	8557	220	288	68	31	4
CONDER ST SB N BELMORE	8525	8557	278	230	-48	-17	3
BELMORE ST WB E CONDER	8555	8557	268	209	-59	-22	4

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BELMORE ST EB E CONDER	8557	8555	236	248	12	5	1

Summary of GEH Calibration Validation

	Counts	%
GEH <= 5 Target = > 60%	35	97
GEH <= 7 Target = > 80%	36	100
GEH <= 10 Target = > 95%	36	100
GEH <= 12 Target = 100%	36	100
GEH > 12 Target = 0%	0	0
Total Counts	36	

Mean, Mean Absolute Difference (MAD) & +/- 10% MAD Analysis - Model 16AMWE17

Date = 08-30-2016. Time = 01:10:47

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	MAD	Counts
		ABS	+-10%	
	%	%	%	
0001 to 0500	-5.72	16.62	6.62	28
0501 to 1000	-2.79	9.51	0.00	8
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	-4.57	13.83	3.83	36
Total of Counts 0501 to Maximum Range	-2.79	9.51	0.00	8

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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.

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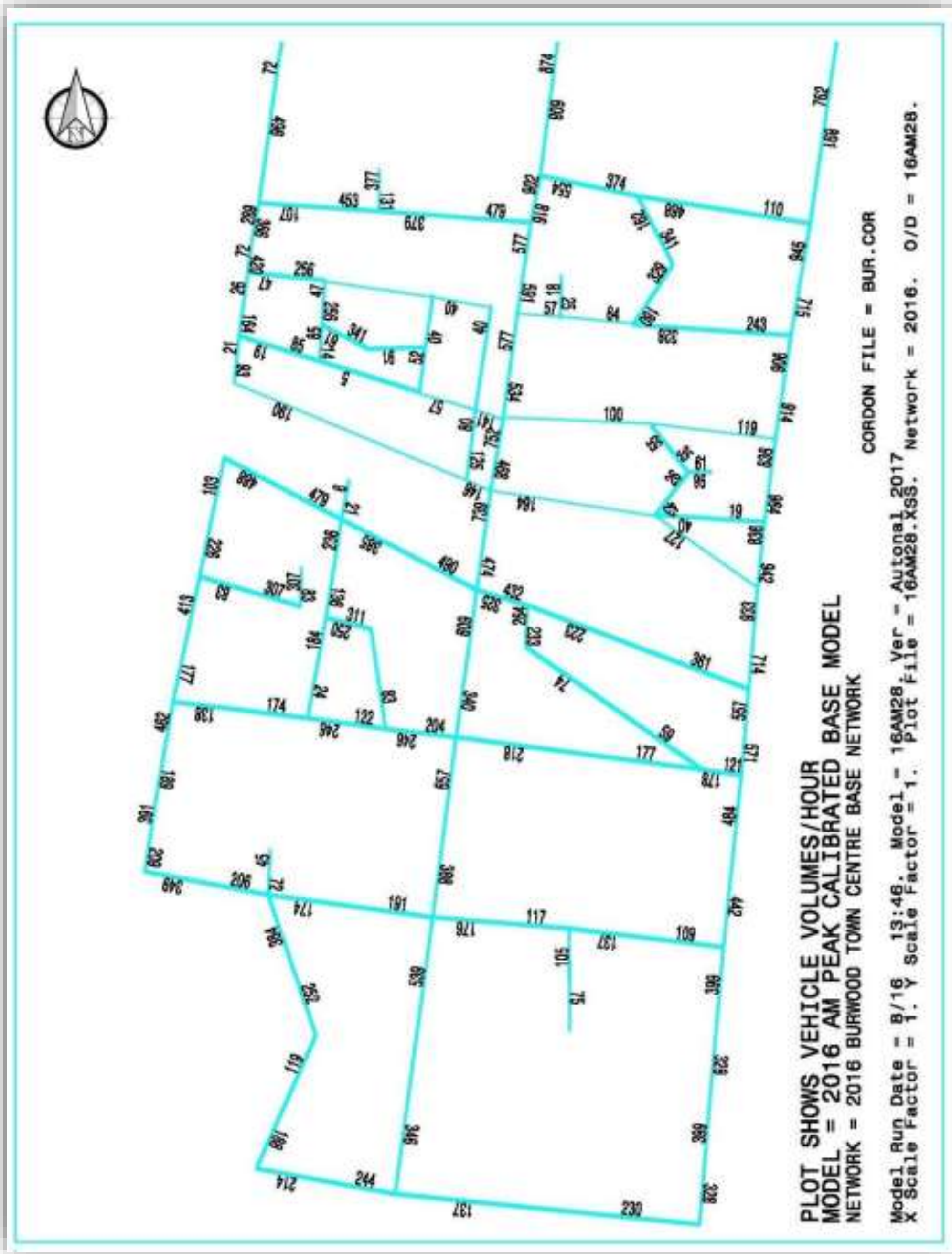
Figure 28 ***2016 AM Calibrated Base Model***

Source *Road Delay Solutions, 2016*



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igure 29 2016 PM Calibrated Base Model

Source Road Delay Solutions, 2016

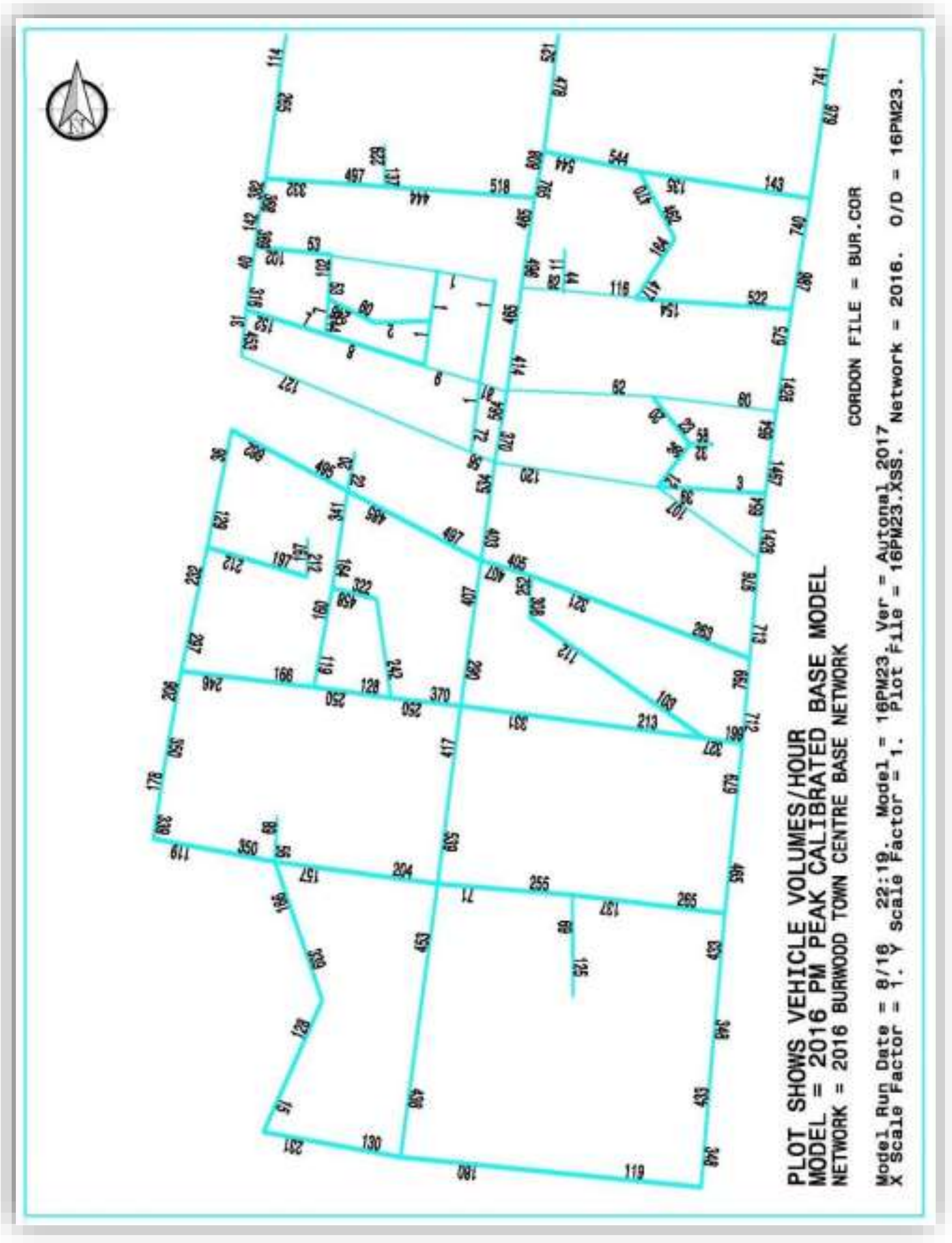

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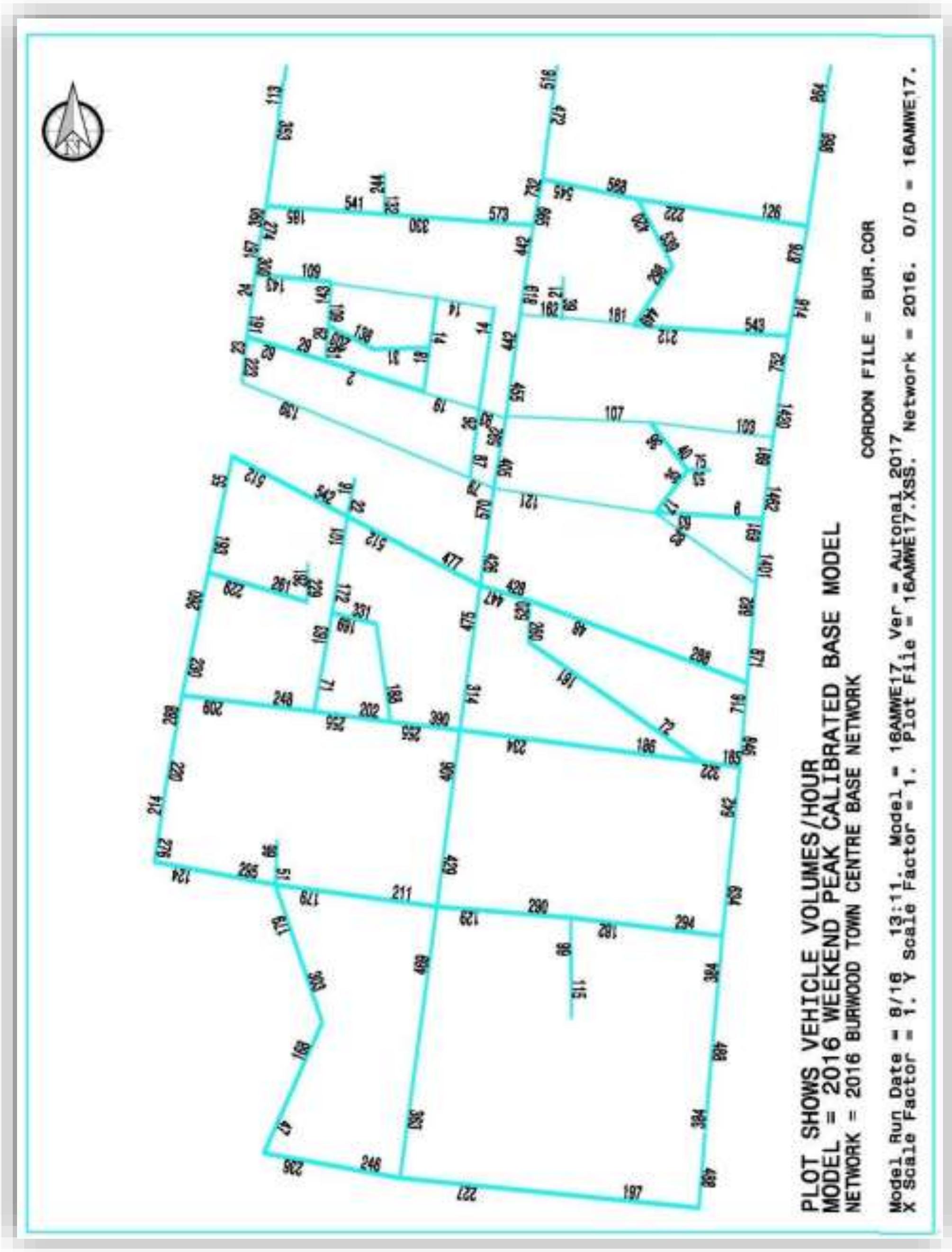
Figure 30 2016 WE Calibrated Base Model

Source Road Delay Solutions, 2016



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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.

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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*'.

Figure 31 ***2016 SIDRA 7 Modelled Road Network***

Source *Sidra/Road Delay Solutions, 2016*

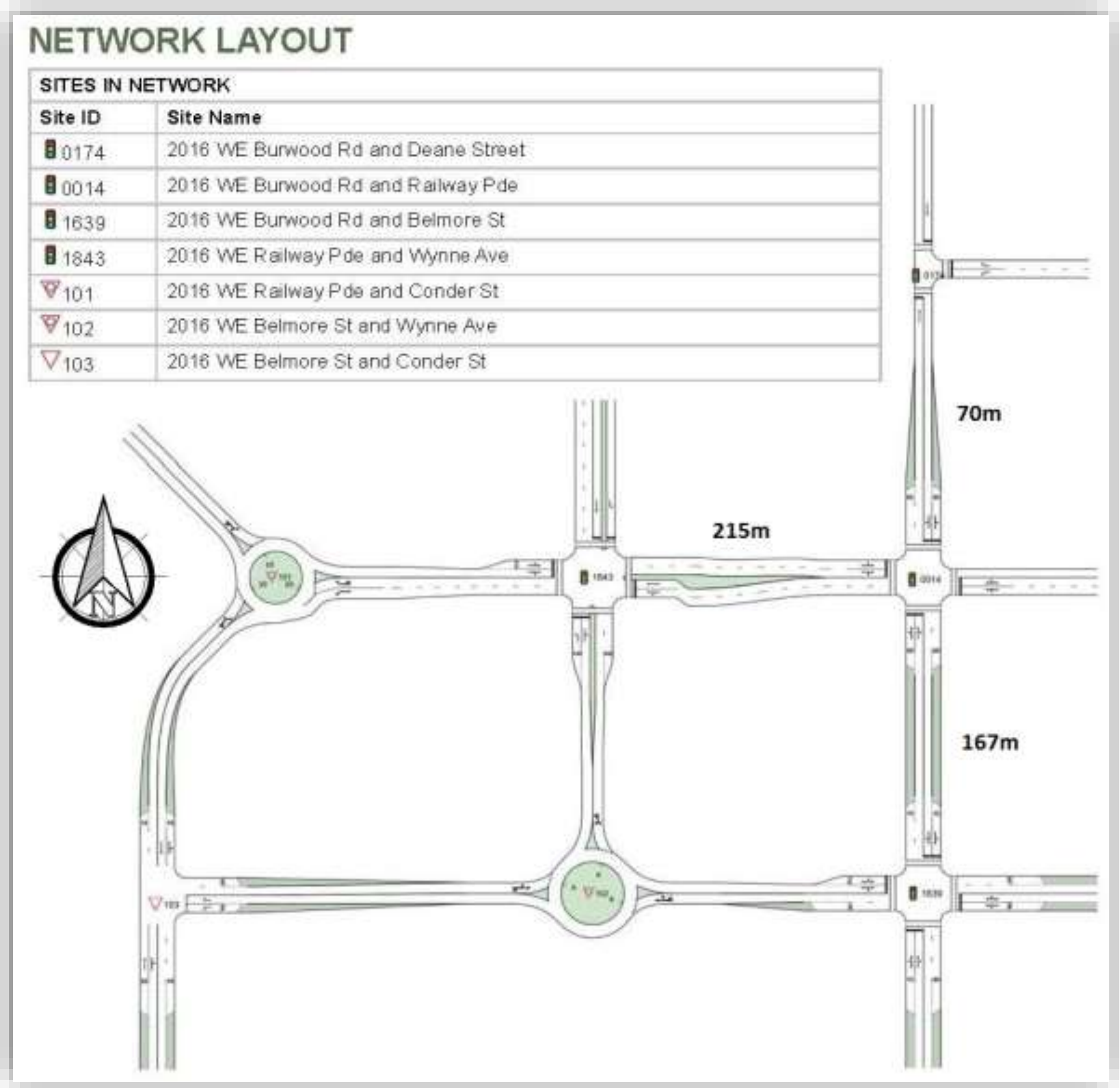

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Figure 32 ***2016 AM Network Summary***

Source *Road Delay Solutions, 2016*

NETWORK SUMMARY

Network: N101 [2016 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 D			
Travel Time Index	4.62			
Speed Efficiency	0.52			
Congestion Coefficient	1.94			
Travel Speed (Average)	31.0 km/h		2.2 km/h	17.6 km/h
Travel Distance (Total)	4817.4 veh-km/h		408.1 ped-km/h	7623.3 pers-km/h
Travel Time (Total)	155.6 veh-h/h		183.5 ped-h/h	433.8 pers-h/h
Desired Speed	60.0 km/h			
Demand Flows (Total)	9894 veh/h		12335 ped/h	17506 pers/h
Arrival Flows (Total)	9894 veh/h		12335 ped/h	17506 pers/h
Percent Heavy Vehicles (Demand)	6.6 %			
Percent Heavy Vehicles (Arrival)	6.6 %			
Degree of Saturation	0.862			
Control Delay (Total)	50.74 veh-h/h		96.29 ped-h/h	184.50 pers-h/h
Control Delay (Average)	18.5 sec		28.1 sec	37.9 sec
Control Delay (Worst Lane)	49.1 sec			
Control Delay (Worst Movement)	52.8 sec		44.8 sec	52.8 sec
Geometric Delay (Average)	2.0 sec			
Stop-Line Delay (Average)	16.4 sec			
Queue Storage Ratio (Worst Lane)	0.65			
Total Effective Stops	6268 veh/h		9118 ped/h	19907 pers/h
Effective Stop Rate	0.63 per veh	1.3 per km	0.74 per ped	1.14 per pers
Proportion Queued	0.61		0.74	1.12
Performance Index	620.4		234.2	854.6
Cost (Total)	7074.21 $/h	1.47 $/km	4624.15 $/h	11698.36 $/h
Fuel Consumption (Total)	563.8 L/h	117.0 mL/km		
Fuel Economy	11.7 L/100km			
Carbon Dioxide (Total)	1338.0 kg/h	277.7 g/km		
Hydrocarbons (Total)	0.129 kg/h	0.027 g/km		
Carbon Monoxide (Total)	1.155 kg/h	0.240 g/km		
NOx (Total)	2.464 kg/h	0.511 g/km		

Network Model Accuracy Level (largest change in degree of saturation for any lane): 0.8 %
Number of Iterations: 10
Network Level of Service (LOS) Method: SIDRA Speed Efficiency.
Setup used: New South Wales.

Network Performance - Annual Values

Performance Measure	Vehicles	Pedestrians	Persons
Demand Flows (Total)	4,748,969 veh/y	5,920,674 ped/y	8,402,766 pers/y
Delay	24,356 veh-h/y	46,220 ped-h/y	88,561 pers-h/y
Effective Stops	3,008,724 veh/y	4,376,545 ped/y	9,555,232 pers/y
Travel Distance	2,312,372 veh-km/y	195,899 ped-km/y	3,659,186 pers-km/y
Travel Time	74,673 veh-h/y	88,079 ped-h/y	208,211 pers-h/y
Cost	3,395,620 $/y	2,219,593 $/y	5,615,213 $/y
Fuel Consumption	270,636 L/y		
Carbon Dioxide	642,228 kg/y		
Hydrocarbons	62 kg/y		
Carbon Monoxide	554 kg/y		
NOx	1,183 kg/y		

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Figure 33 ***2016 AM 95th % Queue Ratios***

Source *Road Delay Solutions, 2016*

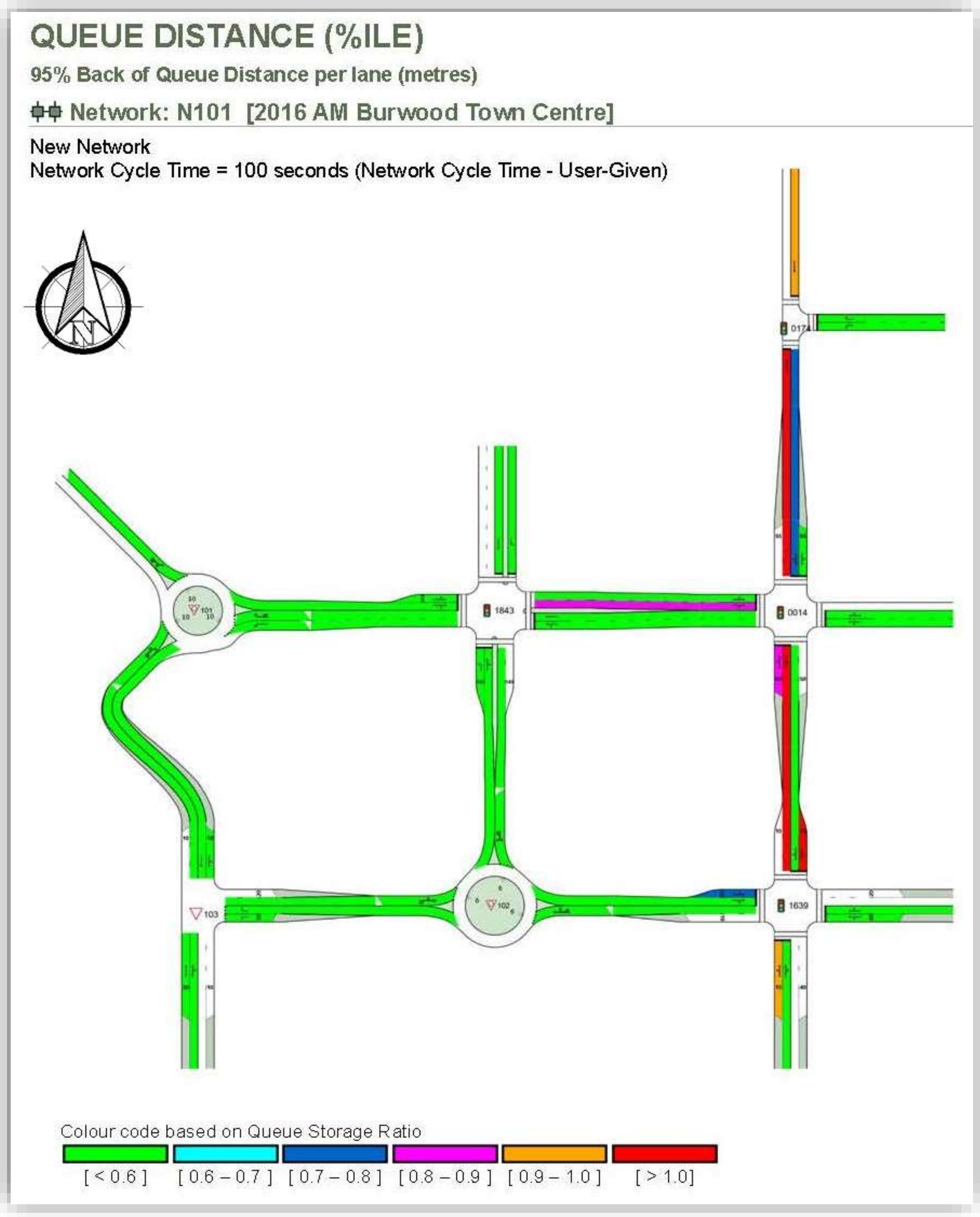

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Figure 34 2016 PM Network Summary

Source Road Delay Solutions, 2016

NETWORK SUMMARY

Network: N101 [2016 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 D			
Travel Time Index	4.85			
Speed Efficiency	0.54			
Congestion Coefficient	1.86			
Travel Speed (Average)	32.2 km/h		2.2 km/h	16.5 km/h
Travel Distance (Total)	4252.1 veh-km/h		418.8 ped-km/h	6590.4 pers-km/h
Travel Time (Total)	132.1 veh-h/h		190.0 ped-h/h	399.2 pers-h/h
Desired Speed	60.0 km/h			
Demand Flows (Total)	8612 veh/h		12636 ped/h	15062 pers/h
Arrival Flows (Total)	8609 veh/h		12636 ped/h	15062 pers/h
Percent Heavy Vehicles (Demand)	5.2 %			
Percent Heavy Vehicles (Arrival)	5.2 %			
Degree of Saturation	1.003			
Control Delay (Total)	41.60 veh-h/h		100.51 ped-h/h	174.75 pers-h/h
Control Delay (Average)	17.4 sec		28.6 sec	41.8 sec
Control Delay (Worst Lane)	94.4 sec			
Control Delay (Worst Movement)	96.6 sec		44.8 sec	96.6 sec
Geometric Delay (Average)	2.3 sec			
Stop-Line Delay (Average)	15.1 sec			
Queue Storage Ratio (Worst Lane)	1.00			
Total Effective Stops	5237 veh/h		9323 ped/h	18594 pers/h
Effective Stop Rate	0.61 per veh	1.2 per km	0.74 per ped	1.23 per pers
Proportion Queued	0.55		0.74	1.20
Performance Index	482.7		241.8	724.5
Cost (Total)	5899.28 $/h	1.39 $/km	4788.10 $/h	10687.38 $/h
Fuel Consumption (Total)	470.4 L/h	110.6 mL/km		
Fuel Economy	11.1 L/100km			
Carbon Dioxide (Total)	1113.3 kg/h	261.8 g/km		
Hydrocarbons (Total)	0.106 kg/h	0.025 g/km		
Carbon Monoxide (Total)	0.972 kg/h	0.229 g/km		
NOx (Total)	1.627 kg/h	0.383 g/km		

Network Model Accuracy Level (largest change in degree of saturation for any lane): 1.9 %
Number of Iterations: 10
Network Level of Service (LOS) Method: SIDRA Speed Efficiency.
Setup used: New South Wales.

Network Performance - Annual Values			
Performance Measure	**Vehicles**	**Pedestrians**	**Persons**
Demand Flows (Total)	4,133,558 veh/y	6,065,179 ped/y	7,229,986 pers/y
Delay	19,967 veh-h/y	48,246 ped-h/y	83,879 pers-h/y
Effective Stops	2,513,985 veh/y	4,475,192 ped/y	8,925,339 pers/y
Travel Distance	2,041,004 veh-km/y	201,033 ped-km/y	3,163,408 pers-km/y
Travel Time	63,409 veh-h/y	91,202 ped-h/y	191,638 pers-h/y
Cost	2,831,653 $/y	2,298,288 $/y	5,129,941 $/y
Fuel Consumption	225,771 L/y		
Carbon Dioxide	534,370 kg/y		
Hydrocarbons	51 kg/y		
Carbon Monoxide	467 kg/y		
NOx	781 kg/y		

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Figure 35 ***2016 PM 95th % Queue Ratios***

Source *Road Delay Solutions, 2016*

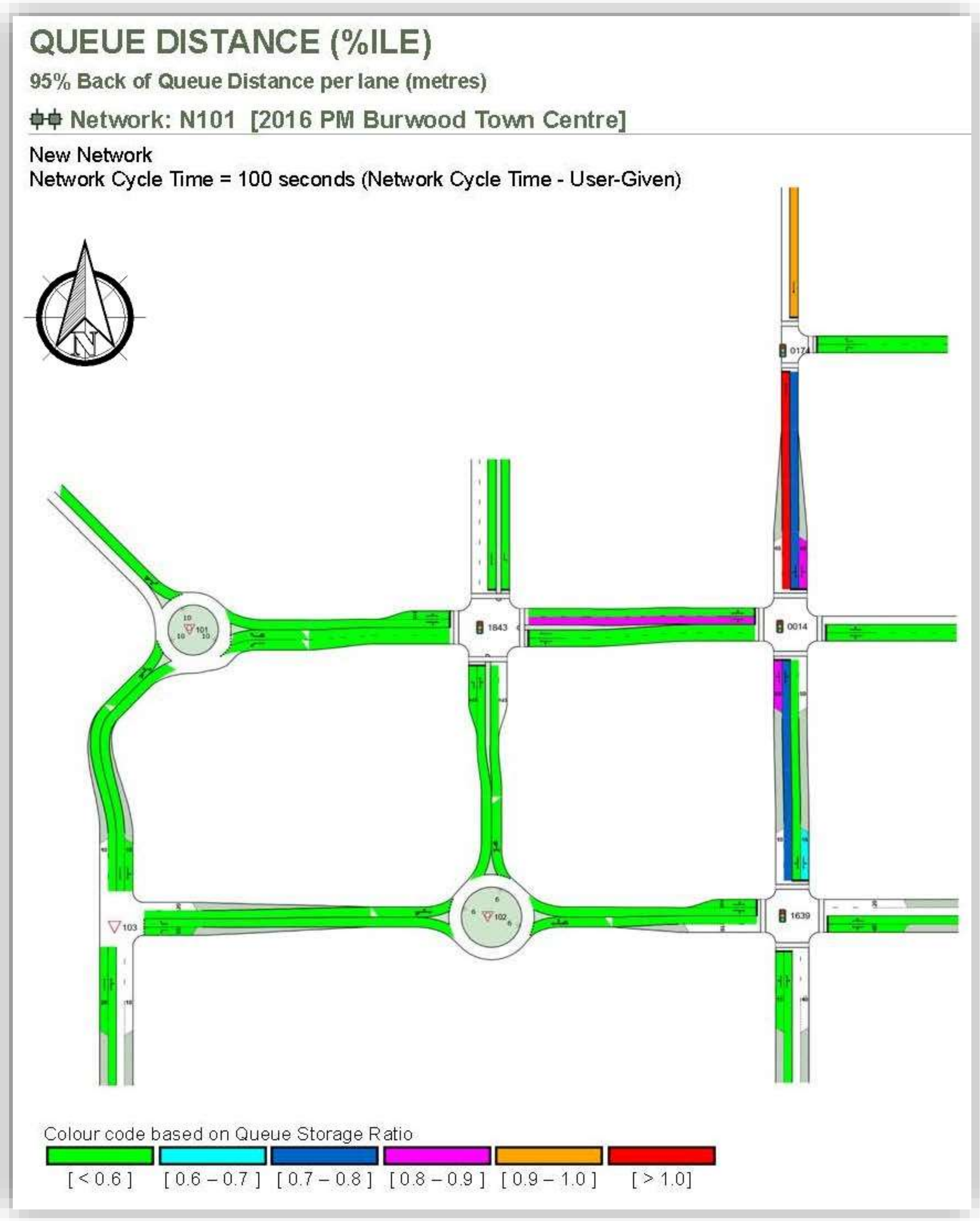

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Figure 36 ***2016 WE Network Summary***

Source *Road Delay Solutions, 2016*

NETWORK SUMMARY

Network: N101 [2016 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 D			
Travel Time Index	5.18			
Speed Efficiency	0.57			
Congestion Coefficient	1.77			
Travel Speed (Average)	34.0 km/h		2.2 km/h	17.4 km/h
Travel Distance (Total)	4054.0 veh-km/h		394.7 ped-km/h	6577.9 pers-km/h
Travel Time (Total)	119.3 veh-h/h		182.1 ped-h/h	377.1 pers-h/h
Desired Speed	60.0 km/h			
Demand Flows (Total)	8348 veh/h		11893 ped/h	16118 pers/h
Arrival Flows (Total)	8348 veh/h		11893 ped/h	16118 pers/h
Percent Heavy Vehicles (Demand)	5.6 %			
Percent Heavy Vehicles (Arrival)	5.6 %			
Degree of Saturation	0.708			
Control Delay (Total)	33.40 veh-h/h		97.80 ped-h/h	156.32 pers-h/h
Control Delay (Average)	14.4 sec		29.6 sec	34.9 sec
Control Delay (Worst Lane)	42.6 sec			
Control Delay (Worst Movement)	42.6 sec		44.8 sec	44.8 sec
Geometric Delay (Average)	2.2 sec			
Stop-Line Delay (Average)	12.2 sec			
Queue Storage Ratio (Worst Lane)	0.55			
Total Effective Stops	4724 veh/h		9053 ped/h	17453 pers/h
Effective Stop Rate	0.57 per veh	1.2 per km	0.76 per ped	1.08 per pers
Proportion Queued	0.54		0.76	1.07
Performance Index	455.4		232.4	687.8
Cost (Total)	5410.80 $/h	1.33 $/km	4589.87 $/h	10000.67 $/h
Fuel Consumption (Total)	441.2 L/h	108.8 mL/km		
Fuel Economy	10.9 L/100km			
Carbon Dioxide (Total)	1044.6 kg/h	257.7 g/km		
Hydrocarbons (Total)	0.099 kg/h	0.024 g/km		
Carbon Monoxide (Total)	0.922 kg/h	0.227 g/km		
NOx (Total)	1.548 kg/h	0.382 g/km		

Network Model Accuracy Level (largest change in degree of saturation for any lane): 0.9 %
Number of Iterations: 9
Network Level of Service (LOS) Method: SIDRA Speed Efficiency.
Setup used: New South Wales.

Network Performance - Annual Values			
Performance Measure	**Vehicles**	**Pedestrians**	**Persons**
Demand Flows (Total)	4,007,242 veh/y	5,708,464 ped/y	7,736,585 pers/y
Delay	16,034 veh-h/y	46,945 ped-h/y	75,032 pers-h/y
Effective Stops	2,267,402 veh/y	4,345,411 ped/y	8,377,411 pers/y
Travel Distance	1,945,930 veh-km/y	189,452 ped-km/y	3,157,382 pers-km/y
Travel Time	57,287 veh-h/y	87,426 ped-h/y	181,028 pers-h/y
Cost	2,597,184 $/y	2,203,138 $/y	4,800,323 $/y
Fuel Consumption	211,787 L/y		
Carbon Dioxide	501,431 kg/y		
Hydrocarbons	48 kg/y		
Carbon Monoxide	443 kg/y		
NOx	743 kg/y		

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Figure 37 ***2016 WE 95th % Queue Ratios***

Source *Road Delay Solutions, 2016*

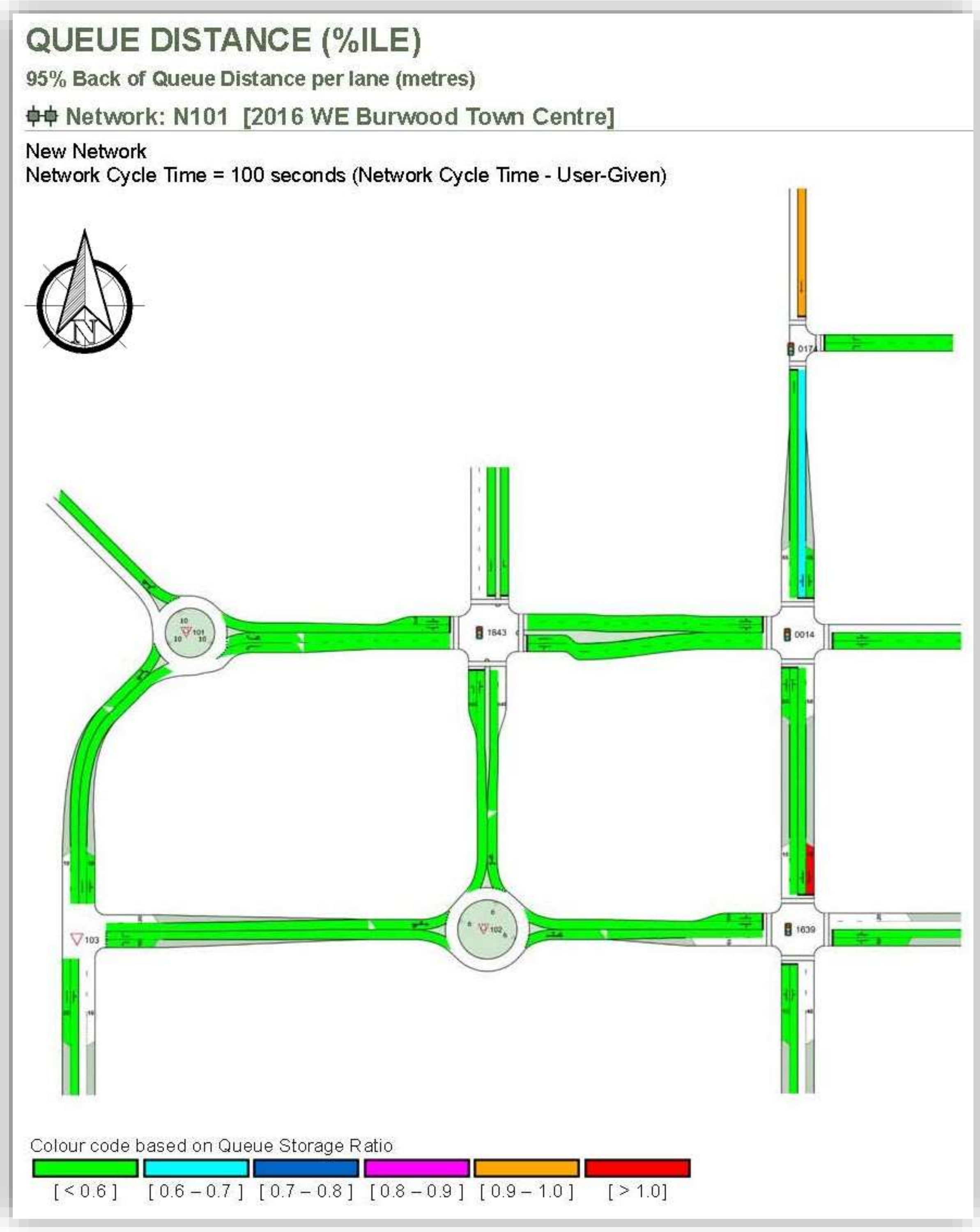

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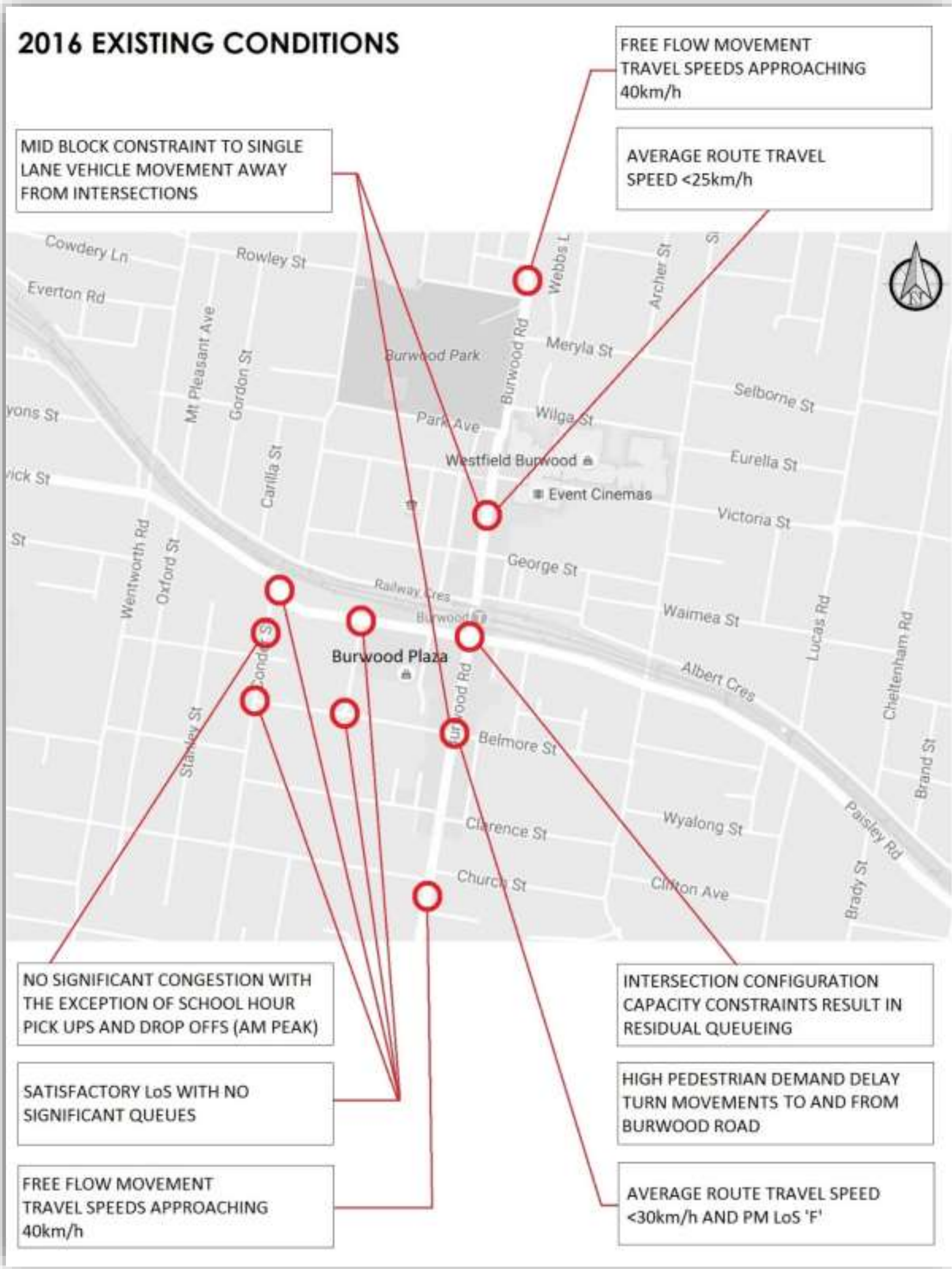
Figure 38 ***2016 Existing Conditions***

Source *Road Delay Solutions, 2016*



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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 Burwood Place 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.*

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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

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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.*

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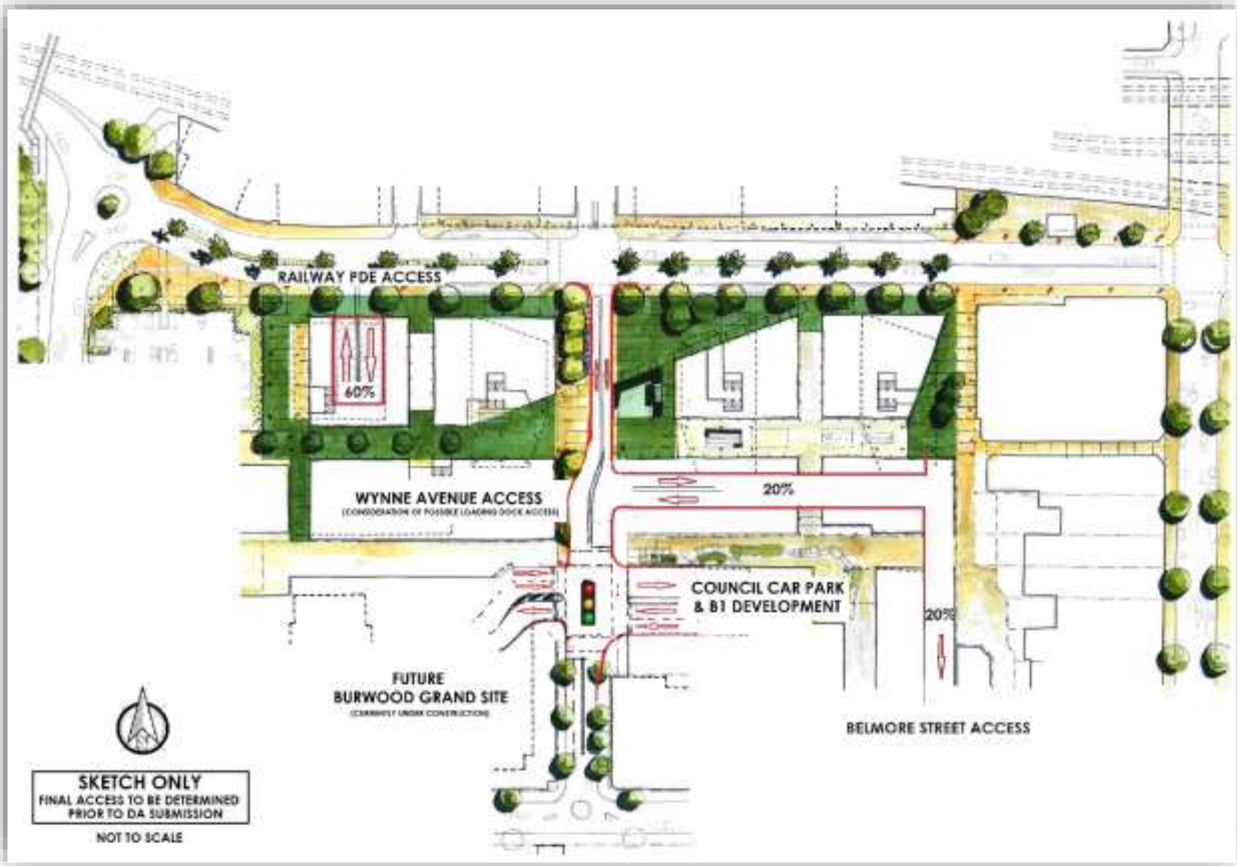
6.6 The Development Footprint

The planning proposal is to provide for…

- → *1,044 residential apartments,*
- → *28,477m² retail GFA (19,400m² GLFA) inclusive of supermarket GFA 4,200m² (2,900m² GLFA), and*
- → *15,092m² (12,075m² GLFA) of commercial floor space.*

Figure 39 ***The Development Footprint***

Source *Architectus/COX, 2016*



The development proposes a reduction in the carriageway width to one (1) lane in each direction on a section of Wynne Parade, immediately south of Railway Parade for a distance of some 81m, to permit the introduction of a cosmopolitan thouroughfare (*widened footway areas*) and reinforced pedestrian mobility and continuity at the podium level within the site.

It is considered the proposed partial closure of Wynne Avenue will provide improved pedestrian amenity and function in a manner condusive with the anticipated pedestrian activity within the town centre.

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The closure will permit the travel of vehicles both northbound and southbound while providing accessibility to the proposed entry/exit driveway on Wynne Avenue.

6.7 Development Access

Vehicular access to the site is currently under consideration from three (3) locations…

- → *Railway Parade servicing some 60% of development,*
- → *Wynne Avenue servicing some 20% of development, and*
- → *Belmore Street servicing some 20% of development.*

Access for resident, tenant and and publicly accessible visitor and retail spaces will be separated and clearly defined within the development by the use of underground car parking. Internal ramps will connect the parking levels.

The approximate 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 model.

The internal machinations of the car park provisions and access locations are yet to be finalised.

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.

A loading dock will provide for deliveries to the retail and commercial components, while also servicing garbage collection needs.

The dock will cater for the use of 12.5 metre rigid trucks, 19 metre semi trailers and lower order service vehicles to enter and leave the facility in a forward direction.

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

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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.

Serviced Apartments

One (1) space per apartment, and

One (1) space per two (2) employees.

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

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6.9 Growth Forecasts

Investigations into the traffic impacts associated with the *Burwood Place* 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 2011, 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 Plaza 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.

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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 40 Burwood Town Centre Adopted Growth Projections

Source BTS Zone Explorer, 2016

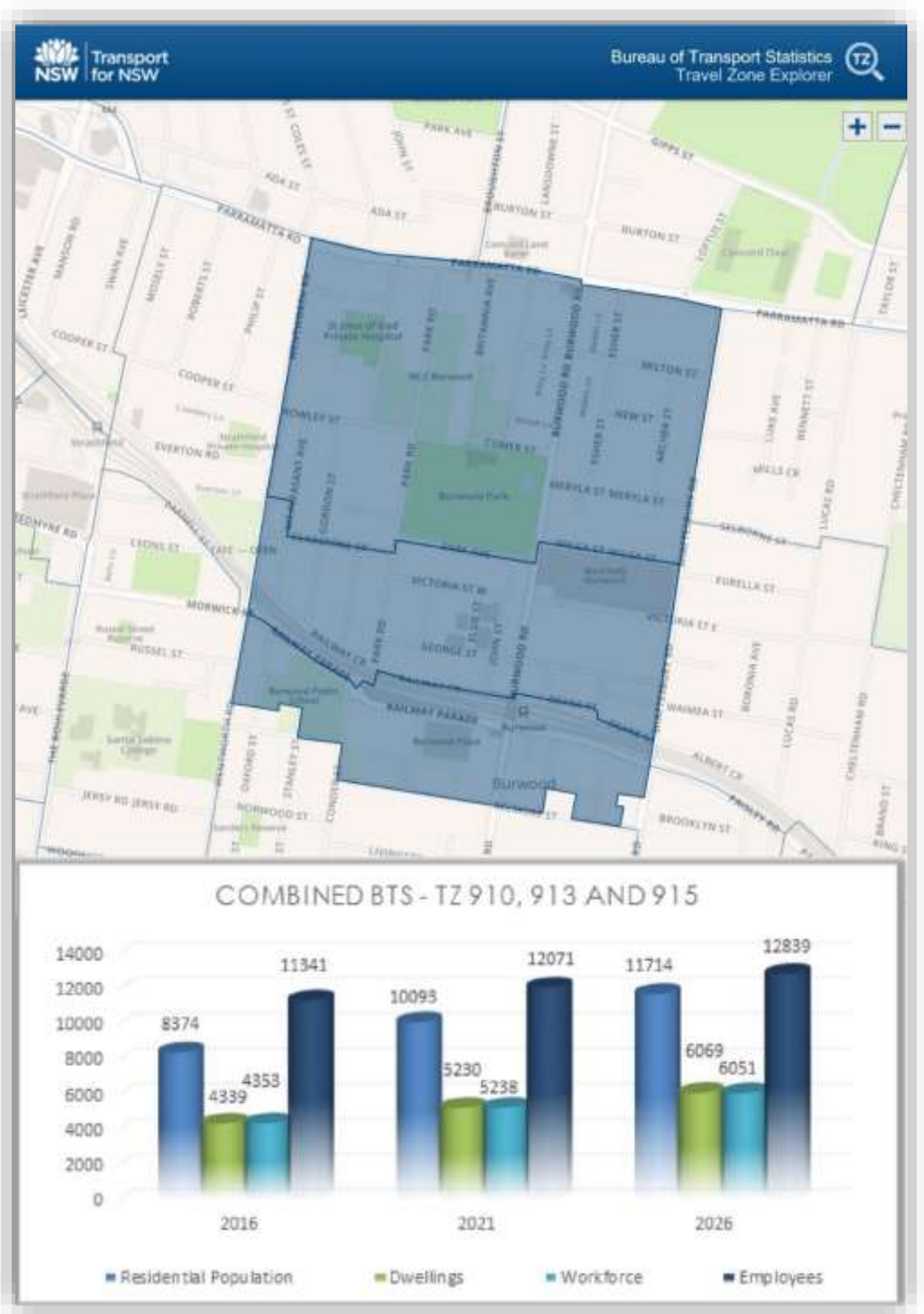

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Figure 41 Burwood Council Approved and Planned Developments

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.

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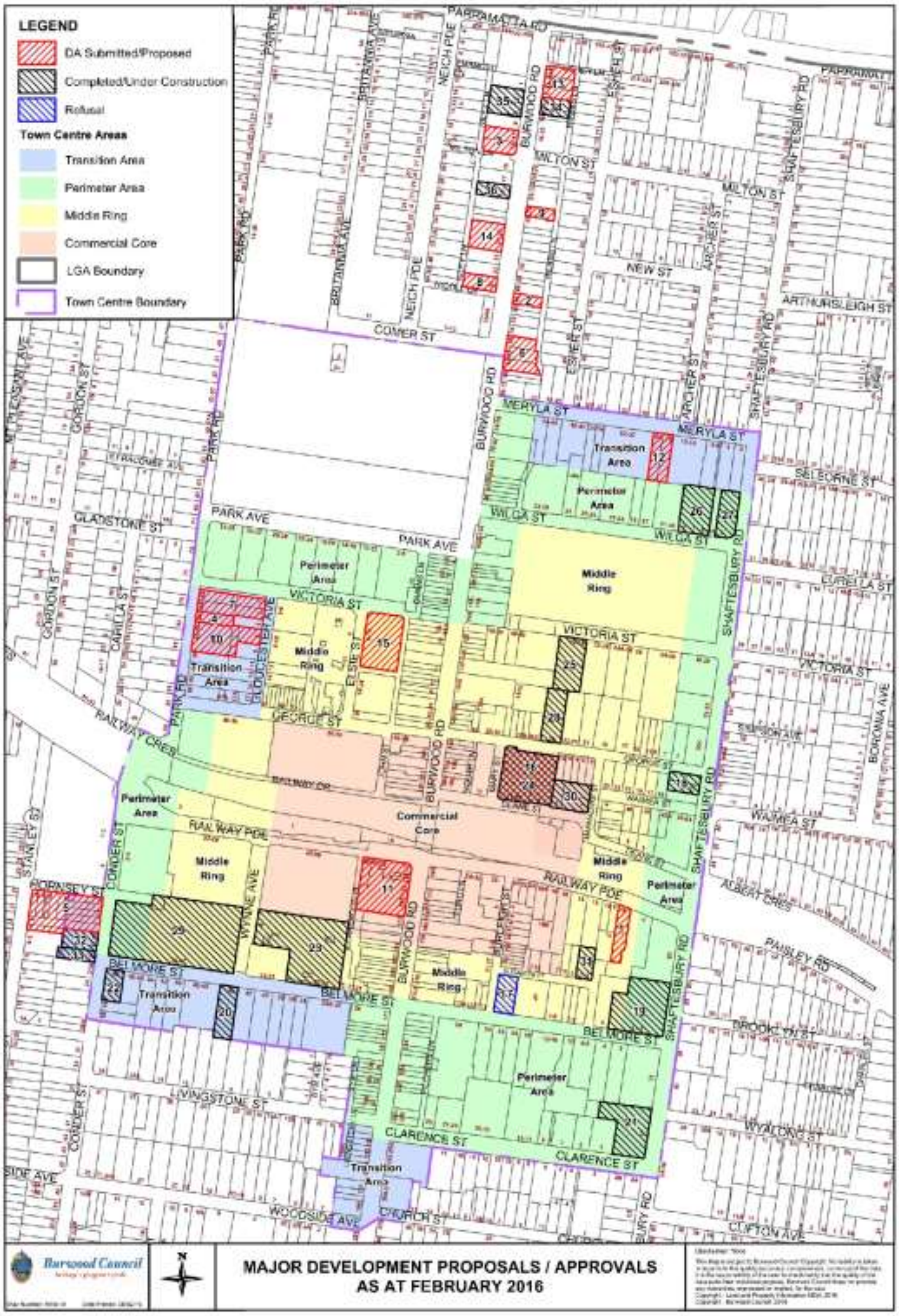
Figure 42 Burwood Town Centre Development Opportunity

Source Architectus/COX, 2016



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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 Plaza 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 routes of Shaftesbury Road and Wentworth Road, suggest a significant volume of through traffic and vehicles accessing the town centre utilise these corridors.

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.

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Table 4 ***Proposed Vehicle Generation***

Source *Road Delay Solutions, 2016*

BURWOOD PLAZA 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	1,044	1,044	1.52	0.19	0.15	0.1	198	157	104	159	40	31	125	57	47
Serviced Apartments#	100	100	3	0.4	0.4	0.4	40	40	20	32	8	8	32	16	4
Retail Specialty Shops*	17,460	24,277	0.3403	0.059	0.059	0.075	1030	1030	1310	464	567	567	464	720	589
Supermarket*	3,100	4,200	0.3403	0.059	0.059	0.075	183	183	233	82	101	101	82	128	105
Commercial	12,075	15,092	0.11	0.016	0.012	0.001	193	145	12	29	164	123	22	7	5
TOTAL			9,912				1645	1555	1678	766	879	830	725	929	750

**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.*

The retail GLFA excludes common areas such as walkways, garbage storage, unoccupied lobby areas and the shared loading dock provisions.

 # The hotel style serviced apartments have adopted the casual accommodation vehicle generation rate prescribed by the RMS of 0.4 trips per apartment during the peak periods given the proximity to Burwood Railway Station.

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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 2011.

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 supermarket, within the model, former analysies of supermarket operations for the Gladesville Shopping Village and Warriewood Square were undertaken by *Road Delay Solutions* in the first quarter of 2016.

The retail distribution pattern was determined by a simple survey of 126 patrons at each complex, entering by vehicle into the carparks, and observed heading to the Coles 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 supermarkets 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.

An average of some 25% of patrons surveyed commented that they frequently utilised competing supermarkets and that each respective Cole supermarket was not their sole source of groceries.

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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 Burwood Place 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 Burwood Place development traffic, and*
- → *2026 Development Model – The 2026 Section 94 road network including proposed infrastructure and traffic generation from the Burwood Place 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

(2026AMBASE.PLT/2026PMBASE.PLT/26AMWEBA.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.

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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.

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Table 5 ***Projected 10 Year Vehicle Growth***

Source *Road Delay Solutions, 2016*

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 and Wentworth 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 can be reduced or eliminated.

It is apparent that with the anticipated metropolitan growth, Burwood Road will continue to 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 routes of Shaftesbury Road and Wentworth Road remain a viable options.

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. 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 and Wentworth Road.

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Table 6 ***Burwood Town Centre Network and Burwood Road Route Operational Performance***

Source *Road Delay Solutions, 2016*

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												
DS	D	D	D	D	D	D	E	D	E	E	D	D
AVD *(sec)*	19	17.5	14.2	18.6	16.9	19	24.7	21.7	27.3	34.4	20.6	21.5
LOS	0.899	1.004	0.691	1.165	0.676	0.911	0.904	0.927	0.96	1.72	0.899	0.894
ROUTE PERFORMANCE - BURWOOD ROAD NORTHBOUND												
DS	E	E	E	E	E	E	E	E	E	E	E	E
AVD *(sec)*	18.8	19.5	11	16.3	15.7	24.9	14.3	15.4	23.6	31.7	26.4	25.3
LOS	0.888	0.863	0.691	0.651	0.64	0.911	0.757	0.64	0.898	1.1	0.899	0.894
ROUTE PERFORMANCE - BURWOOD ROAD SOUTHBOUND												
DS	E	E	E	E	E	E	E	E	E	E	E	E
AVD *(sec)*	11.6	8.4	11	12.6	17.7	22	11.1	17.4	20.2	16.3	27.2	23.4
LOS	0.779	0.763	0.691	1.165	0.676	0.799	0.58	0.863	0.762	1.087	0.766	0.844

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Table 7 ***Burwood Town Centre Intersection Operational Performance***

Source *Road Delay Solutions, 2016*

BURWOOD TOWN CENTRE SIDRA NETWORK MODELLING												
	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
Burwood Road and Victoria Street East												
DS										0.535	0.521	0.567
AVD *(sec)*										16.4	18.8	19.5
LOS										B	B	B
Burwood Road, Deane Street and Railway Crescent												
DS	0.531	0.368	0.416	0.887	0.437	0.44	0.493	0.56	0.488	0.673	0.319	0.398
AVD *(sec)*	9.7	12.8	6.9	15.2	12.8	13.8	6.1	6.1	7.7	8.2	7.3	6.5
LOS	A	A	A	B	A	A	A	A	A	A	A	A
Burwood Road and Railway Parade												
DS	0.899	0.863	0.661	1.022	0.845	0.938	0.761	0.64	0.79	1.064	1.021	0.894
AVD *(sec)*	33.8	32.5	24.9	49	27.8	39.4	28.6	25.3	32.8	54	46.1	37.6
LOS	C	C	B	D	B	C	C	B	C	D	D	C
Burwood Road and Belmore Street												
DS	0.859	1.004	0.703	0.96	0.709	0.931	0.757	0.683	0.898	0.916	0.895	0.946
AVD *(sec)*	27.8	25.1	17.5	36.6	21.6	30.9	24.4	23.2	28.6	27.2	32.3	33.7
LOS	B	B	B	C	B	C	B	B	C	B	C	C
Railway Parade and Wynne Avenue												
DS	0.402	0.348	0.376	0.335	0.388	0.384	0.403	0.347	0.479	0.443	0.422	0.465
AVD *(sec)*	14	14.6	19.2	15.9	16.5	13.1	25.6	24.1	26.6	18.7	22	20.5
LOS	A	B	B	B	B	A	B	B	B	B	B	B
Railway Parade and Conder Street												
DS	0.569	0.513	0.498	0.519	0.548	0.538	0.904	0.927	0.96	0.878	0.893	0.885
AVD *(sec)*	8.3	7.7	7.6	7.5	7.3	7	33.8	21.3	34.9	32.6	33.6	36.9
LOS	A	A	A	A	A	A	C	B	C	C	C	C
Belmore Street and Wynne Avenue												
DS	0.2	0.258	0.29	0.196	0.254	0.25	0.307	0.359	0.422	0.495	0.373	0.451
AVD *(sec)*	6	6.1	6.2	6.3	6.9	6.3	19.8	26.5	23.1	17.8	17.6	18.8
LOS	A	A	A	A	A	A	B	B	B	B	B	B
Belmore Street and Conder Street												
DS	0.241	0.2	0.24	0.239	0.252	0.258	0.557	0.47	0.614	0.898	0.457	0.621
AVD *(sec)*	4.1	3.8	4.1	13.1	4	4.4	20.5	23.9	24.4	31	21.5	21.4
LOS	A	A	A	A	A	A	B	B	B	C	B	B
Railway Parade and Development Access												
DS										0.447	0.483	0.605
AVD *(sec)*										3	3.1	3.4
LOS										A	A	A
Belmore Street and Development Access												
DS										0.198	0.162	0.225
AVD *(sec)*										1.6	1.8	2.1
LOS										A	A	A
Wynne Avenue and Development Access												
DS										0.345	0.281	0.34
AVD *(sec)*										20	21.4	19.6
LOS										B	B	B

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Figure 43 2026 AM 'Do Nothing' Traffic Projections

Source Road Delay Solutions, 2016

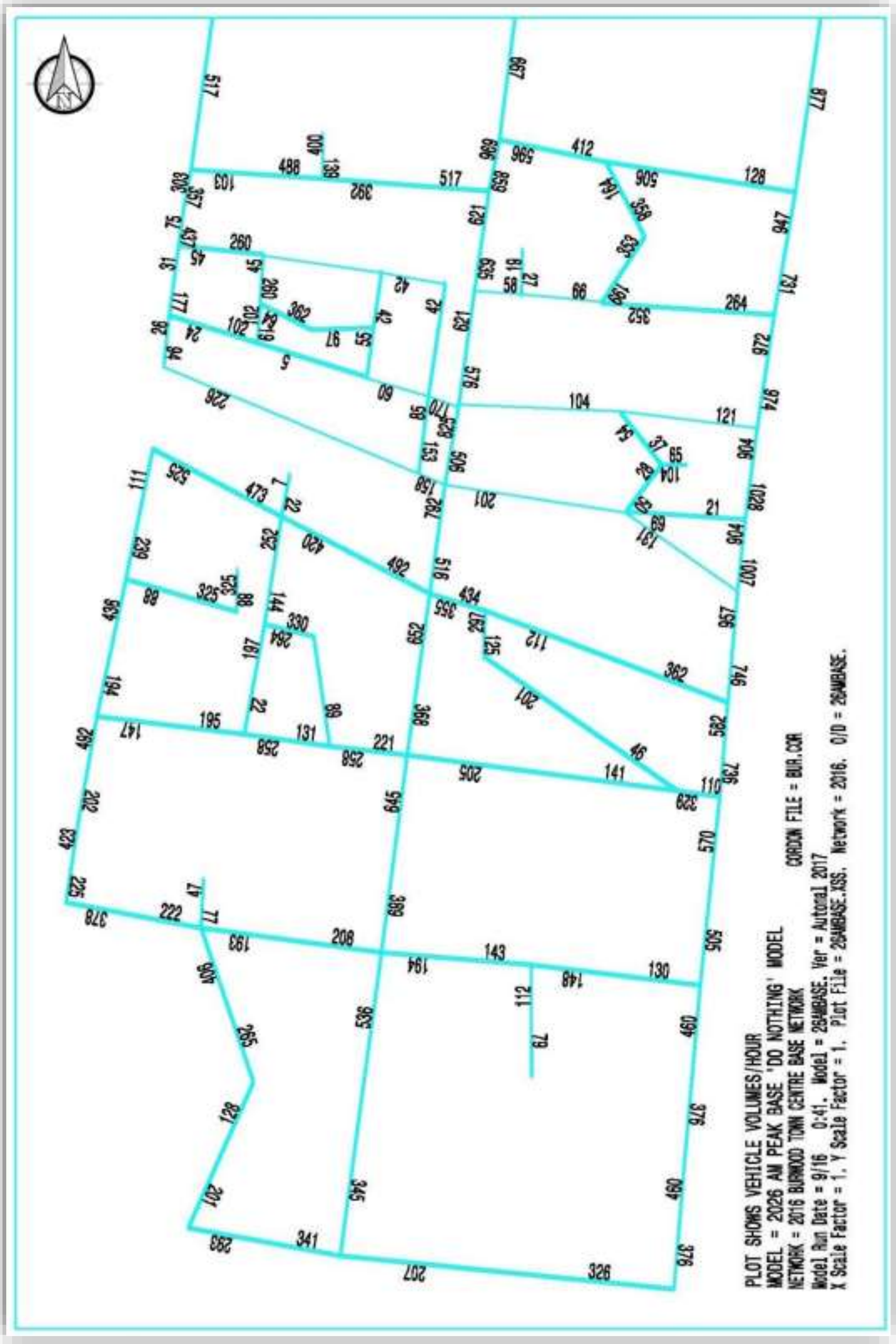

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Figure 44 2026 PM 'Do Nothing' Traffic Projections

Source Road Delay Solutions, 2016

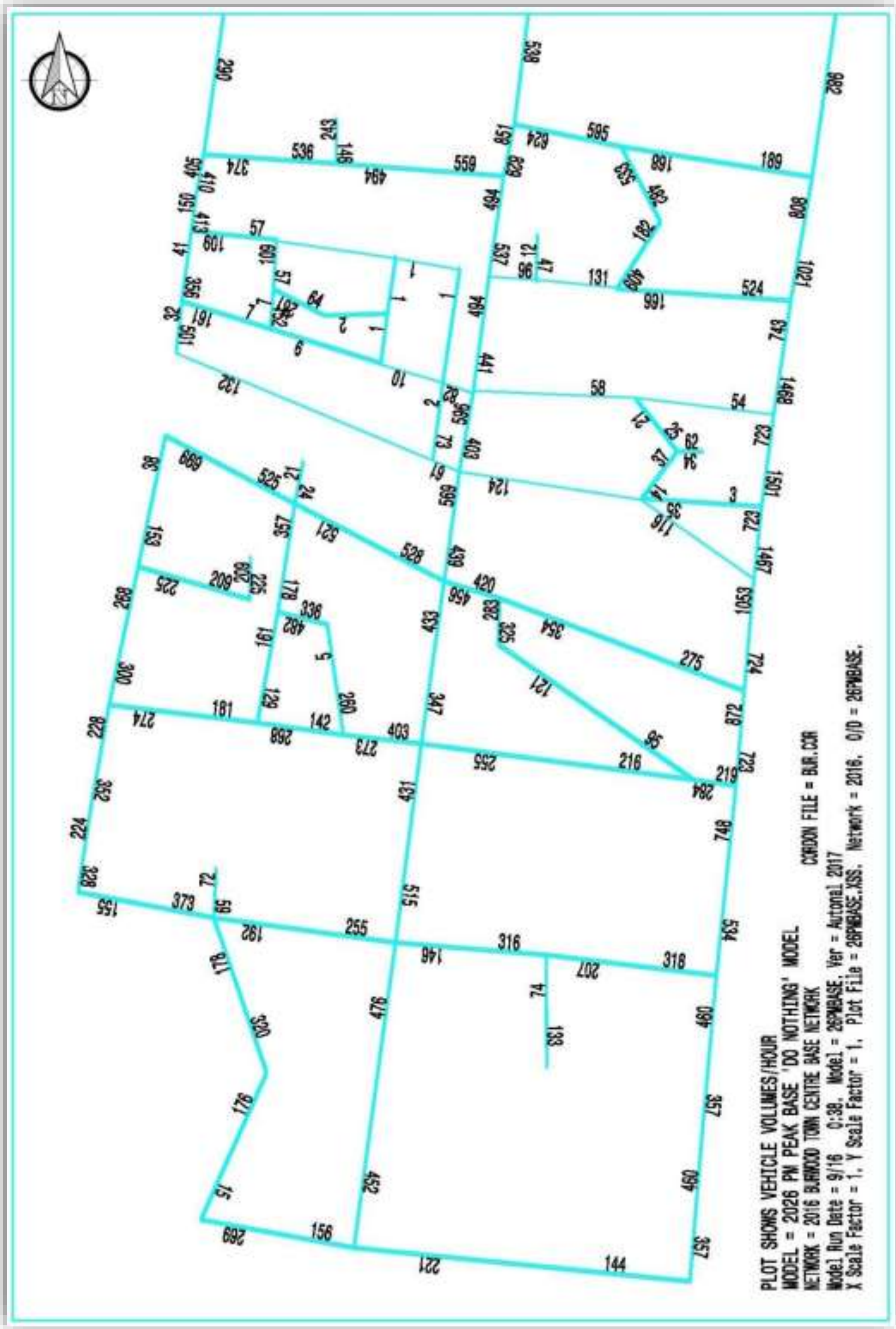

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Figure 45 2026 WE 'Do Nothing' Traffic Projections

Source Road Delay Solutions, 2016

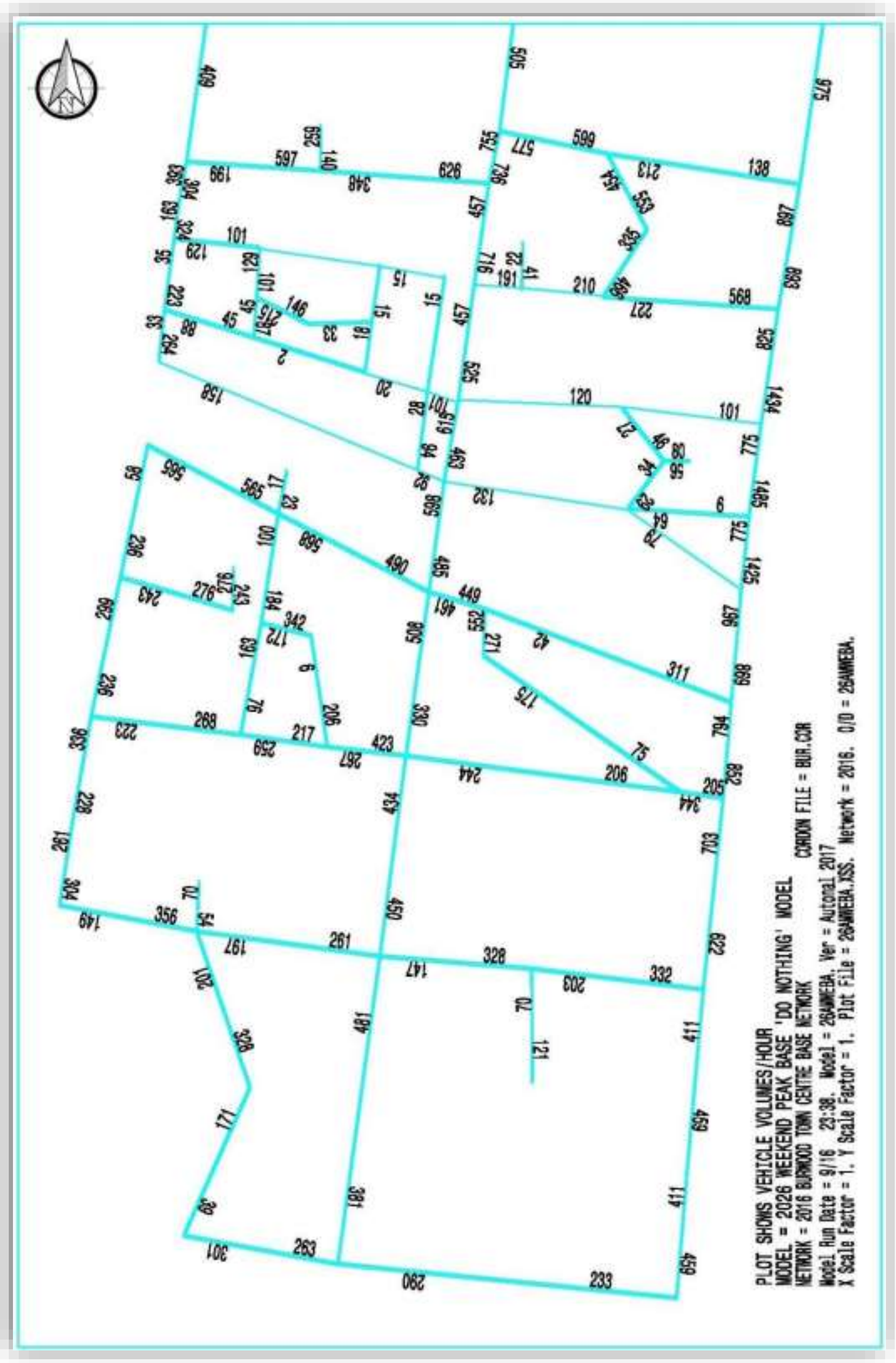

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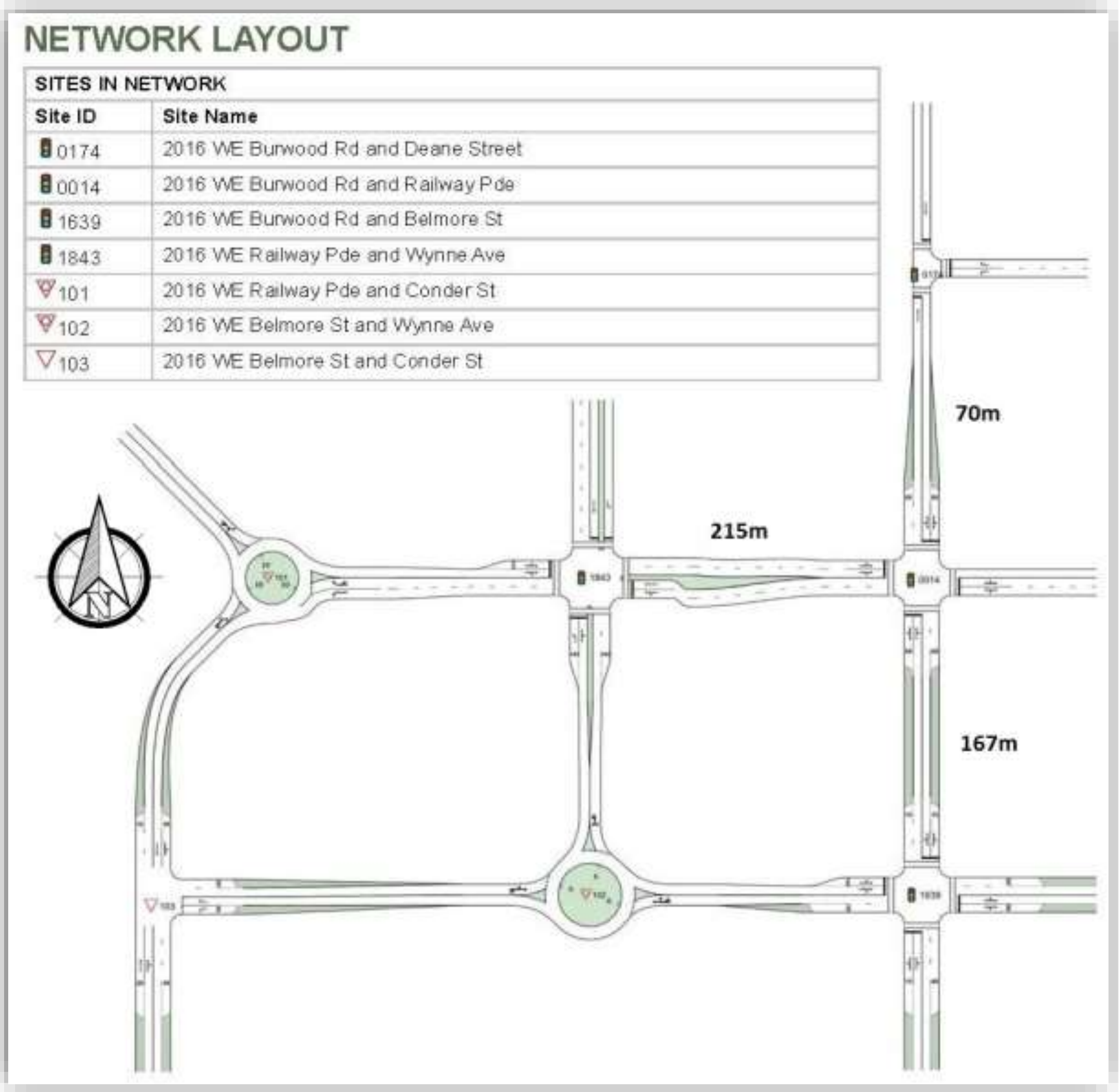
Figure 46 2026 SIDRA 7 'Do Nothing' Modelled Road Network

Source Sidra/Road Delay Solutions, 2016



SITES IN NETWORK	
Site ID	**Site Name**
0174	2016 WE Burwood Rd and Deane Street
0014	2016 WE Burwood Rd and Railway Pde
1639	2016 WE Burwood Rd and Belmore St
1843	2016 WE Railway Pde and Wynne Ave
101	2016 WE Railway Pde and Conder St
102	2016 WE Belmore St and Wynne Ave
103	2016 WE Belmore St and Conder St

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Figure 47 2026 SIDRA 7 'Do Nothing' AM Peak Network Report

Source Sidra/Road Delay Solutions, 2016

NETWORK SUMMARY

Network: N101 [2026 AM Base 'Do Nothing']

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	4.10			
Speed Efficiency	0.47			
Congestion Coefficient	2.13			
Travel Speed (Average)	28.1 km/h		2.3 km/h	15.2 km/h
Travel Distance (Total)	4244.7 veh-km/h		408.1 ped-km/h	6819.2 pers-km/h
Travel Time (Total)	150.9 veh-h/h		181.3 ped-h/h	449.8 pers-h/h
Desired Speed	60.0 km/h			
Demand Flows (Total)	9089 veh/h		12335 ped/h	16441 pers/h
Arrival Flows (Total)	9089 veh/h		12335 ped/h	16441 pers/h
Percent Heavy Vehicles (Demand)	6.7 %			
Percent Heavy Vehicles (Arrival)	6.7 %			
Degree of Saturation	1.022			
Control Delay (Total)	60.01 veh-h/h		94.09 ped-h/h	220.59 pers-h/h
Control Delay (Average)	23.8 sec		27.5 sec	48.3 sec
Control Delay (Worst Lane)	100.3 sec			
Control Delay (Worst Movement)	103.9 sec		44.3 sec	103.9 sec
Geometric Delay (Average)	2.0 sec			
Stop-Line Delay (Average)	21.7 sec			
Queue Storage Ratio (Worst Lane)	1.00			
Total Effective Stops	6068 veh/h		9022 ped/h	20817 pers/h
Effective Stop Rate	0.67 per veh	1.4 per km	0.73 per ped	1.27 per pers
Proportion Queued	0.58		0.73	1.17
Performance Index	648.1		231.4	879.5
Cost (Total)	7630.95 $/h	1.80 $/km	4568.66 $/h	12199.61 $/h
Fuel Consumption (Total)	529.1 L/h	124.6 mL/km		
Fuel Economy	12.5 L/100km			
Carbon Dioxide (Total)	1256.1 kg/h	295.9 g/km		
Hydrocarbons (Total)	0.131 kg/h	0.031 g/km		
Carbon Monoxide (Total)	1.122 kg/h	0.264 g/km		
NOx (Total)	2.403 kg/h	0.566 g/km		

Network Model Accuracy Level (largest change in degree of saturation for any lane): 5.0 %
Number of Iterations: 10
Network Level of Service (LOS) Method: SIDRA Speed Efficiency.
Setup used: New South Wales.

Network Performance - Annual Values

Performance Measure	Vehicles	Pedestrians	Persons
Demand Flows (Total)	4,362,948 veh/y	5,920,674 ped/y	7,891,769 pers/y
Delay	28,803 veh-h/y	45,163 ped-h/y	105,881 pers-h/y
Effective Stops	2,912,632 veh/y	4,330,651 ped/y	9,992,143 pers/y
Travel Distance	2,037,445 veh-km/y	195,899 ped-km/y	3,273,225 pers-km/y
Travel Time	72,426 veh-h/y	87,022 ped-h/y	215,883 pers-h/y
Cost	3,662,858 $/y	2,192,957 $/y	5,855,815 $/y
Fuel Consumption	253,958 L/y		
Carbon Dioxide	602,921 kg/y		
Hydrocarbons	63 kg/y		
Carbon Monoxide	539 kg/y		
NOx	1,153 kg/y		

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Figure 48 ***2026 AM 'Do Nothing' 95th Percentile Queue Ratios***

Source *Road Delay Solutions, 2016*

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Figure 49 2026 SIDRA 7 'Do Nothing' PM Peak Network Report

Source Sidra/Road Delay Solutions, 2016

NETWORK SUMMARY

Network: N101 [2026 PM Base 'Do Nothing']

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 D			
Travel Time Index	5.06			
Speed Efficiency	0.56			
Congestion Coefficient	1.80			
Travel Speed (Average)	33.3 km/h		2.2 km/h	17.7 km/h
Travel Distance (Total)	4703.1 veh-km/h		418.8 ped-km/h	7088.9 pers-km/h
Travel Time (Total)	141.2 veh-h/h		186.7 ped-h/h	400.4 pers-h/h
Desired Speed	60.0 km/h			
Demand Flows (Total)	9147 veh/h		12636 ped/h	15590 pers/h
Arrival Flows (Total)	9147 veh/h		12636 ped/h	15590 pers/h
Percent Heavy Vehicles (Demand)	5.0 %			
Percent Heavy Vehicles (Arrival)	5.0 %			
Degree of Saturation	0.845			
Control Delay (Total)	40.63 veh-h/h		97.25 ped-h/h	165.25 pers-h/h
Control Delay (Average)	16.0 sec		27.7 sec	38.2 sec
Control Delay (Worst Lane)	45.1 sec			
Control Delay (Worst Movement)	46.6 sec		41.8 sec	46.6 sec
Geometric Delay (Average)	2.4 sec			
Stop-Line Delay (Average)	13.6 sec			
Queue Storage Ratio (Worst Lane)	1.00			
Total Effective Stops	5446 veh/h		9380 ped/h	18694 pers/h
Effective Stop Rate	0.60 per veh	1.2 per km	0.74 per ped	1.20 per pers
Proportion Queued	0.56		0.74	1.19
Performance Index	504.6		238.9	743.5
Cost (Total)	6028.52 $/h	1.28 $/km	4705.83 $/h	10734.35 $/h
Fuel Consumption (Total)	509.1 L/h	108.3 mL/km		
Fuel Economy	10.8 L/100km			
Carbon Dioxide (Total)	1205.0 kg/h	256.2 g/km		
Hydrocarbons (Total)	0.112 kg/h	0.024 g/km		
Carbon Monoxide (Total)	1.038 kg/h	0.221 g/km		
NOx (Total)	1.770 kg/h	0.376 g/km		

Network Model Accuracy Level (largest change in degree of saturation for any lane): 1.6 %
Number of Iterations: 10
Network Level of Service (LOS) Method: SIDRA Speed Efficiency.
Setup used: New South Wales.

Network Performance - Annual Values			
Performance Measure	**Vehicles**	**Pedestrians**	**Persons**
Demand Flows (Total)	4,390,737 veh/y	6,065,179 ped/y	7,483,053 pers/y
Delay	19,502 veh-h/y	46,679 ped-h/y	79,321 pers-h/y
Effective Stops	2,614,316 veh/y	4,502,627 ped/y	8,973,262 pers/y
Travel Distance	2,257,499 veh-km/y	201,033 ped-km/y	3,402,674 pers-km/y
Travel Time	67,759 veh-h/y	89,635 ped-h/y	192,206 pers-h/y
Cost	2,893,692 $/y	2,258,796 $/y	5,152,488 $/y
Fuel Consumption	244,388 L/y		
Carbon Dioxide	578,393 kg/y		
Hydrocarbons	54 kg/y		
Carbon Monoxide	498 kg/y		
NOx	850 kg/y		

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Figure 50 ***2026 PM 'Do Nothing' 95th Percentile Queue Ratios***

Source *Road Delay Solutions, 2016*

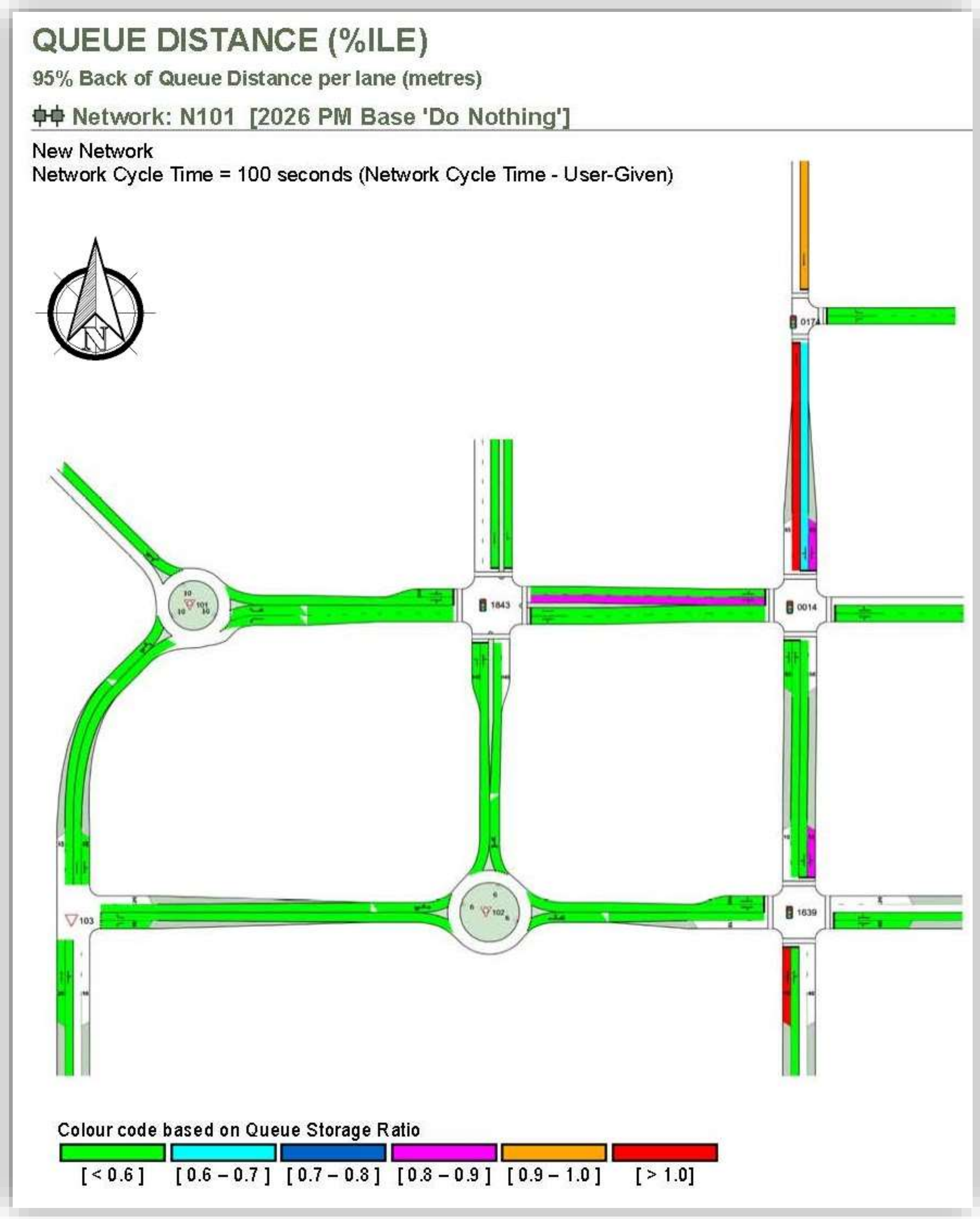

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Figure 51 ***2026 SIDRA 7 'Do Nothing' WE Peak Network Report***

Source *Sidra/Road Delay Solutions, 2016*

NETWORK SUMMARY

Network: N101 [2026 WE Base 'Do Nothing']

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 D			
Travel Time Index	4.51			
Speed Efficiency	0.51			
Congestion Coefficient	1.98			
Travel Speed (Average)	30.4 km/h		2.2 km/h	16.3 km/h
Travel Distance (Total)	4279.0 veh-km/h		394.7 ped-km/h	6833.6 pers-km/h
Travel Time (Total)	141.0 veh-h/h		176.7 ped-h/h	420.1 pers-h/h
Desired Speed	60.0 km/h			
Demand Flows (Total)	8922 veh/h		11893 ped/h	16973 pers/h
Arrival Flows (Total)	8922 veh/h		11893 ped/h	16973 pers/h
Percent Heavy Vehicles (Demand)	5.7 %			
Percent Heavy Vehicles (Arrival)	5.7 %			
Degree of Saturation	0.938			
Control Delay (Total)	49.26 veh-h/h		92.40 ped-h/h	192.85 pers-h/h
Control Delay (Average)	19.9 sec		28.0 sec	40.9 sec
Control Delay (Worst Lane)	64.0 sec			
Control Delay (Worst Movement)	67.7 sec		44.8 sec	67.7 sec
Geometric Delay (Average)	2.2 sec			
Stop-Line Delay (Average)	17.7 sec			
Queue Storage Ratio (Worst Lane)	1.00			
Total Effective Stops	5740 veh/h		8830 ped/h	20244 pers/h
Effective Stop Rate	0.64 per veh	1.3 per km	0.74 per ped	1.19 per pers
Proportion Queued	0.57		0.74	1.15
Performance Index	582.2		225.8	808.0
Cost (Total)	6820.67 $/h	1.59 $/km	4453.72 $/h	11274.39 $/h
Fuel Consumption (Total)	500.9 L/h	117.1 mL/km		
Fuel Economy	11.7 L/100km			
Carbon Dioxide (Total)	1186.5 kg/h	277.3 g/km		
Hydrocarbons (Total)	0.119 kg/h	0.028 g/km		
Carbon Monoxide (Total)	1.052 kg/h	0.246 g/km		
NOx (Total)	1.918 kg/h	0.448 g/km		

Network Model Accuracy Level (largest change in degree of saturation for any lane): 133.4 %
Number of Iterations: 10
Network Level of Service (LOS) Method: SIDRA Speed Efficiency.
Setup used: New South Wales.

Network Performance - Annual Values			
Performance Measure	**Vehicles**	**Pedestrians**	**Persons**
Demand Flows (Total)	4,282,611 veh/y	5,708,464 ped/y	8,147,036 pers/y
Delay	23,645 veh-h/y	44,352 ped-h/y	92,568 pers-h/y
Effective Stops	2,755,363 veh/y	4,238,240 ped/y	9,717,057 pers/y
Travel Distance	2,053,902 veh-km/y	189,452 ped-km/y	3,280,149 pers-km/y
Travel Time	67,682 veh-h/y	84,833 ped-h/y	201,648 pers-h/y
Cost	3,273,921 $/y	2,137,788 $/y	5,411,709 $/y
Fuel Consumption	240,434 L/y		
Carbon Dioxide	569,529 kg/y		
Hydrocarbons	57 kg/y		
Carbon Monoxide	505 kg/y		
NOx	920 kg/y		

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Figure 52 *2026 WE 'Do Nothing' 95th Percentile Queue Ratios*

Source *Road Delay Solutions, 2016*

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6.14 2026 Section 94 Infrastructure Model

(2026AMS94.PLT/2026PMS94.PLT/26AMWE94.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 53 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 Burwood Place (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.

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Figure 54 ***Section 94 Infrastructure Plan***

Source *Burwood Council, 2016*

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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 Burwood Place 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

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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 Burwood Place 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.

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Figure 55 ***2026 AM Section 94 Traffic Projections***

Source *Road Delay Solutions, 2016*

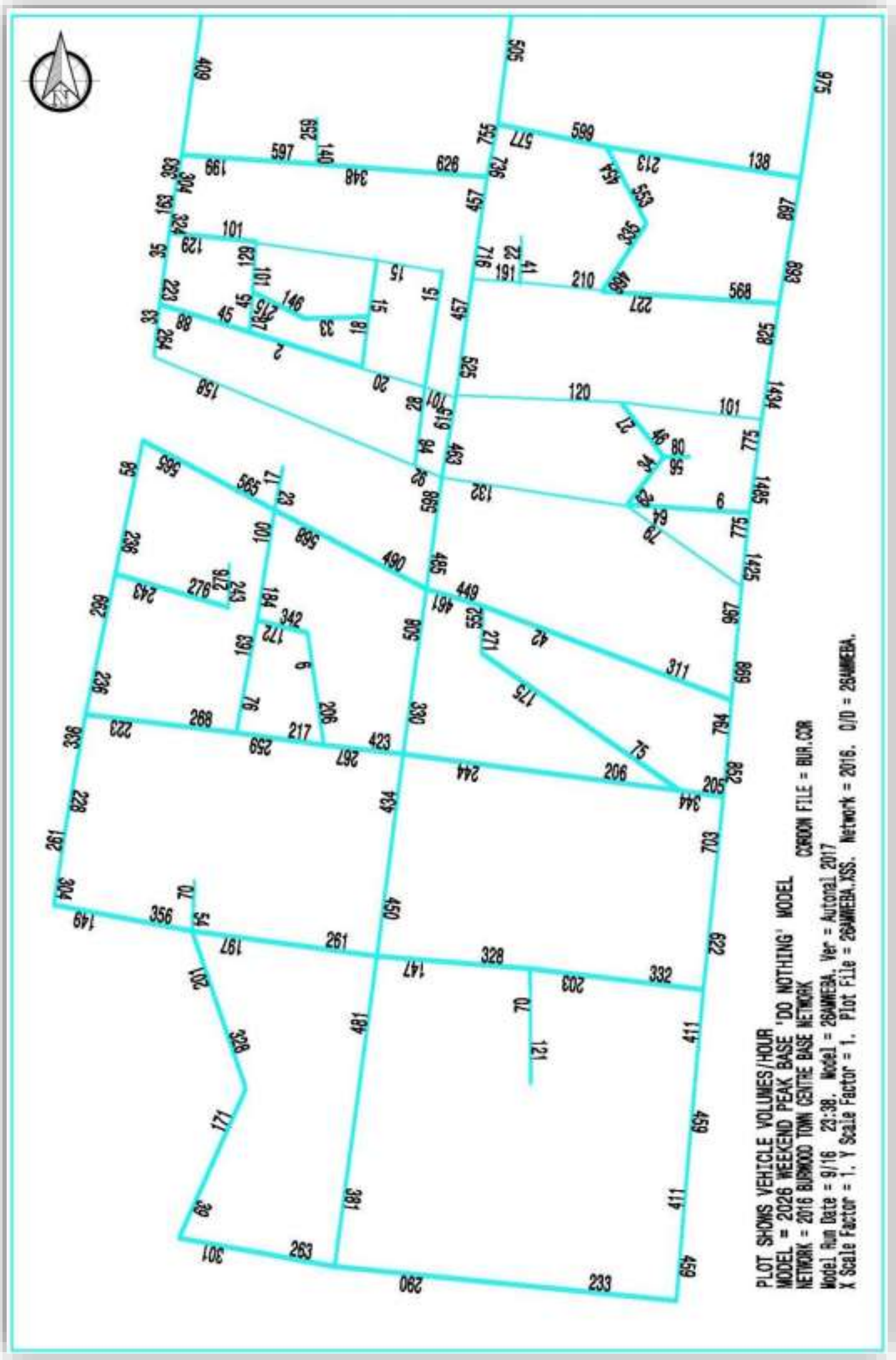

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Figure 56 ***2026 PM Section 94 Traffic Projections***

Source *Road Delay Solutions, 2016*

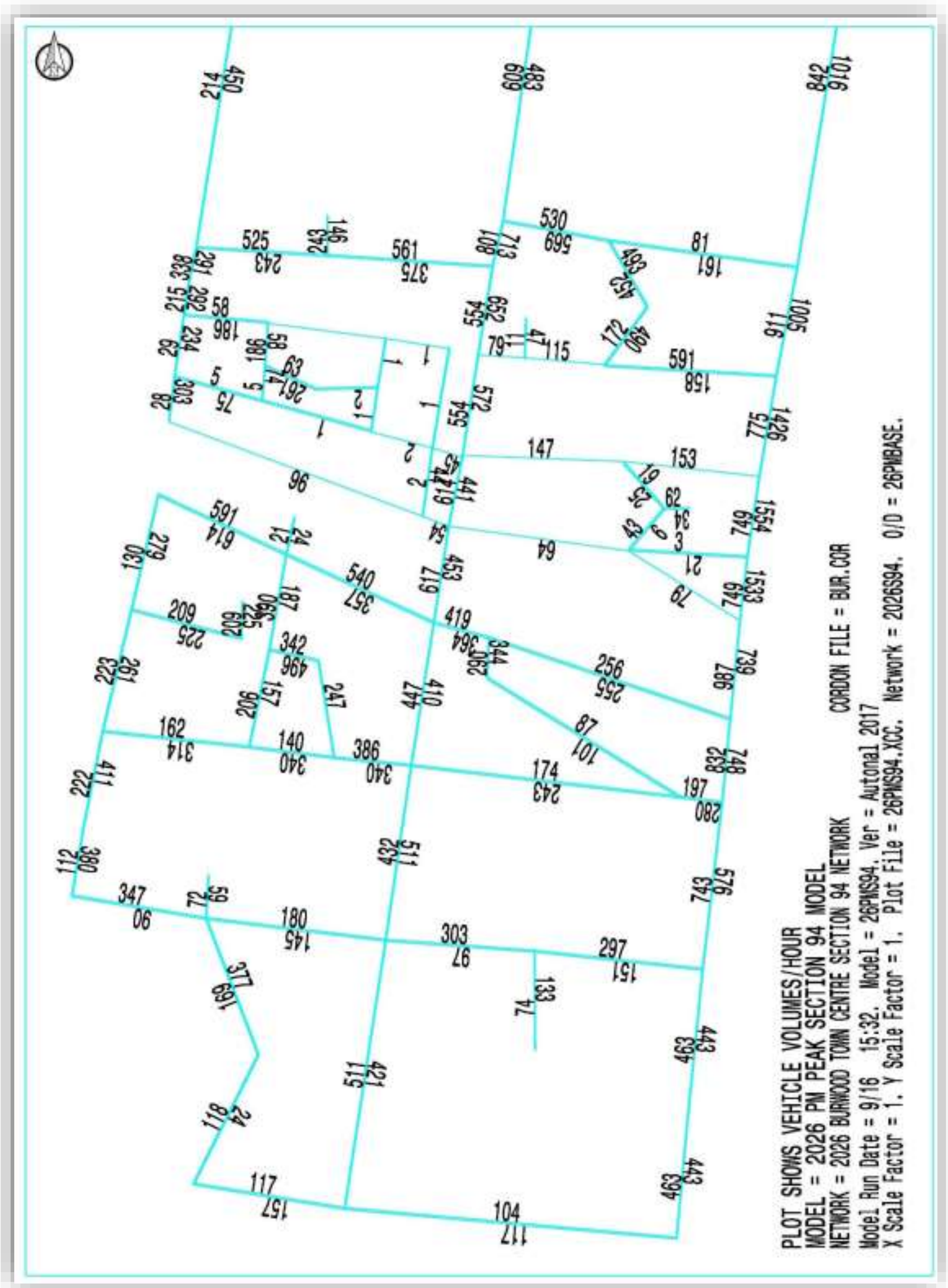

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Figure 57 2026 WE Section 94 Traffic Projections

Source Road Delay Solutions, 2016

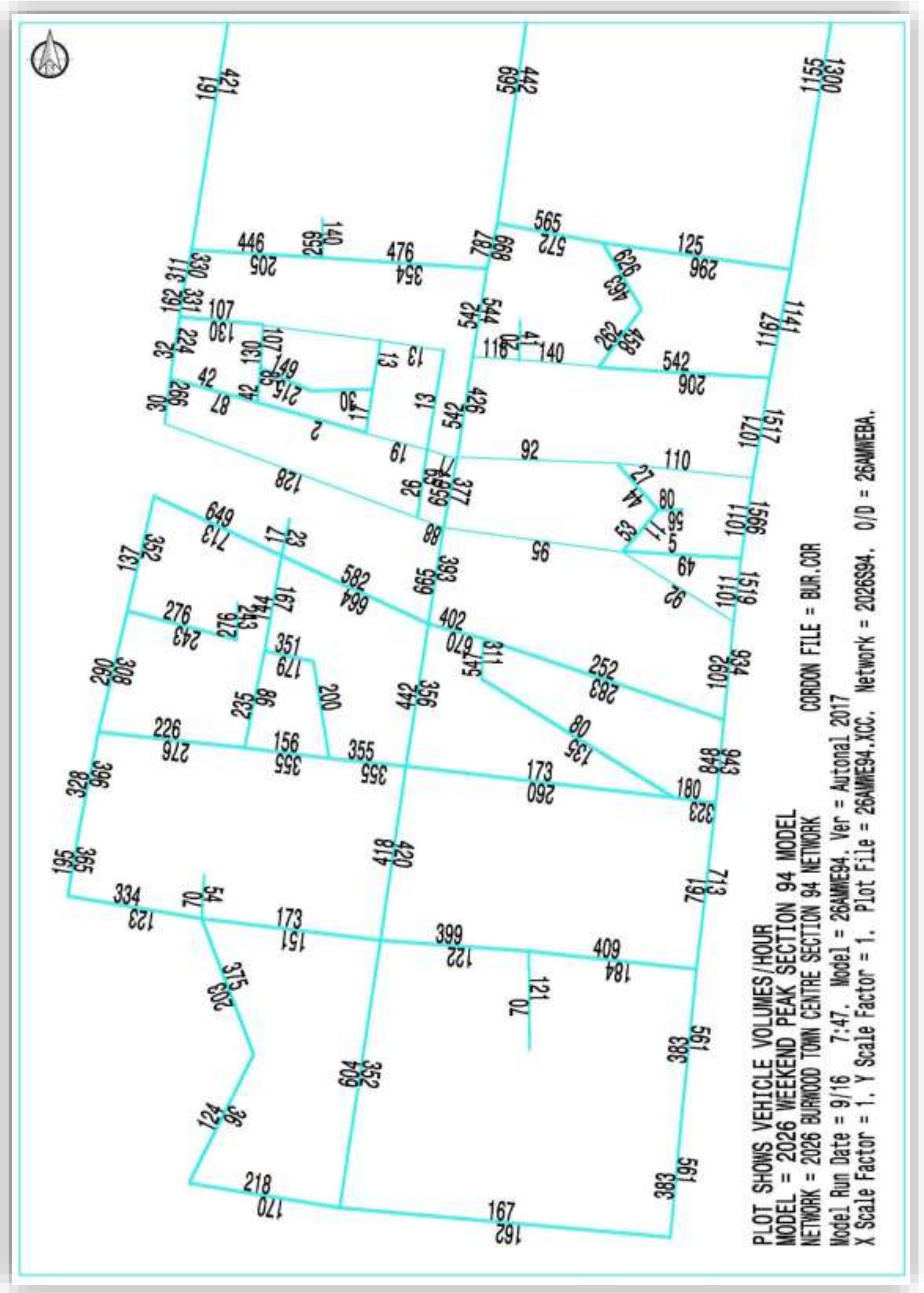

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Figure 58 ***2026 SIDRA 7 Section 94 Modelled Road Network***

Source *Sidra/Road Delay Solutions, 2016*

NETWORK LAYOUT

Network: N101 [2026 PM Sect 94 Network]

SITES IN NETWORK

Site ID	Site Name
0174	2026 PM Sect 94 Burwood Rd and Deane Street
0014	2026 PM Sect 94 Burwood Rd and Railway Pde
1639	2026 PM Sect 94 Burwood Rd and Belmore St
1843	2026 PM Sect 94 Railway Pde and Wynne Ave
101v	2026 PM Sect 94 Railway Pde and Conder St
102v	2026 PM Sect 94 Belmore St and Wynne Ave
103v	2026 PM Sect 94 Belmore St and Conder St

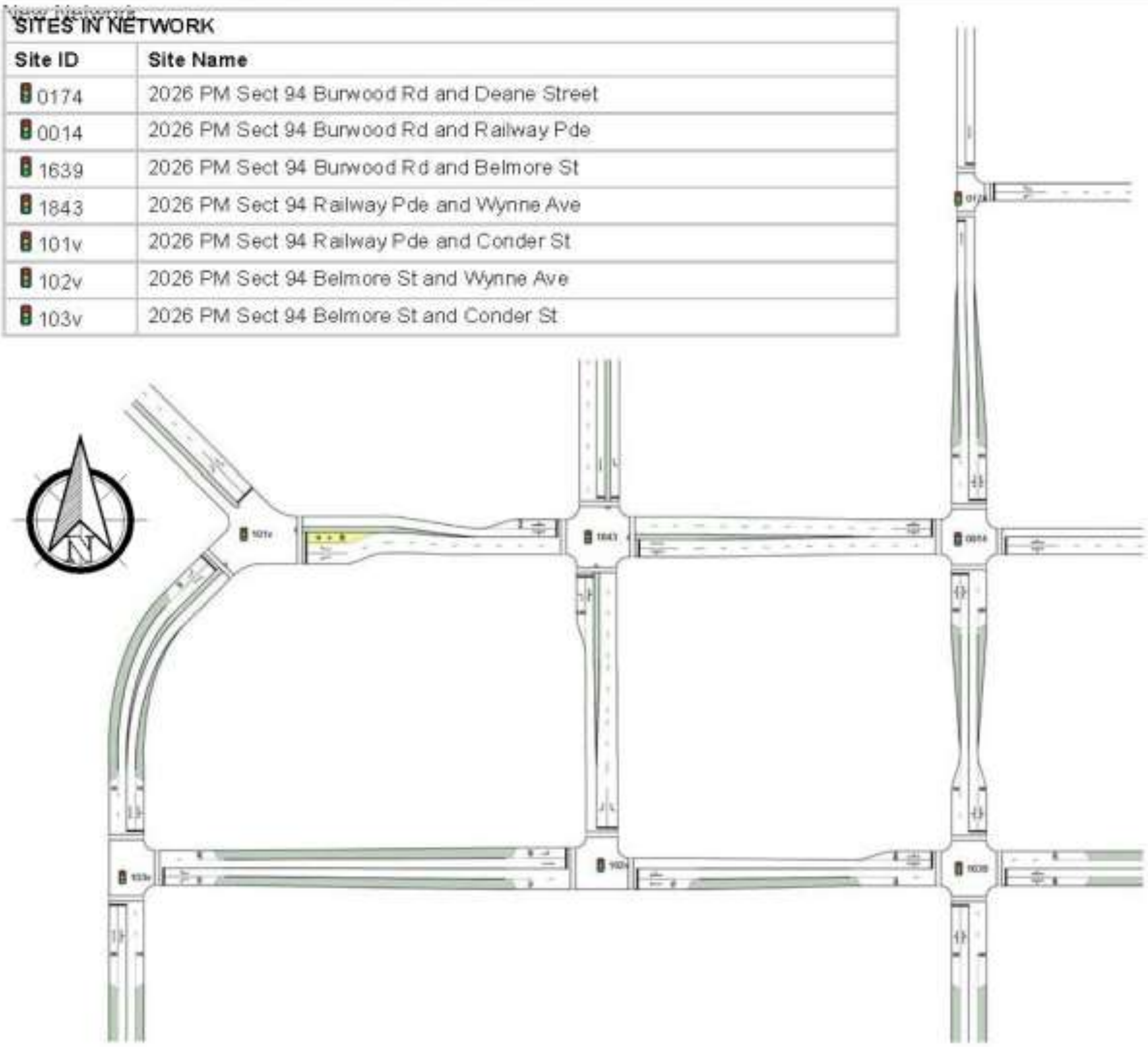

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Figure 59 ***2026 SIDRA 7 Section 94 AM Peak Network Report***

Source *Sidra/Road Delay Solutions, 2016*

NETWORK SUMMARY

Network: N101 [2026 AM Sect 94 Network]

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	4.23			
Speed Efficiency	0.48			
Congestion Coefficient	2.08			
Travel Speed (Average)	28.8 km/h		2.2 km/h	15.6 km/h
Travel Distance (Total)	4792.1 veh-km/h		489.3 ped-km/h	7437.2 pers-km/h
Travel Time (Total)	166.2 veh-h/h		225.9 ped-h/h	477.1 pers-h/h
Desired Speed	60.0 km/h			
Demand Flows (Total)	10011 veh/h		14598 ped/h	17298 pers/h
Arrival Flows (Total)	9679 veh/h		14598 ped/h	17298 pers/h
Percent Heavy Vehicles (Demand)	6.5 %			
Percent Heavy Vehicles (Arrival)	6.7 %			
Degree of Saturation	0.904			
Control Delay (Total)	66.40 veh-h/h		121.39 ped-h/h	224.37 pers-h/h
Control Delay (Average)	24.7 sec		29.9 sec	46.7 sec
Control Delay (Worst Lane)	61.4 sec			
Control Delay (Worst Movement)	61.4 sec		44.7 sec	61.4 sec
Geometric Delay (Average)	1.9 sec			
Stop-Line Delay (Average)	22.8 sec			
Queue Storage Ratio (Worst Lane)	0.76			
Total Effective Stops	6477 veh/h		11060 ped/h	21673 pers/h
Effective Stop Rate	0.67 per veh	1.4 per km	0.76 per ped	1.25 per pers
Proportion Queued	0.70		0.76	1.28
Performance Index	658.0		287.4	945.4
Cost (Total)	7268.62 $/h	1.52 $/km	5693.90 $/h	12962.52 $/h
Fuel Consumption (Total)	592.6 L/h	123.7 mL/km		
Fuel Economy	12.4 L/100km			
Carbon Dioxide (Total)	1405.6 kg/h	293.3 g/km		
Hydrocarbons (Total)	0.137 kg/h	0.029 g/km		
Carbon Monoxide (Total)	1.279 kg/h	0.267 g/km		
NOx (Total)	2.599 kg/h	0.542 g/km		

Network Model Accuracy Level (largest change in degree of saturation for any lane): 132.9 %
Number of Iterations: 10
Network Level of Service (LOS) Method: SIDRA Speed Efficiency.
Setup used: New South Wales.

Network Performance - Annual Values			
Performance Measure	**Vehicles**	**Pedestrians**	**Persons**
Demand Flows (Total)	4,805,053 veh/y	7,006,990 ped/y	8,303,144 pers/y
Delay	31,870 veh-h/y	58,268 ped-h/y	107,698 pers-h/y
Effective Stops	3,109,106 veh/y	5,308,719 ped/y	10,402,800 pers/y
Travel Distance	2,300,201 veh-km/y	234,876 ped-km/y	3,569,854 pers-km/y
Travel Time	79,784 veh-h/y	108,455 ped-h/y	228,991 pers-h/y
Cost	3,488,936 $/y	2,733,073 $/y	6,222,009 $/y
Fuel Consumption	284,437 L/y		
Carbon Dioxide	674,686 kg/y		
Hydrocarbons	66 kg/y		
Carbon Monoxide	614 kg/y		
NOx	1,247 kg/y		

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Figure 60 ***2026 SIDRA 7 Section 94 AM Peak 95th % Queues***

Source *Sidra/Road Delay Solutions, 2016*

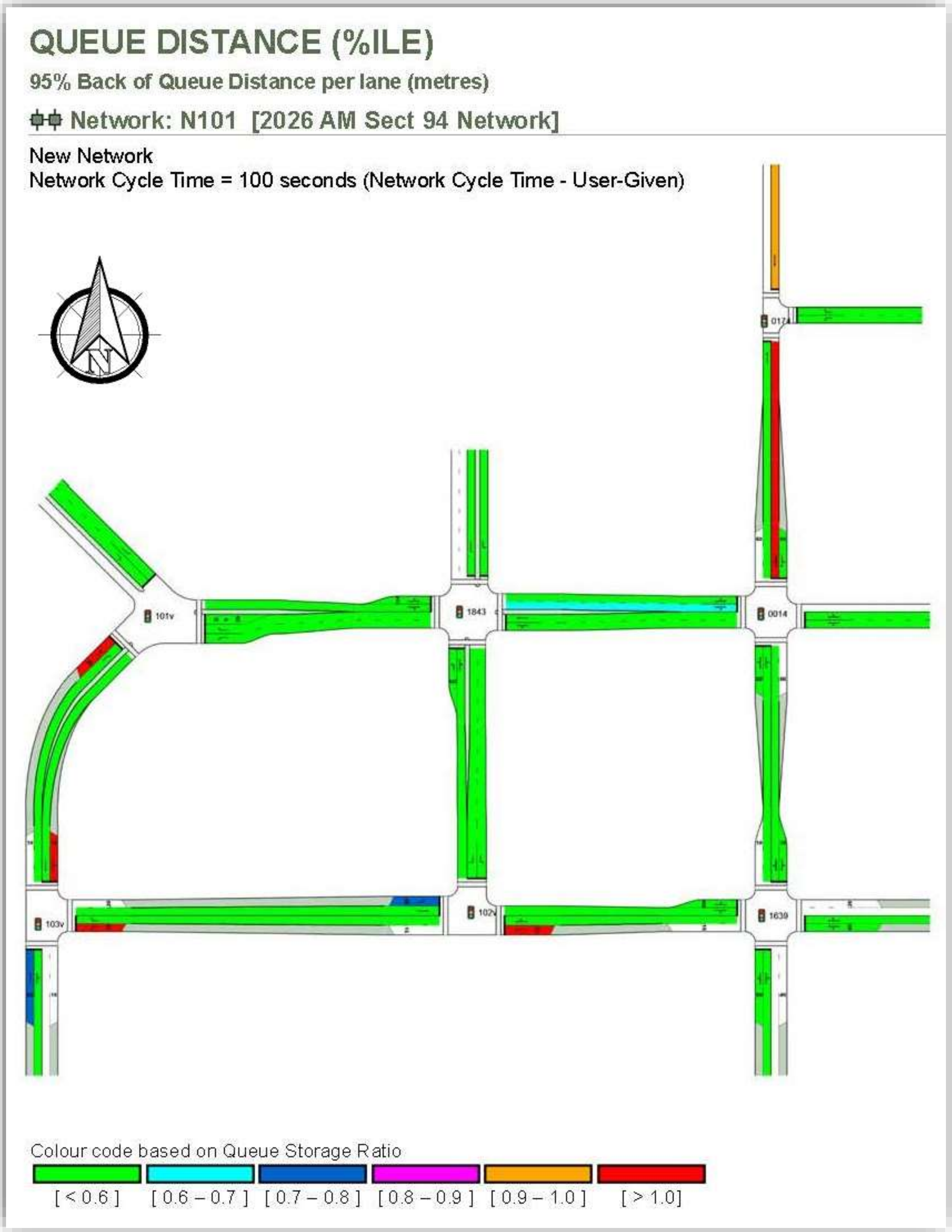

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Figure 61 ***2026 SIDRA 7 Section 94 PM Peak Network Report***

Source *Sidra/Road Delay Solutions, 2016*

NETWORK SUMMARY

Network: N101 [2026 PM Sect 94 Network]

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 D			
Travel Time Index	4.45			
Speed Efficiency	0.50			
Congestion Coefficient	2.00			
Travel Speed (Average)	30.0 km/h		2.2 km/h	15.9 km/h
Travel Distance (Total)	4568.7 veh-km/h		489.3 ped-km/h	7104.3 pers-km/h
Travel Time (Total)	152.1 veh-h/h		217.6 ped-h/h	447.8 pers-h/h
Desired Speed	60.0 km/h			
Demand Flows (Total)	9141 veh/h		14598 ped/h	16257 pers/h
Arrival Flows (Total)	9141 veh/h		14598 ped/h	16257 pers/h
Percent Heavy Vehicles (Demand)	6.7 %			
Percent Heavy Vehicles (Arrival)	6.7 %			
Degree of Saturation	0.927			
Control Delay (Total)	55.01 veh-h/h		113.02 ped-h/h	200.64 pers-h/h
Control Delay (Average)	21.7 sec		27.9 sec	44.4 sec
Control Delay (Worst Lane)	69.6 sec			
Control Delay (Worst Movement)	69.6 sec		44.6 sec	69.6 sec
Geometric Delay (Average)	1.9 sec			
Stop-Line Delay (Average)	19.8 sec			
Queue Storage Ratio (Worst Lane)	0.83			
Total Effective Stops	5795 veh/h		10836 ped/h	20483 pers/h
Effective Stop Rate	0.63 per veh	1.3 per km	0.74 per ped	1.26 per pers
Proportion Queued	0.64		0.74	1.27
Performance Index	586.7		277.8	864.5
Cost (Total)	6544.16 $/h	1.43 $/km	5482.88 $/h	12027.04 $/h
Fuel Consumption (Total)	551.5 L/h	120.7 mL/km		
Fuel Economy	12.1 L/100km			
Carbon Dioxide (Total)	1309.2 kg/h	286.6 g/km		
Hydrocarbons (Total)	0.125 kg/h	0.027 g/km		
Carbon Monoxide (Total)	1.159 kg/h	0.254 g/km		
NOx (Total)	2.512 kg/h	0.550 g/km		

Network Model Accuracy Level (largest change in degree of saturation for any lane): 0.5 %
Number of Iterations: 10
Network Level of Service (LOS) Method: SIDRA Speed Efficiency.
Setup used: New South Wales.

Network Performance - Annual Values

Performance Measure	Vehicles	Pedestrians	Persons
Demand Flows (Total)	4,387,706 veh/y	7,006,990 ped/y	7,803,573 pers/y
Delay	26,404 veh-h/y	54,249 ped-h/y	96,307 pers-h/y
Effective Stops	2,781,833 veh/y	5,201,150 ped/y	9,832,050 pers/y
Travel Distance	2,192,973 veh-km/y	234,876 ped-km/y	3,410,042 pers-km/y
Travel Time	72,998 veh-h/y	104,436 ped-h/y	214,945 pers-h/y
Cost	3,141,196 $/y	2,631,784 $/y	5,772,979 $/y
Fuel Consumption	264,721 L/y		
Carbon Dioxide	628,418 kg/y		
Hydrocarbons	60 kg/y		
Carbon Monoxide	556 kg/y		
NOx	1,206 kg/y		

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Figure 62 ***2026 SIDRA 7 Section 94 PM Peak 95th % Queues***

Source *Sidra/Road Delay Solutions, 2016*

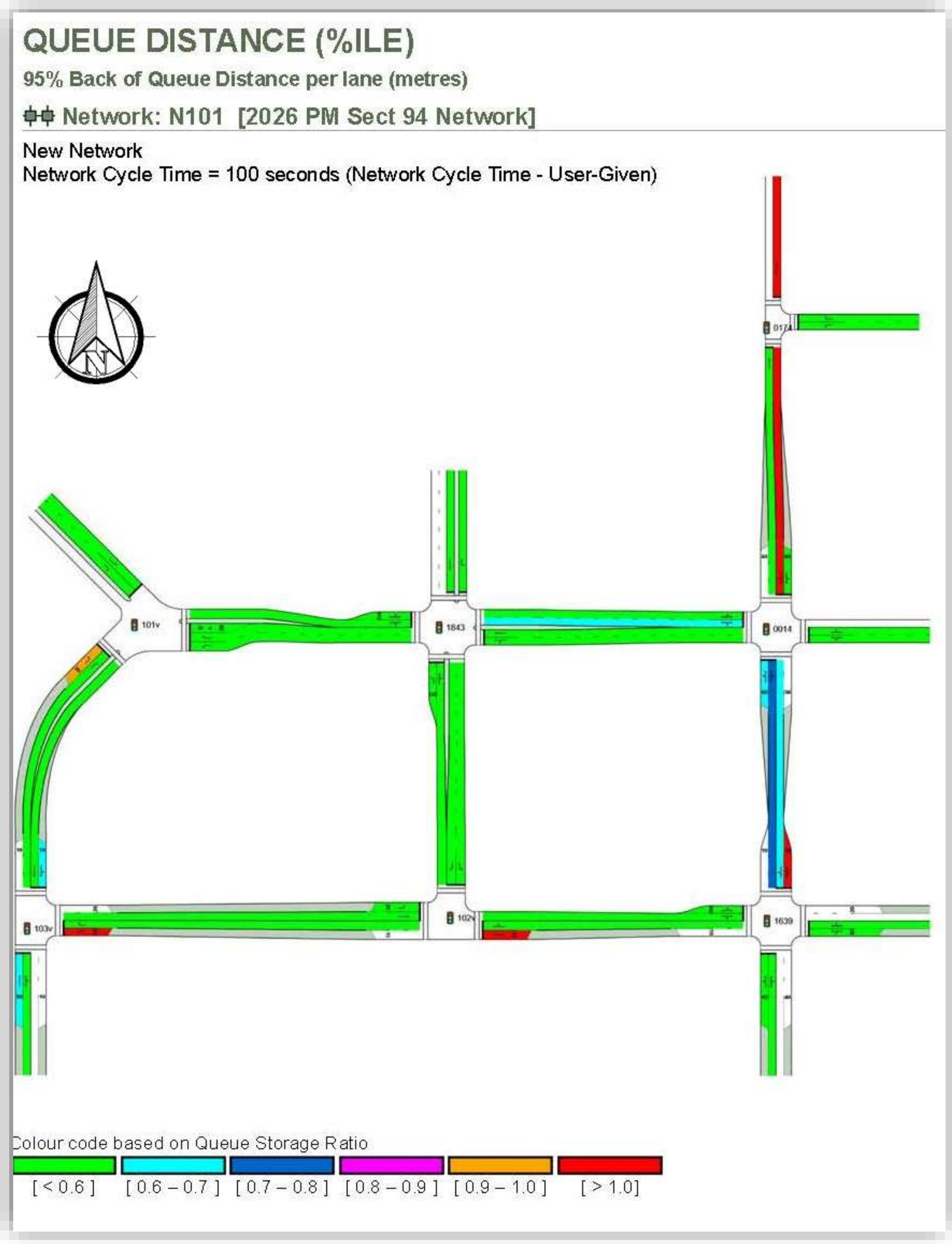

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Figure 63 ***2026 SIDRA 7 Section 94 WE Peak Network Report***

Source *Sidra/Road Delay Solutions, 2016*

NETWORK SUMMARY

Network: N101 [2026 WE Sect 94 Network]

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	4.01			
Speed Efficiency	0.46			
Congestion Coefficient	2.17			
Travel Speed (Average)	27.7 km/h		2.2 km/h	14.7 km/h
Travel Distance (Total)	4919.9 veh-km/h		489.3 ped-km/h	7636.0 pers-km/h
Travel Time (Total)	177.9 veh-h/h		225.1 ped-h/h	518.7 pers-h/h
Desired Speed	60.0 km/h			
Demand Flows (Total)	9843 veh/h		14598 ped/h	19111 pers/h
Arrival Flows (Total)	9843 veh/h		14598 ped/h	19111 pers/h
Percent Heavy Vehicles (Demand)	6.9 %			
Percent Heavy Vehicles (Arrival)	6.9 %			
Degree of Saturation	0.960			
Control Delay (Total)	74.52 veh-h/h		120.56 ped-h/h	262.67 pers-h/h
Control Delay (Average)	27.3 sec		29.7 sec	49.5 sec
Control Delay (Worst Lane)	77.7 sec			
Control Delay (Worst Movement)	77.7 sec		44.8 sec	77.7 sec
Geometric Delay (Average)	1.9 sec			
Stop-Line Delay (Average)	25.4 sec			
Queue Storage Ratio (Worst Lane)	0.83			
Total Effective Stops	6868 veh/h		11117 ped/h	23970 pers/h
Effective Stop Rate	0.70 per veh	1.4 per km	0.76 per ped	1.25 per pers
Proportion Queued	0.72		0.76	1.28
Performance Index	706.1		286.9	993.0
Cost (Total)	8548.75 $/h	1.74 $/km	5672.92 $/h	14221.67 $/h
Fuel Consumption (Total)	624.0 L/h	126.8 mL/km		
Fuel Economy	12.7 L/100km			
Carbon Dioxide (Total)	1481.9 kg/h	301.2 g/km		
Hydrocarbons (Total)	0.149 kg/h	0.030 g/km		
Carbon Monoxide (Total)	1.350 kg/h	0.274 g/km		
NOx (Total)	2.781 kg/h	0.565 g/km		

Network Model Accuracy Level (largest change in degree of saturation for any lane): 1.4 %
Number of Iterations: 10
Network Level of Service (LOS) Method: SIDRA Speed Efficiency.
Setup used: New South Wales.

Network Performance - Annual Values			
Performance Measure	Vehicles	Pedestrians	Persons
Demand Flows (Total)	4,724,716 veh/y	7,006,990 ped/y	9,173,380 pers/y
Delay	35,768 veh-h/y	57,869 ped-h/y	126,080 pers-h/y
Effective Stops	3,296,465 veh/y	5,336,396 ped/y	11,505,400 pers/y
Travel Distance	2,361,572 veh-km/y	234,876 ped-km/y	3,665,302 pers-km/y
Travel Time	85,391 veh-h/y	108,056 ped-h/y	248,973 pers-h/y
Cost	4,103,401 $/y	2,723,002 $/y	6,826,403 $/y
Fuel Consumption	299,508 L/y		
Carbon Dioxide	711,304 kg/y		
Hydrocarbons	71 kg/y		
Carbon Monoxide	648 kg/y		
NOx	1,335 kg/y		

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Figure 64 2026 SIDRA 7 Section 94 WE Peak 95th % Queues

Source Sidra/Road Delay Solutions, 2016

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6.15 2026 Plaza Development Model

(2026AMDV.PLT/2026PMDV.PLT/26AMWEDV.PLT)

The third scenario model of the Year 2026 includes the impacts of the Burwood Place Development.

The Plaza 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 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 within the town centre.*

The major input parameters incorporated in the 2026 Plaza 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,*
- → *The introduction of traffic generation associated with the Burwood Place development, via the proposed access locations on Railway Parade, Belmore Street and Wynne Avenue, 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 Plaza development.

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Figure 65 2026 Plaza Development Model – Road Network Treatment Options

Source Road Delay Solutions, 2016

Identifier	Proposed Road Network Component	Priority in Relation to Plaza Development	Reasoning
1	Widening of pedestrian crossings to 5m at select locations	Low	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.
4	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.
5	Retention of current intersection configuration and phasing on Burwood Road at Belmore Street	Medium	Retention of the RT movement for all vehicle classes at Railway Parade negates the need for a dedicated RT phase from Burwood Road, SB, in Burwood Road.
6	Introduction of a partial closure of Wynne Avenue, south of Railway Parade	Low	The partial closure, or narrowing, of Wynne Avenue is proposed to consolidate continuity and pedestrian mobility at the podium level, between the two Burwood Plaza development sites.
7	Introduction of priority sign controlled development access in Railway Parade	High	Required to provide access to the Burwood Plaza development. No RT from development site onto Railway Parade to be permitted.
8	Introduction of traffic signal controlled development access in Wynne Avenue	High	Required to provide access to the Burwood Plaza development and manage the movement of pedestrian across the driveway and Wynne Avenue. Possible loading dock access to also be considered prior to DA.
9	Introduction of priority sign controlled development access in Belmore Street	High	Necessary to provide access to the development.
9	Signalisation of the Railway Parade intersection with Conder Street	Medium	Signalisation will formalise pedestrian movements, efficiently manage traffic movements and allow buses to perform a 'U' turn movement to access the bus layover on the northern side of Railway Parade, adjacent to Burwood Central.
10	Signalisation of Burwood Road intersection at Victoria Street East. Buses Only RT movement from Burwood Road NB	Low	Necessary to formalise both bus and pedestrian movements. Intended to reduce the incidence of 'J' walking across Burwood Road.
11	Traffic signalisation of the Belmore Street intersection with Conder Street	Medium	Treatment will effectively manage vehicle and pedestrian movements.
12	Traffic signalisation of the Belmore Street intersection with Wynne Avenue	Medium	Treatment will effectively manage vehicle and pedestrian movements.

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Burwood Plaza currently generates some 940 vehicle trips per hour during the one (1) hour morning and evening commuter peak periods. With the proposed mixed use development the subsequent, calculated ,vehicle generation is 1,645vph during the morning AM peak and 1,555vph during the PM.

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 indicates that with the addition of the Burwood Place traffic generation, Burwood Road traffic volumes do not rise significantly. However, traffic vehicle volume increases do occur on Shaftesbury Road and Wentworth Road.

The model results would suggest that residents of the proposed Plaza development will opt for the less congested alternate, parallel, routes to avoid congestion and reduce travel times to their elected destinations, should they be outside the cordon of the town centre. This was evident from select link analysis of the development traffic generation movements.

The growth reported on Burwood Road is consistent with that reported between the years 2000 and 2016.

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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.

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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 of 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.

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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.

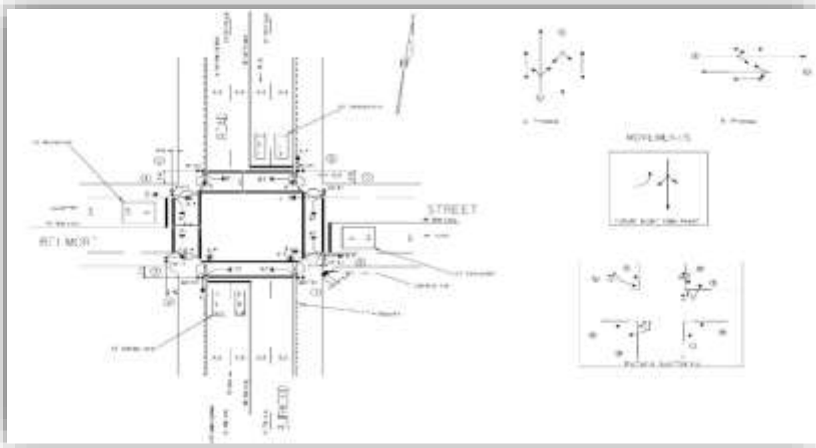
6.18 Burwood Road and Belmore Street

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 66 ***Future Right Turn Treatment at Belmore Street***

Source *Extract RMS Traffic Signal Design, 2016*



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6.19 Wynne Avenue Partial Closure

A partial closure, or narrowing, of Wynne Avenue is proposed to consolidate continuity and pedestrian mobility at the podium level, between the two Burwood Place development sites. The partial closure is to take the form of widened footway provisions and the restriction of one (1) trafficable lane each way in Wynne Avenue, south of Railway Parade, for a distance of some 81m.

A sensitivity model was built with the section of Wynne Avenue, immediately south of Railway Parade, restricted to one (1) lane in each direction with a regulated speed of 20km/hr.

The following figures depict the numerical volume difference between the development model with the partial closure of Wynne Avenue (26AMDV.PLT, 26PMDV.PLT, 26AMWEDV.PLT) minus the Wynne Avenue sensitivity model which retained Wynne Avenue open to all traffic with the introduction of traffic generation associated with the Plaza Development in 2026 (26AMDM.PLT/26PMDM.PLT/26AMWEDM.PLT). The difference plots clearly show the change in traffic volumes with the partial closure of Wynne Avenue.

Traffic volumes on Burwood Road remain relatively constant, while inherently, any increases occur in close proximity to Wynne Avenue on Railway Parade, Conder Street and Belmore Street.

Sidra network modelling of Conder Street with both the Belmore Street and Railway Parade intersections and the Belmore Street and Wynne Avenue intersection do not indicate any significant deterioration with the changed travel patterns associated with the Wynne Avenue partial closure.

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The following plots depict the difference in traffic volumes with the introduction of a single trafficable lane in each direction on Wynne Avenue between Railway Parade and the proposed access.

Further investigation is required into the operation of a partial closure of Wynne Avenue. For the purposes of the Planning Proposal modelling, all movements are permitted at the signalised intersection with Railway Parade as it impacts also the Burwood Central access.

These investigations will be undertaken in consultation with Council and any identified stakeholders early in the DA design phase.

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Figure 67 ***2026 AM Peak Wynne Avenue Difference Plot***

Source *Road Delay Solutions, 2016*

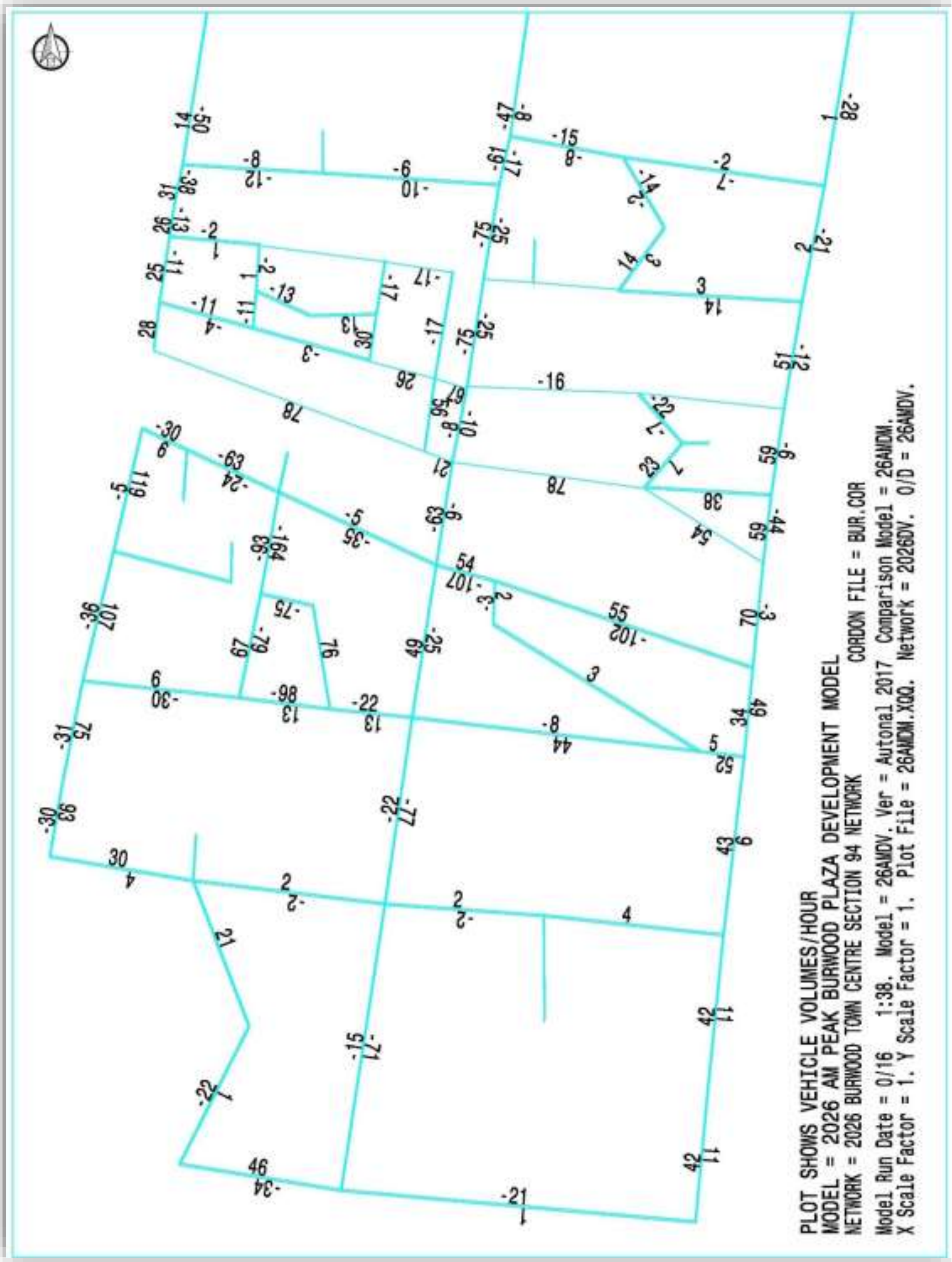

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Figure 68 ***2026 PM Peak Difference Plot***

Source *Road Delay Solutions, 2016*

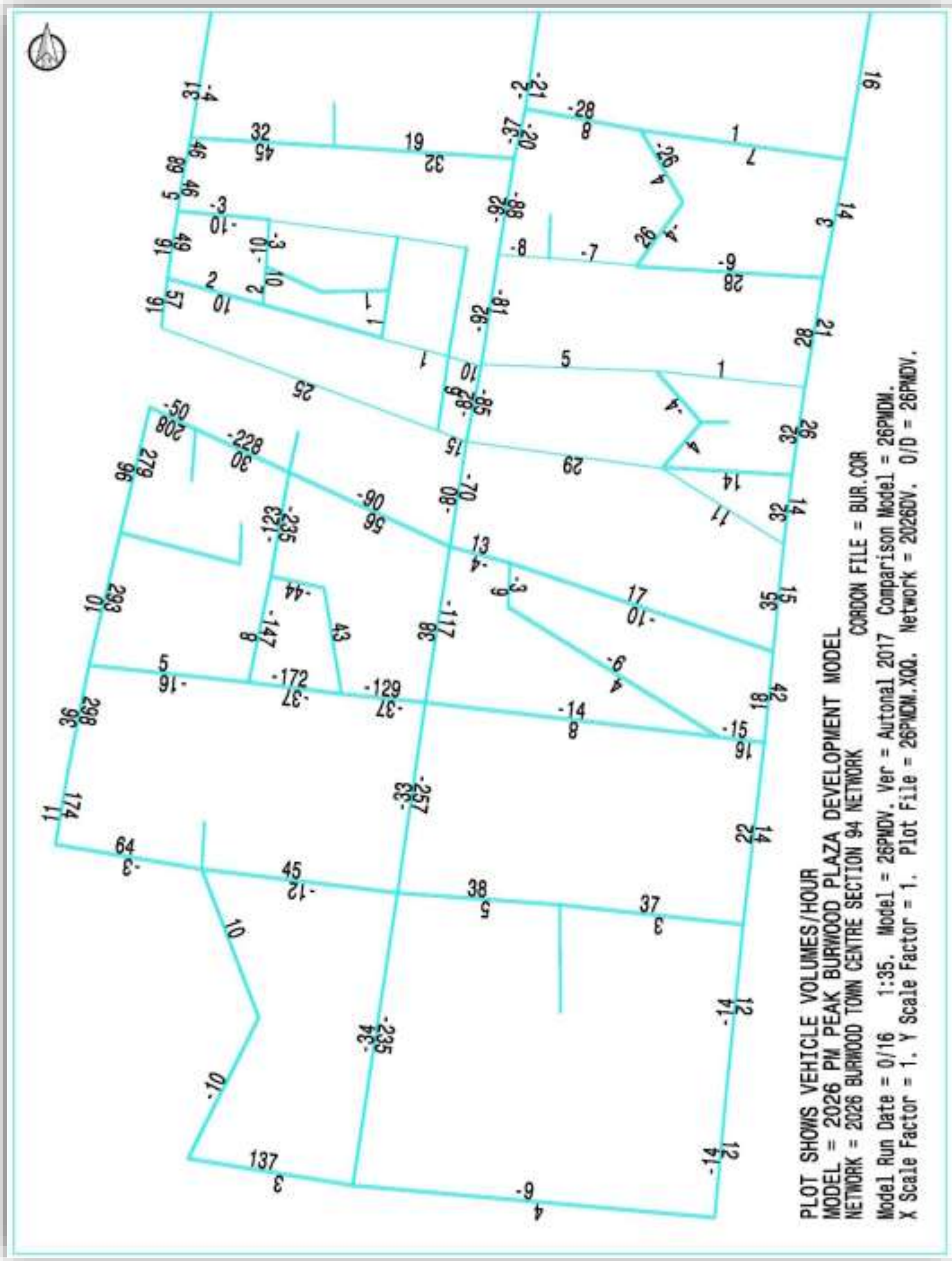

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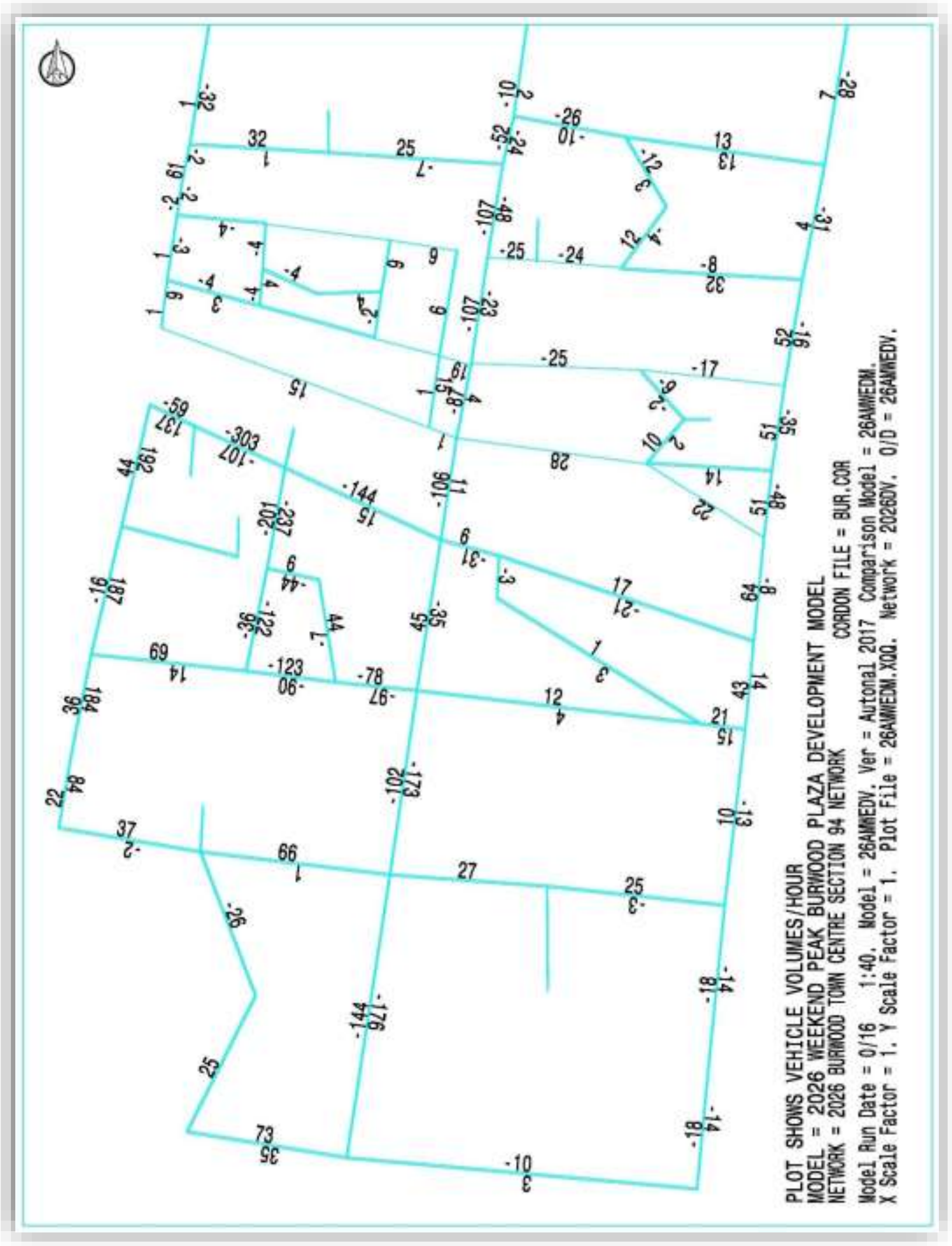
Figure 69 2026 WE Peak Difference Plot

Source Road Delay Solutions, 2016



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6.20 Railway Parade Access

The modelled access locations on Railway Parade, Wynne Avenue and Belmore Street are subject to on going discussions between the proponent, Council and key stakeholders. For the purpose of the Planning Proposal, the access locations have been tentatively located to service the two sites. Details of their design and final proposed locations are to be considered during the DA design stage.

The proposed access from Railway Parade has been found to operate at a good LoS 'A' for all peak periods. The intersection is proposed to incorporate…

- → *Sign priority control,*
- → *Modification of the central median in Railway Parade to allow for a single lane right turn movement from Railway Parade, eastbound, into the site,*
- → *Location a minimum of 60m east from the Conder Street intersection,*
- → *Clearly identified multiple lane entry for the differing uses within the site, and*
- → *Employment of a right turn ban from the site onto Railway Parade.*

The access is anticipated to cater for some 60% of the development's traffic generation and be located a minimum of 60m from Conder Street to provide satisfactory sight distance and queueing capacities.

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6.21 Wynne Avenue Access

The modelled access locations on Railway Parade, Wynne Avenue and Belmore Street are subject to on going discussions between the proponent, Council and key stakeholders. For the purpose of the Planning Proposal, the access locations have been tentatively located to service the two sites. Details of their design and final proposed locations are to be considered during the DA design stage.

Discussions are currently underway as to the viability of a possible access to the development from Wynne Avenue. Modelling reports a LoS ‘A’ at the location when servicing some 20% of the Plaza development’s traffic generation.

The site should also be considered for the introduction of a loading dock as pedestrian activity is currently low and no significant increase is foreseen.

In conjunction with the possible partial closure in Wynne Avenue, it is anticipated that the site will provide a low speed environment and reduced severity for any possible pedestrian vehichular conflicts.

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6.22 Belmore Street Access

The modelled access locations on Railway Parade, Wynne Avenue and Belmore Street are subject to on going discussions between the proponent, Council and key stakeholders. For the purpose of the Planning Proposal, the access locations have been tentatively located to service the two sites. Details of their design and final proposed locations are to be considered during the DA design stage.

Historically recognised as an access location to the former Plaza, the right of carriageway is currently under consideration for use by the development. Single lane egress is proposed.

With an anticipated 20% of development traffic generation utilising the site, modelling indicates a LoS 'A' during the peak periods.

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6.23 Railway Parade and Conder Street

The introduction of traffic signal control is proposed under Counci'ls Section 94 Infrastructure Plan.

The signalisation of the site will formalise pedestrian movements and effectively manage the increasing vehicle activity. The future signalised pedestrian crossings at the site should be designed 5m wide to increase the throughput and reduce the delay of pedestrians per phase.

Of critical note when introducing traffic signals at the aite is the inclusion of a 'U' turn provision for buses only in Railway Parade, westbound. Current bus lay over provisions on the northern side of Railway Parade, adjacent to Burwood Central, necessitate the need for a 'U' turn facility for buses only. Modelling of the site has reported a LoS 'D' with the 'U' turn movement occurring during the intergreen period, prior to 'A' phase. The movement is to be controlled by use of an exclusive 20m long bus lane and bus lantern display.

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6.24 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 Westfields.

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 will improve pedestrian safety.

The site reports a LoS 'B' during the peak periods and

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6.25 Belmore Street and Conder Street

The introduction of traffic signal control at the site is proposed under Counci'ls Section 94 Infrastructure Plan.

The signals will provide improved management and formalisation of vehicle movements and pedestrian demands.

The site reports a LoS 'B' during each of the modelled peak hour periods.

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6.26 Belmore Street and Wynne Avenue

The introduction of traffic signal control at the site is proposed under Counci'ls Section 94 Infrastructure Plan.

Once again, the introduction of traffic signals will provide improved management and formalisation of vehicle movements and pedestrian demands.

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Figure 70 ***2026 AM Peak Plaza Development Model***

Source *Road Delay Solutions, 2016*

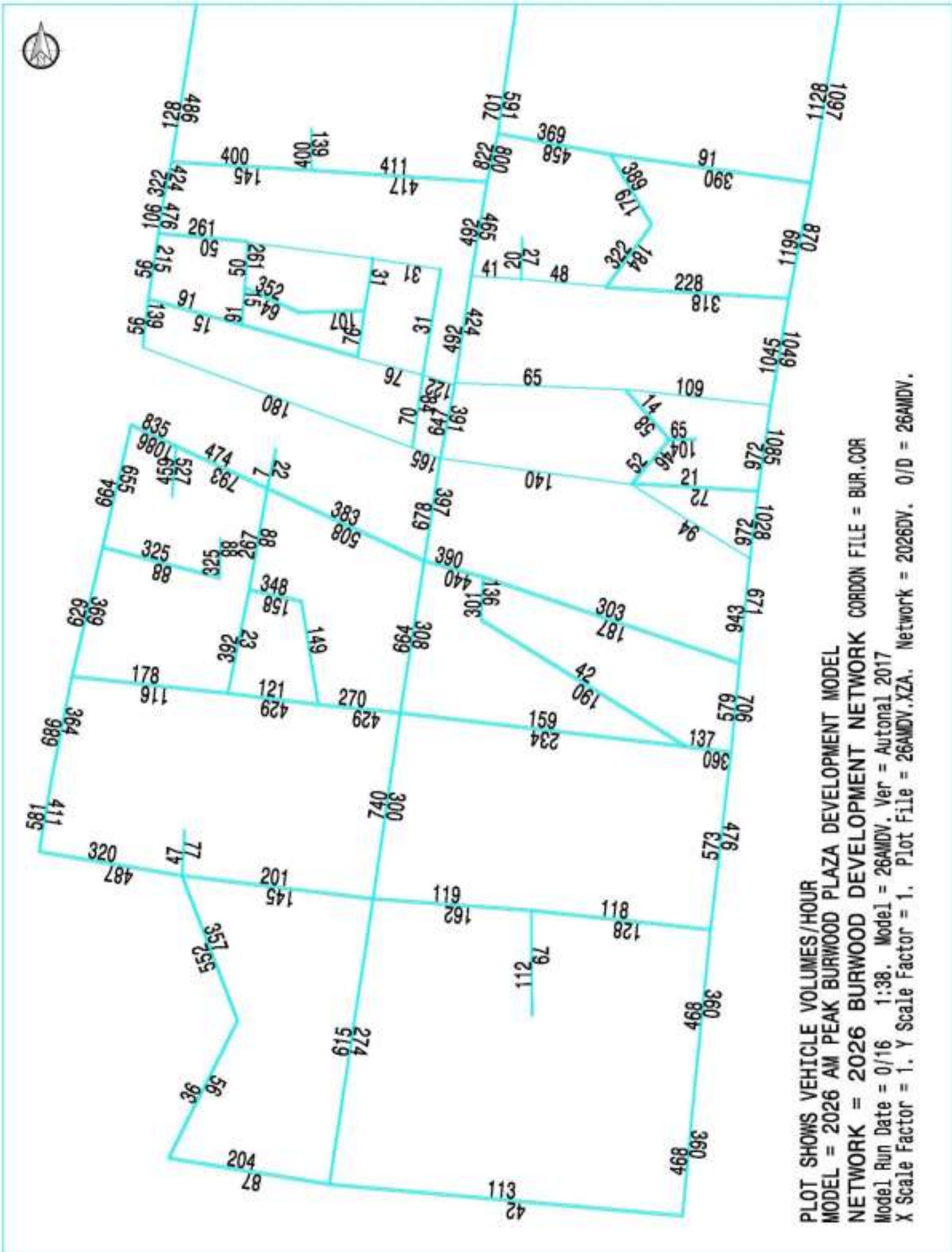

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Figure 71 ***2026 PM Peak Plaza Development Model***

Source *Road Delay Solutions, 2016*

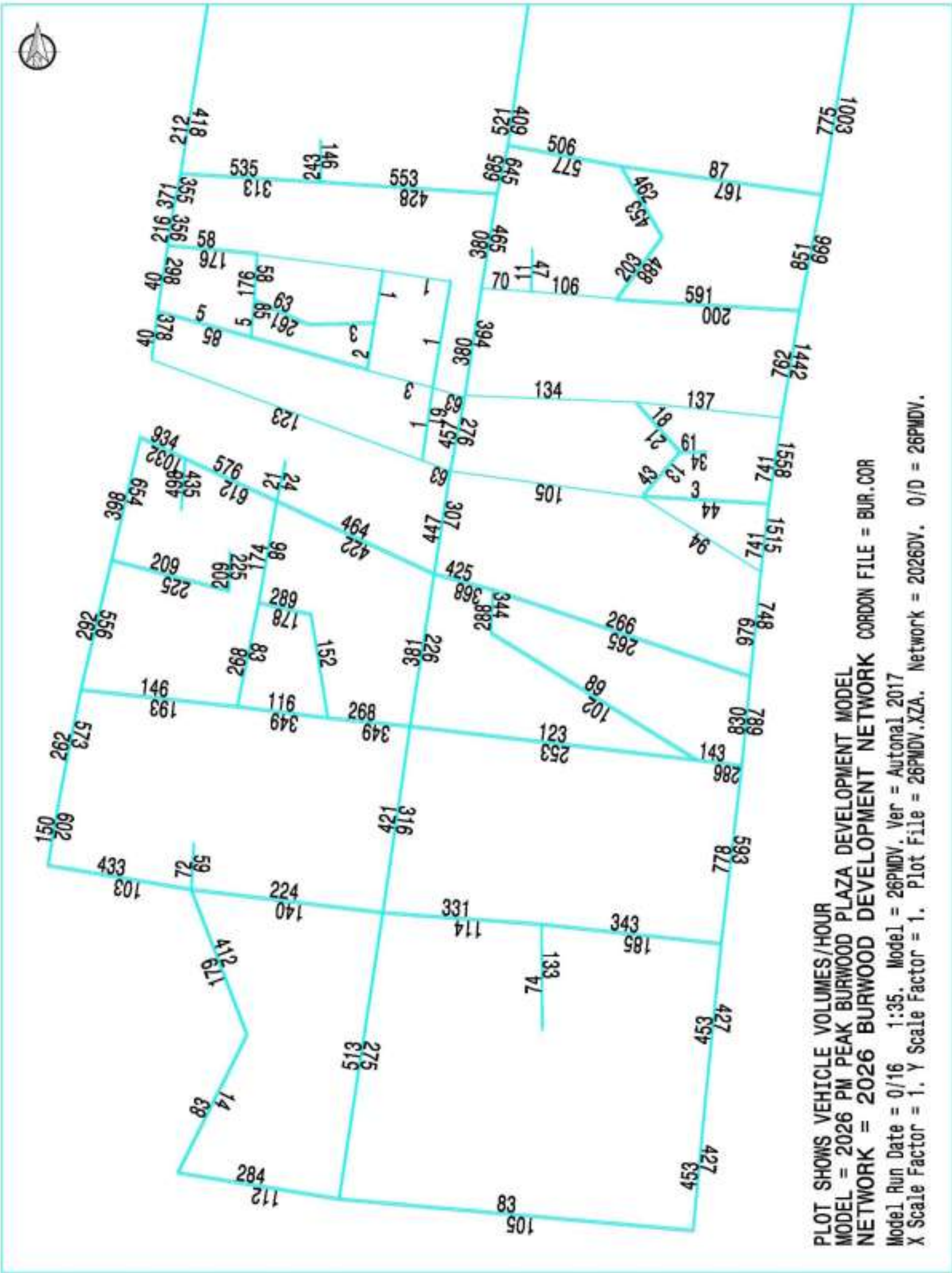

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Figure 72 ***2026 WE Peak Plaza Development Model***

Source *Road Delay Solutions, 2016*

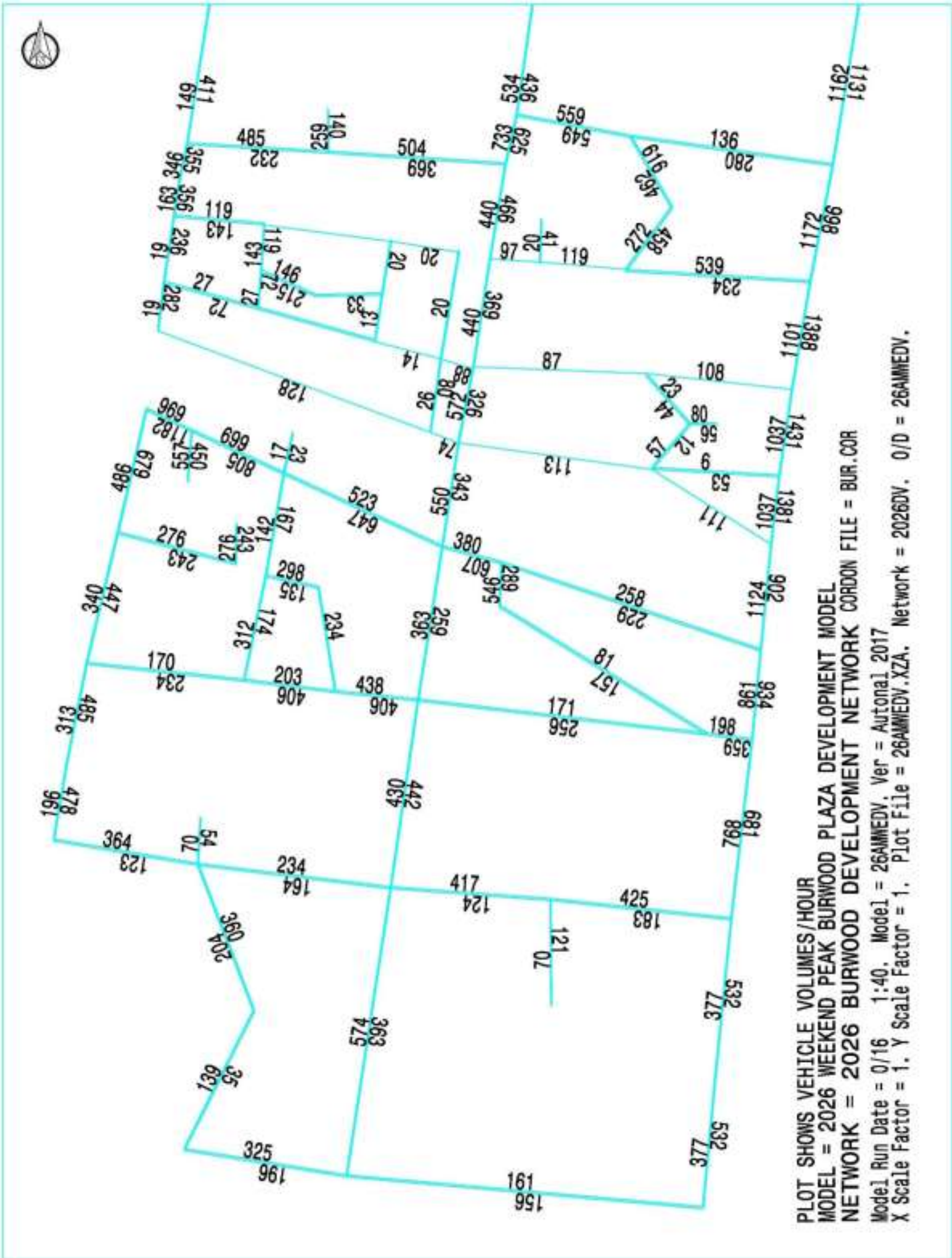

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Figure 73 ***2026 SIDRA 7 Development Model Road Network***

Source *Sidra/Road Delay Solutions, 2016*

NETWORK LAYOUT

Network: N101 [2026 AM Development Network]

SITES IN NETWORK

Site ID	Site Name
0001	2026 AM Development Burwood Rd and Victoria Street
0174	2026 AM Development Burwood Rd and Deane Street
0014	2026 AM Development Burwood Rd and Railway Pde
1639	2026 AM Development Burwood Rd and Belmore St
1843	2026 AM Development Railway Pde and Wynne Ave
101v	2026 AM Development Railway Pde and Conder St
0002	2026 AM Development Railway Parade and Access
0004	2026 AM Development Wynne Ave and Development Access
0003	2026 AM Development Belmore Street and Development Access
102v	2026 AM Development Belmore St and Wynne Ave
103v	2026 AM Development Belmore St and Conder St

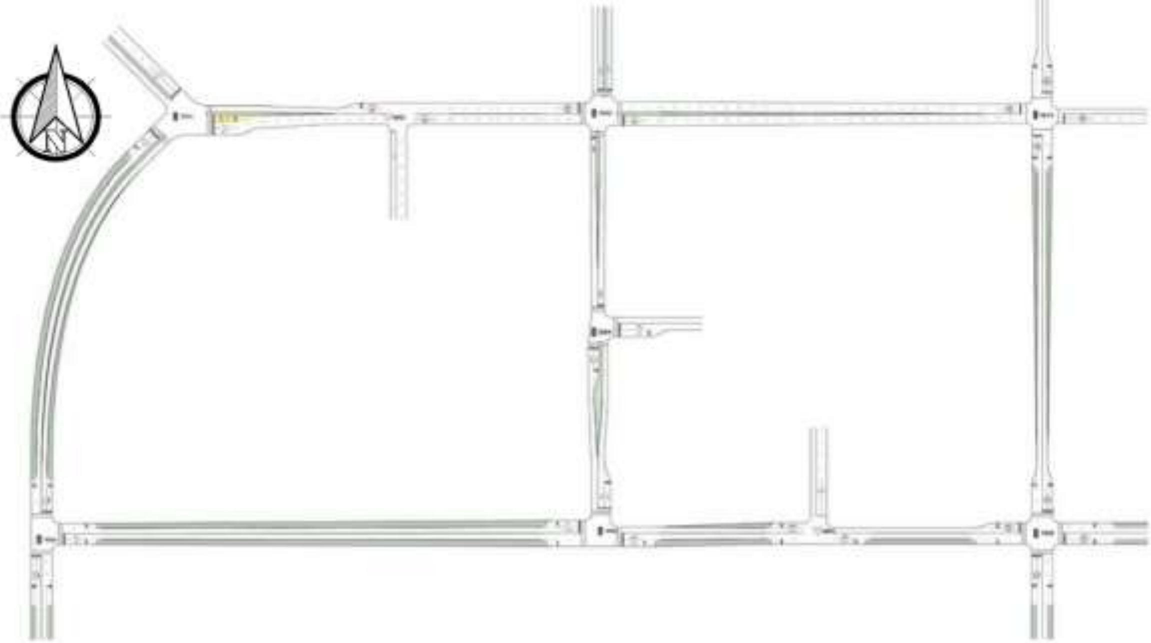

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Figure 74 ***2026 SIDRA 7 Development Model AM Peak Network Report***

Source *Sidra/Road Delay Solutions, 2016*

NETWORK SUMMARY

Network: N101 [2026 AM Development Network]

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	3.79			
Speed Efficiency	0.44			
Congestion Coefficient	2.27			
Travel Speed (Average)	26.4 km/h		2.2 km/h	16.7 km/h
Travel Distance (Total)	8534.7 veh-km/h		553.2 ped-km/h	13557.5 pers-km/h
Travel Time (Total)	322.7 veh-h/h		249.9 ped-h/h	810.6 pers-h/h
Desired Speed	60.0 km/h			
Demand Flows (Total)	15471 veh/h		16214 ped/h	26267 pers/h
Arrival Flows (Total)	15156 veh/h		16214 ped/h	26267 pers/h
Percent Heavy Vehicles (Demand)	5.1 %			
Percent Heavy Vehicles (Arrival)	5.2 %			
Degree of Saturation	1.520			
Control Delay (Total)	154.86 veh-h/h		136.13 ped-h/h	430.58 pers-h/h
Control Delay (Average)	36.8 sec		30.2 sec	59.0 sec
Control Delay (Worst Lane)	533.1 sec			
Control Delay (Worst Movement)	536.1 sec		54.7 sec	536.1 sec
Geometric Delay (Average)	2.1 sec			
Stop-Line Delay (Average)	34.7 sec			
Queue Storage Ratio (Worst Lane)	1.00			
Total Effective Stops	10264 veh/h		12261 ped/h	30411 pers/h
Effective Stop Rate	0.68 per veh	1.2 per km	0.76 per ped	1.16 per pers
Proportion Queued	0.57		0.76	1.06
Performance Index	1109.9		318.0	1427.9
Cost (Total)	15511.63 $/h	1.82 $/km	6297.71 $/h	21809.34 $/h
Fuel Consumption (Total)	1035.1 L/h	121.3 mL/km		
Fuel Economy	12.1 L/100km			
Carbon Dioxide (Total)	2452.9 kg/h	287.4 g/km		
Hydrocarbons (Total)	0.263 kg/h	0.031 g/km		
Carbon Monoxide (Total)	2.379 kg/h	0.279 g/km		
NOx (Total)	3.715 kg/h	0.435 g/km		

Network Model Accuracy Level (largest change in degree of saturation for any lane): 6.0 %
Number of Iterations: 10
Network Level of Service (LOS) Method: SIDRA Speed Efficiency.
Setup used: New South Wales.

Network Performance - Annual Values

Performance Measure	Vehicles	Pedestrians	Persons
Demand Flows (Total)	7,425,853 veh/y	7,782,569 ped/y	12,608,080 pers/y
Delay	74,332 veh-h/y	65,341 ped-h/y	206,680 pers-h/y
Effective Stops	4,926,729 veh/y	5,885,397 ped/y	14,597,110 pers/y
Travel Distance	4,096,637 veh-km/y	265,555 ped-km/y	6,507,622 pers-km/y
Travel Time	154,889 veh-h/y	119,957 ped-h/y	389,100 pers-h/y
Cost	7,445,582 $/y	3,022,903 $/y	10,468,480 $/y
Fuel Consumption	496,843 L/y		
Carbon Dioxide	1,177,397 kg/y		
Hydrocarbons	126 kg/y		
Carbon Monoxide	1,142 kg/y		
NOx	1,783 kg/y		

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Figure 75 ***2026 SIDRA 7 Development Model AM Peak 95th % Queues***

Source *Sidra/Road Delay Solutions, 2016*

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Figure 76 ***2026 SIDRA 7 Development Model PM Peak Network Report***

Source *Sidra/Road Delay Solutions, 2016*

NETWORK SUMMARY

Network: N101 [2026 PM Development Network]

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 D			
Travel Time Index	4.87			
Speed Efficiency	0.54			
Congestion Coefficient	1.86			
Travel Speed (Average)	32.3 km/h		2.2 km/h	18.2 km/h
Travel Distance (Total)	7334.9 veh-km/h		544.2 ped-km/h	11340.4 pers-km/h
Travel Time (Total)	227.0 veh-h/h		244.1 ped-h/h	623.4 pers-h/h
Desired Speed	60.0 km/h			
Demand Flows (Total)	13451 veh/h		15997 ped/h	23817 pers/h
Arrival Flows (Total)	13447 veh/h		15997 ped/h	23817 pers/h
Percent Heavy Vehicles (Demand)	5.0 %			
Percent Heavy Vehicles (Arrival)	5.0 %			
Degree of Saturation	1.021			
Control Delay (Total)	83.72 veh-h/h		131.75 ped-h/h	294.80 pers-h/h
Control Delay (Average)	22.4 sec		29.6 sec	44.6 sec
Control Delay (Worst Lane)	66.0 sec			
Control Delay (Worst Movement)	69.7 sec		44.7 sec	69.7 sec
Geometric Delay (Average)	2.3 sec			
Stop-Line Delay (Average)	20.1 sec			
Queue Storage Ratio (Worst Lane)	0.74			
Total Effective Stops	8133 veh/h		12155 ped/h	26855 pers/h
Effective Stop Rate	0.60 per veh	1.1 per km	0.76 per ped	1.13 per pers
Proportion Queued	0.58		0.76	1.12
Performance Index	811.2		311.6	1122.8
Cost (Total)	10802.68 $/h	1.47 $/km	6151.28 $/h	16953.95 $/h
Fuel Consumption (Total)	823.3 L/h	112.2 mL/km		
Fuel Economy	11.2 L/100km			
Carbon Dioxide (Total)	1950.8 kg/h	266.0 g/km		
Hydrocarbons (Total)	0.194 kg/h	0.026 g/km		
Carbon Monoxide (Total)	1.925 kg/h	0.263 g/km		
NOx (Total)	2.992 kg/h	0.408 g/km		

Network Model Accuracy Level (largest change in degree of saturation for any lane): 1.0 %
Number of Iterations: 8
Network Level of Service (LOS) Method: SIDRA Speed Efficiency.
Setup used: New South Wales.

Network Performance - Annual Values

Performance Measure	Vehicles	Pedestrians	Persons
Demand Flows (Total)	6,456,253 veh/y	7,678,485 ped/y	11,432,360 pers/y
Delay	40,184 veh-h/y	63,241 ped-h/y	141,506 pers-h/y
Effective Stops	3,903,977 veh/y	5,834,629 ped/y	12,890,340 pers/y
Travel Distance	3,520,768 veh-km/y	261,228 ped-km/y	5,443,406 pers-km/y
Travel Time	108,944 veh-h/y	117,167 ped-h/y	299,231 pers-h/y
Cost	5,185,286 $/y	2,952,612 $/y	8,137,898 $/y
Fuel Consumption	395,165 L/y		
Carbon Dioxide	936,404 kg/y		
Hydrocarbons	93 kg/y		
Carbon Monoxide	924 kg/y		
NOx	1,436 kg/y		

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Figure 77 2026 SIDRA 7 Development Model PM Peak 95th % Queues

Source Sidra/Road Delay Solutions, 2016

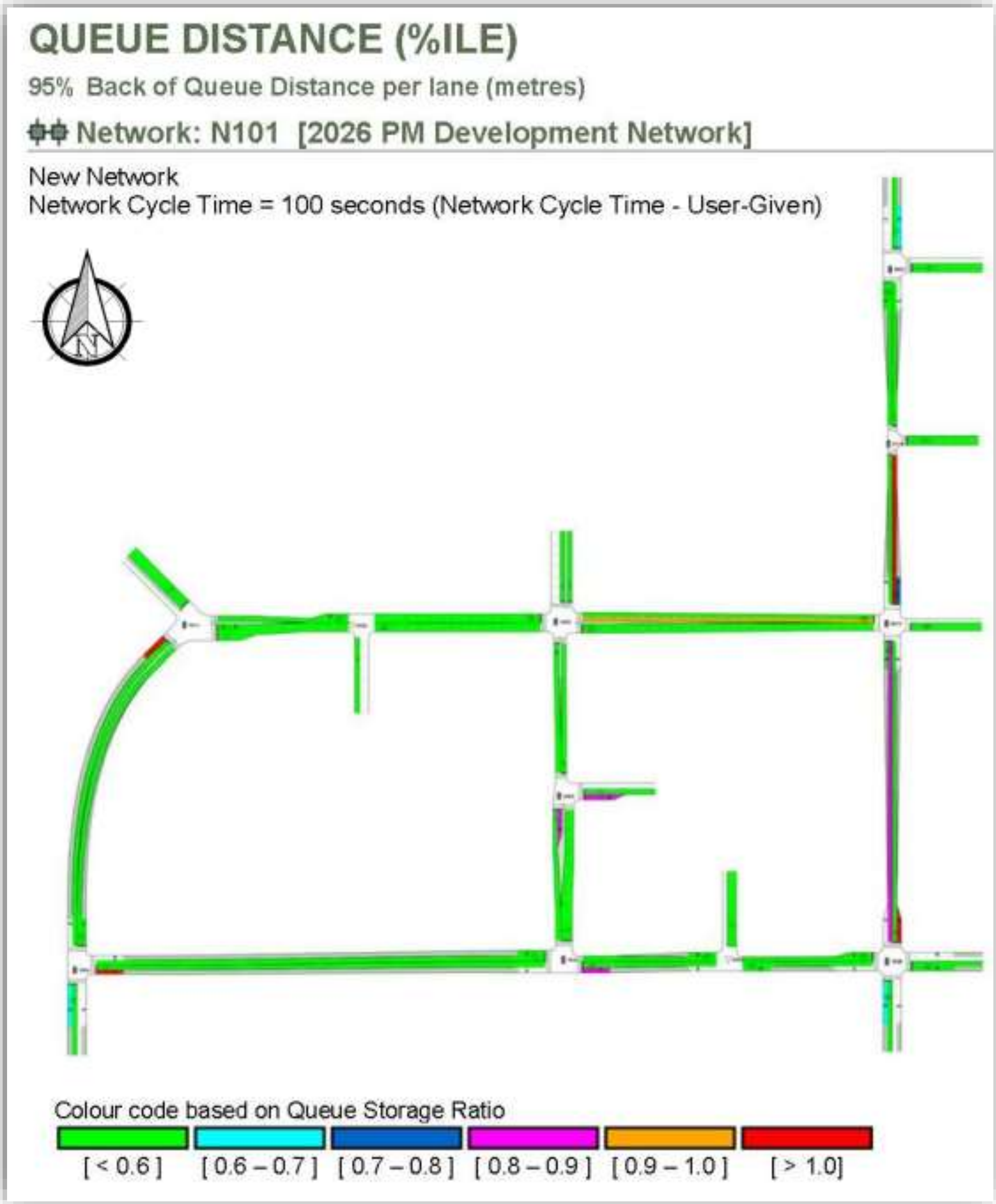

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Figure 78 ***2026 SIDRA 7 Development Model WE Peak Network Report***

Source *Sidra/Road Delay Solutions, 2016*

NETWORK SUMMARY

Network: N101 [2026 WE Development Network]

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 D			
Travel Time Index	4.87			
Speed Efficiency	0.54			
Congestion Coefficient	1.86			
Travel Speed (Average)	32.3 km/h		2.2 km/h	19.0 km/h
Travel Distance (Total)	8087.2 veh-km/h		537.4 ped-km/h	11991.0 pers-km/h
Travel Time (Total)	250.3 veh-h/h		241.4 ped-h/h	632.4 pers-h/h
Desired Speed	60.0 km/h			
Demand Flows (Total)	15304 veh/h		15707 ped/h	26160 pers/h
Arrival Flows (Total)	15304 veh/h		15707 ped/h	26160 pers/h
Percent Heavy Vehicles (Demand)	4.8 %			
Percent Heavy Vehicles (Arrival)	4.8 %			
Degree of Saturation	0.946			
Control Delay (Total)	91.93 veh-h/h		130.76 ped-h/h	292.78 pers-h/h
Control Delay (Average)	21.6 sec		30.0 sec	40.3 sec
Control Delay (Worst Lane)	69.3 sec			
Control Delay (Worst Movement)	71.6 sec		44.8 sec	71.6 sec
Geometric Delay (Average)	2.1 sec			
Stop-Line Delay (Average)	19.5 sec			
Queue Storage Ratio (Worst Lane)	0.94			
Total Effective Stops	9336 veh/h		11994 ped/h	27869 pers/h
Effective Stop Rate	0.61 per veh	1.2 per km	0.76 per ped	1.07 per pers
Proportion Queued	0.59		0.76	1.06
Performance Index	894.2		308.0	1202.2
Cost (Total)	11335.23 $/h	1.40 $/km	6082.70 $/h	17417.93 $/h
Fuel Consumption (Total)	904.3 L/h	111.8 mL/km		
Fuel Economy	11.2 L/100km			
Carbon Dioxide (Total)	2141.5 kg/h	264.8 g/km		
Hydrocarbons (Total)	0.210 kg/h	0.026 g/km		
Carbon Monoxide (Total)	2.098 kg/h	0.259 g/km		
NOx (Total)	3.258 kg/h	0.403 g/km		

Network Model Accuracy Level (largest change in degree of saturation for any lane): 0.9 %
Number of Iterations: 10
Network Level of Service (LOS) Method: SIDRA Speed Efficiency.
Setup used: New South Wales.

Network Performance - Annual Values

Performance Measure	Vehicles	Pedestrians	Persons
Demand Flows (Total)	7,346,021 veh/y	7,539,537 ped/y	12,556,580 pers/y
Delay	44,126 veh-h/y	62,764 ped-h/y	140,534 pers-h/y
Effective Stops	4,481,268 veh/y	5,757,117 ped/y	13,376,910 pers/y
Travel Distance	3,881,873 veh-km/y	257,947 ped-km/y	5,755,668 pers-km/y
Travel Time	120,147 veh-h/y	115,861 ped-h/y	303,573 pers-h/y
Cost	5,440,909 $/y	2,919,698 $/y	8,360,607 $/y
Fuel Consumption	434,063 L/y		
Carbon Dioxide	1,027,921 kg/y		
Hydrocarbons	101 kg/y		
Carbon Monoxide	1,007 kg/y		
NOx	1,564 kg/y		

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Figure 79 ***2026 SIDRA 7 Development Model WE Peak 95th % Queues***

Source *Sidra/Road Delay Solutions, 2016*

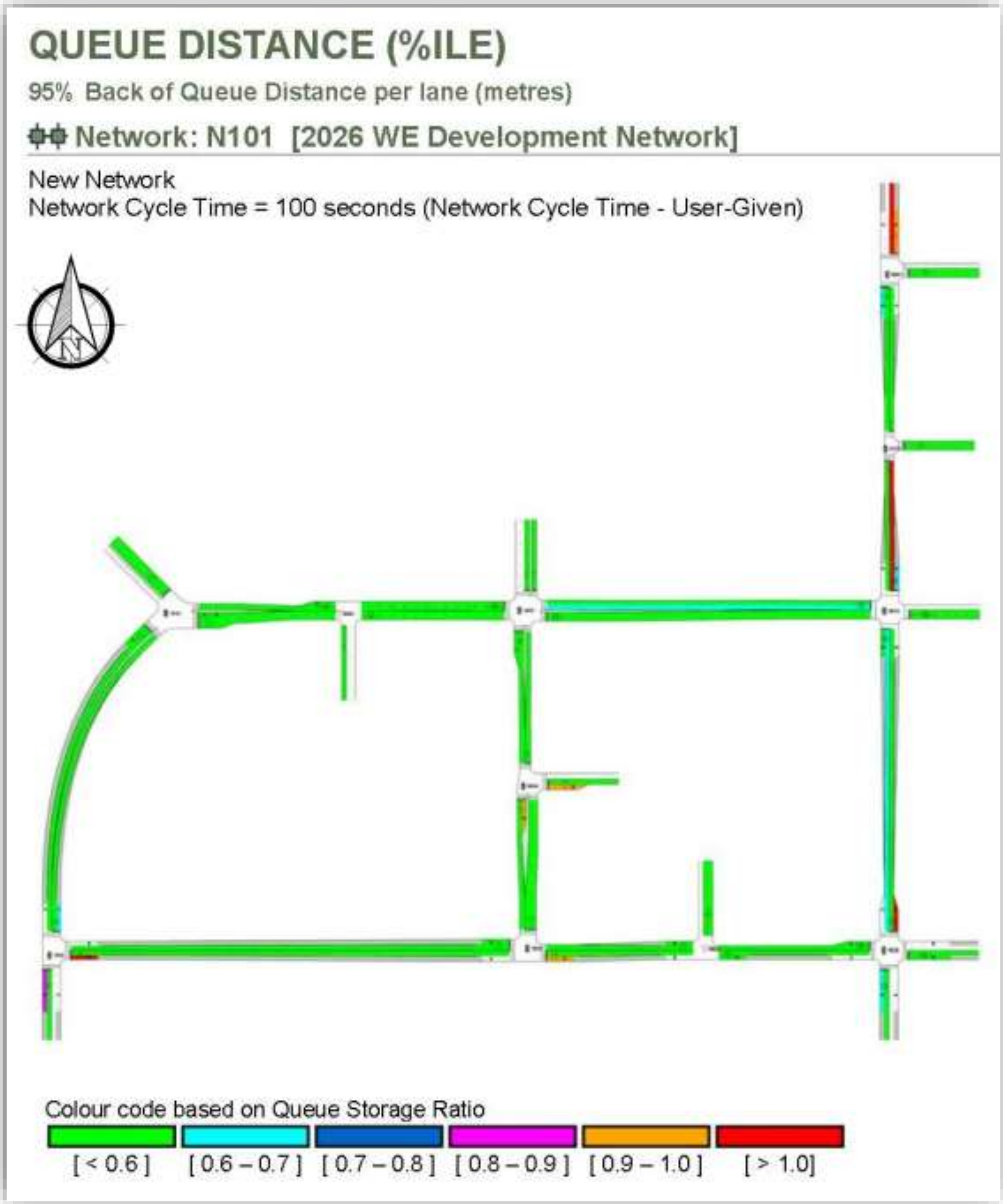

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Table 8 ***Modelled Vehicle Projections***

Source *Road Delay Solutions, 2016*

Road Link	16AM28	26AMBASE	Variance 2026 Base Model minus Existing	26AMS94	Variance 2026 S94 Model minus Existing	26AMDV	Variance 2026 Plaza Model minus Existing	16PM23	26PMBASE	Variance 2026 Base Model minus Existing	26PMS94	Variance 2026 S94 Model minus Existing	26PMDV	Variance 2026 Plaza Model minus Existing	16AMWE17	26AMWEBA	Variance 2026 Base Model minus Existing	26AMWE94	Variance 2026 S94 Model minus Existing	26AMWEDV	Variance 2026 Plaza Model minus Existing
	MESOSCOPIC MODEL HOURLY TRAFFIC VOLUME PROJECTIONS																				
	Model																				
BURWOOD RD NB S DEANE ST	739	792	53	831	39	678	-61	534	569	35	611	77	447	-87	570	598	28	631	61	550	-20
BURWOOD RD SB S DEANE ST	474	516	42	439	-77	397	-77	403	439	36	463	60	307	-96	426	485	59	403	-23	343	-83
BURWOOD RD NB S RAILWAY PDE	609	652	43	688	36	664	55	407	433	26	456	49	381	-26	475	508	33	428	-47	363	-112
BURWOOD RD SB S RAILWAY PDE	340	368	28	313	-55	308	-32	290	347	57	348	58	226	-64	314	330	16	273	-41	259	-55
RAILWAY PDE EB E WYNNE AVE	490	492	2	458	-34	383	-107	497	528	31	505	8	464	-33	477	490	13	548	71	523	46
RAILWAY PDE WB E WYNNE AVE	385	420	35	581	161	508	123	485	521	36	459	-26	422	-63	512	568	56	747	235	647	135
RAILWAY PDE EB W CONDER ST	660	662	2	826	164	966	306	571	651	80	728	157	883	312	658	685	27	836	178	825	167
RAILWAY PDE WB W CONDER ST	546	587	41	1091	504	1226	680	646	710	64	674	28	726	80	489	508	19	707	218	844	355
CONDER ST NB N BELMORE ST	413	436	23	540	104	629	216	232	268	36	210	-22	292	60	260	299	39	275	15	340	80
CONDER ST SB N BELMORE ST	177	194	17	248	54	369	192	297	300	3	282	-15	556	259	230	236	6	327	97	447	217
CONDER ST NB S BELMORE ST	462	492	30	622	130	686	224	206	228	22	232	26	262	56	288	336	48	357	69	313	25
CONDER ST SB S BELMORE ST	189	202	13	269	67	364	175	350	352	2	373	23	573	223	220	228	8	389	169	485	265
BELMORE ST EB E CONDER ST	174	195	21	202	7	178	4	166	181	15	195	29	146	-20	248	268	20	271	23	170	-78
BELMORE ST WB E CONDER ST	138	147	9	141	-6	116	-22	246	274	28	263	17	193	-53	209	223	14	251	42	234	25
WYNNE AVE NB N BELMORE ST	184	197	13	193	-4	392	208	160	161	1	183	23	268	108	163	163	0	209	46	312	149
WYNNE AVE SB N BELMORE ST	24	22	-2	43	21	23	-1	119	129	10	154	35	83	-36	71	76	5	86	15	174	103
BELMORE ST EB W BURWOOD RD	204	221	17	259	38	270	66	370	403	33	417	47	268	-102	390	423	33	401	11	438	48
BELMORE ST WB W BURWOOD RD	246	258	12	265	7	429	183	250	273	23	264	14	349	99	255	267	12	303	48	406	151
RAILWAY PDE EB E BURWOOD RD	432	434	2	389	-45	390	-42	405	420	15	391	-14	425	20	428	449	21	388	-40	380	-48
RAILWAY PDE WB E BURWOOD RD	325	355	30	530	175	440	115	407	456	49	387	-20	368	-39	447	461	14	660	213	607	160
DEANE ST WB E BURWOOD RD	164	201	37	102	-99	140	-24	120	124	4	86	-34	105	-15	121	132	11	106	-15	113	-8
RAILWAY CRES W BURWOOD RD	146	158	12	167	9	165	19	56	61	5	54	-2	63	7	79	92	13	88	9	74	-5
WENTWORTH ROAD NB	367	464	97	321	-143	622	255	258	254	-4	210	-48	538	280	218	319	101	296	78	564	346
WENTWORTH ROAD SB	312	353	41	344	-9	638	326	662	767	105	722	60	989	327	465	559	94	527	62	782	317
SHAFTESBURY AVENUE NB	484	570	86	600	30	573	89	679	748	69	725	46	778	99	642	703	61	724	82	768	126
SHAFTESBURY AVENUE SB	442	505	63	476	-29	476	34	465	534	69	579	114	593	128	634	622	-12	729	95	681	47

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LOADING DOCK MANAGEMENT PLAN

Prior to submission of the DA a concise Loading Dock Management Plan will be prepared and presented addressing the location, responsibilities and machinations of the dock, and its operators, outlining mitigation treatment(s), as required, to minimise the impact on the surrounding road network and its users.

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.

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CONCLUSION

Road Delay Solutions has been engaged by *Holdmark Property NSW Pty Ltd* to undertake the preparation of a Traffic Impact Assessment in support of the Planning Proposal for a mixed use development at 42-50 and 52-60 Railway Parade, Burwood, commonly known as '*Burwood Plaza*'.

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 Burwood Place development is just one of these.

This report has critically analysed the impacts of the Plaza development on the Burwood Town Centre road network and concluded that the impacts of traffic generation, both vehicular and pedestrian, is benign on a network of roads which currently operate at capacity.

The impacts of growth throughout the centre, not only that of the Burwood Place site, is able to mesh with the current travel patterns which indicate as 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 is relatively static given the corridor currently operates at capacity and any further growth is shared with the competing routes of Shaftesbury Road and Wentworth Road. Shaftesbury Road and Wentworth Road provide viable through traffic avenues 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 to sustain the movement of traffic within the town centre and support the planned level of growth anticipated with the Burwood Place development to year 2026…

→ *Widening of existing signalised foot crossings along Burwood Road between Wilga Street and Belmore Street to 5m,*

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- → *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,*
- → *Introduction of a partial closure of Wynne Avenue to accommodate a single trafficable lane in each direction, south of Railway Parade for a distance of some 81m,*
- → *The introduction of site specific access from Railway Parade, Wynne Avenue and Belmore Street,*
- → *The introduction of traffic signal control at the intersections of…*
    - o *Railway Parade and Conder Street,*
    - o *Belmore Street and Wynne Avenue,*
    - o *Belmore Street and Conder 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 Burwood Place 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.

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APPENDIX A – TRAFFIC COUNT FIELD DATA

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

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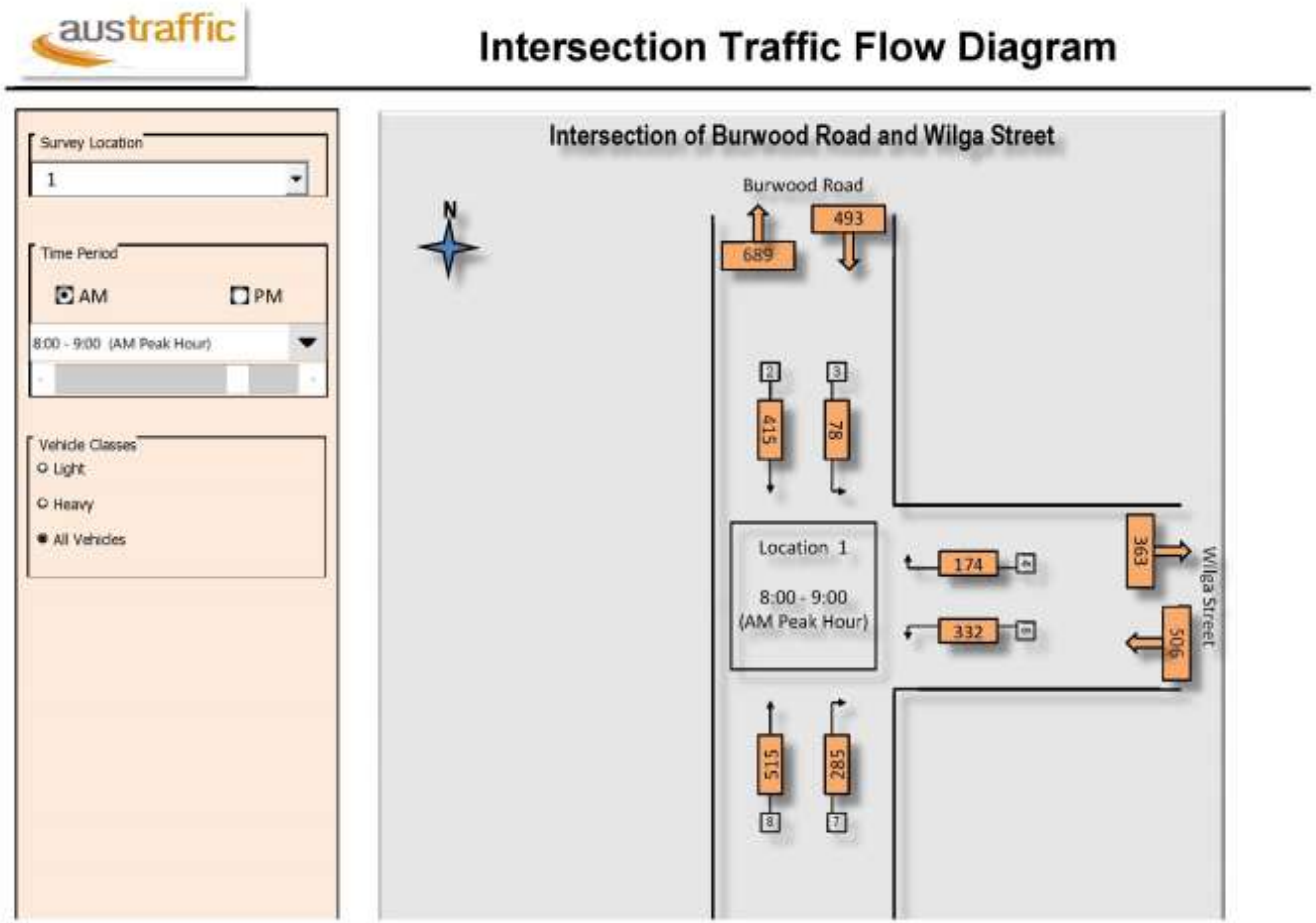

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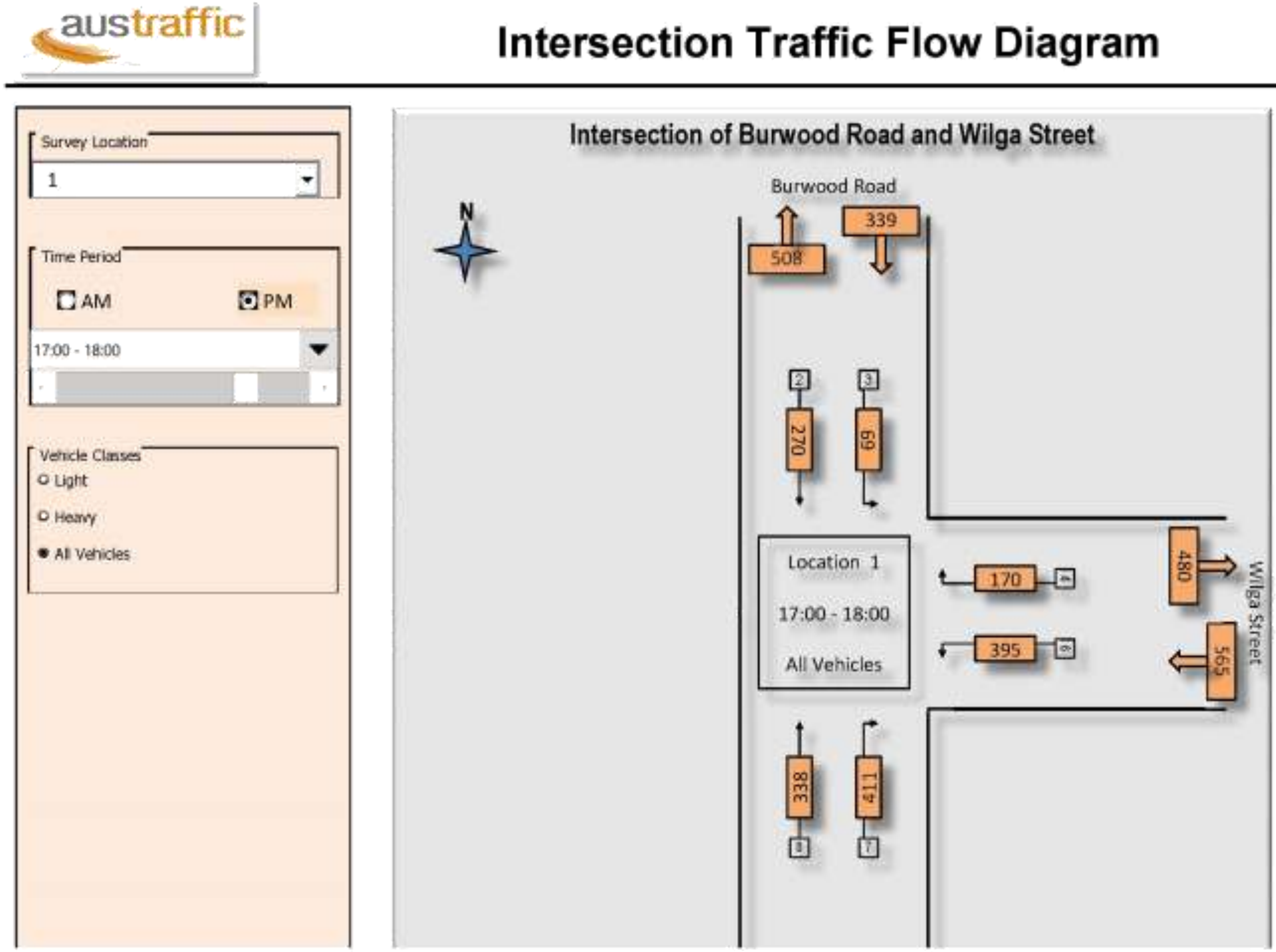
Intersection Traffic Flow Diagram



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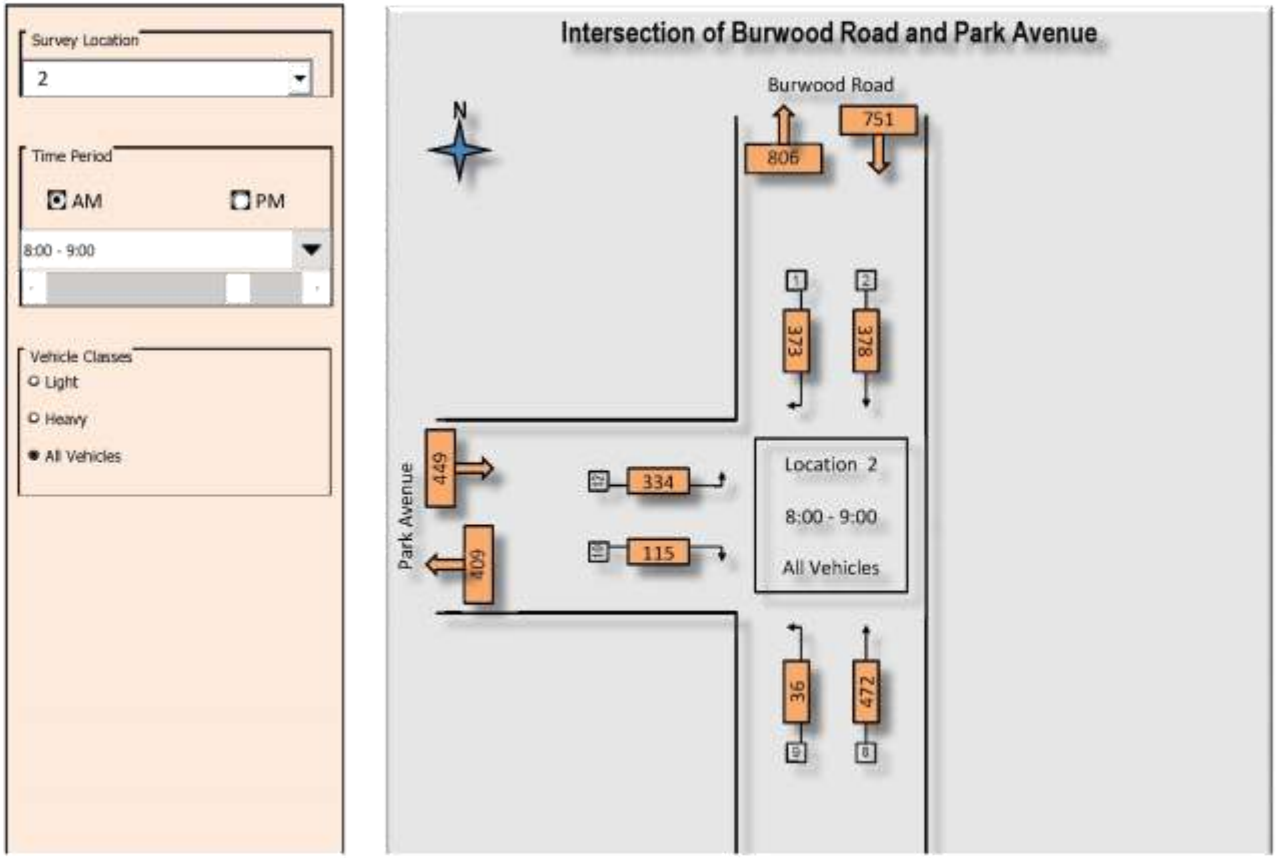
Intersection Traffic Flow Diagram



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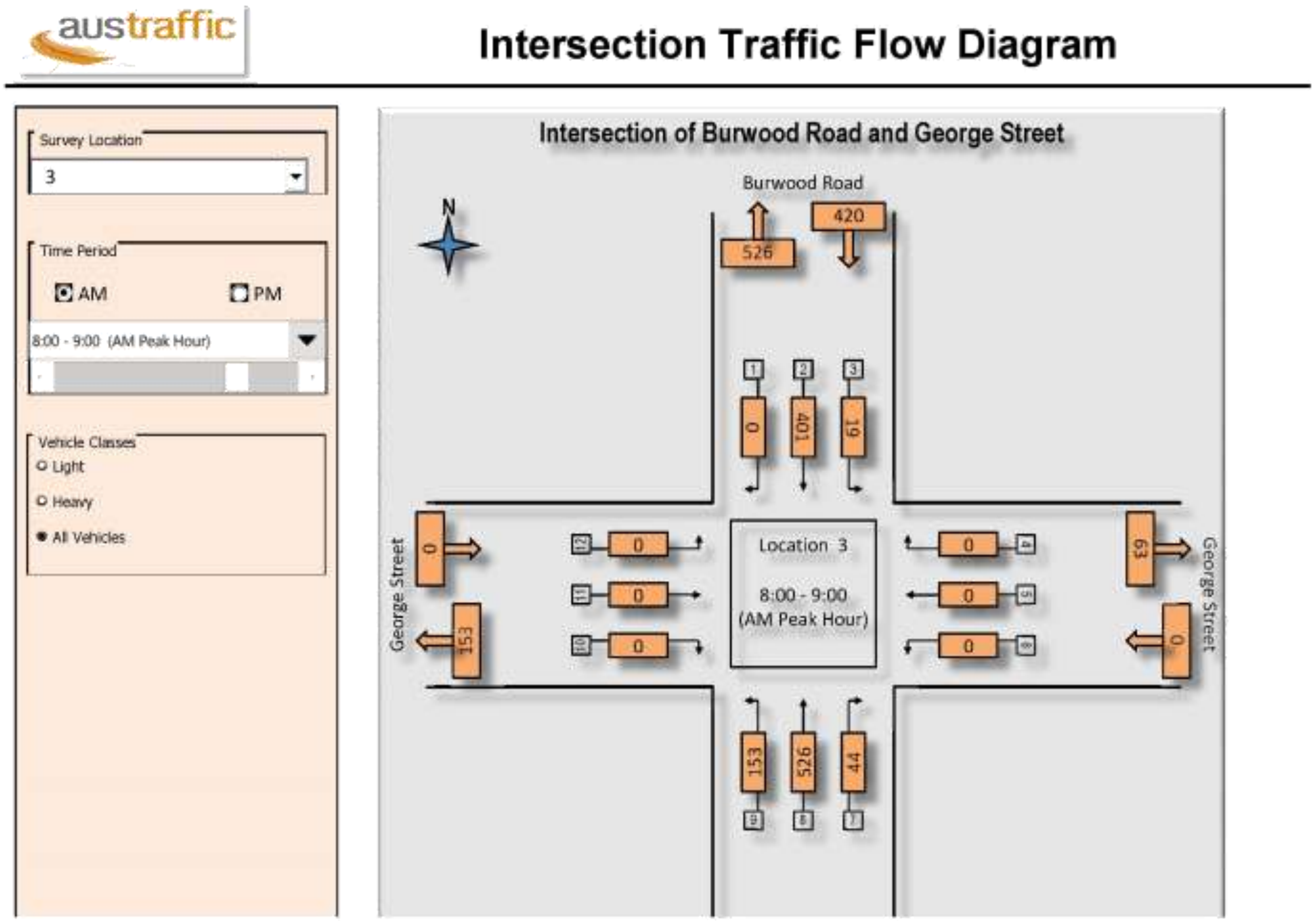

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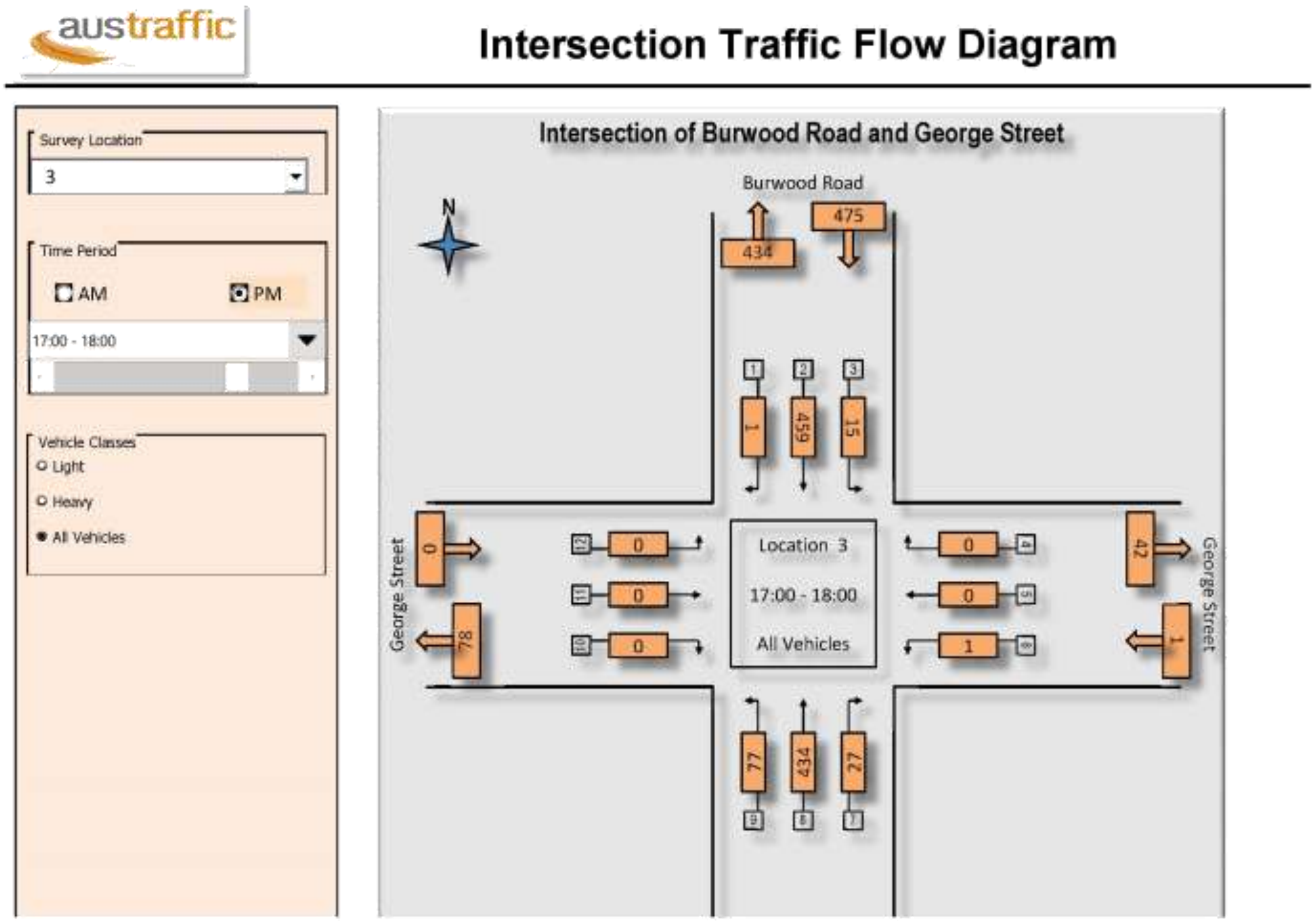

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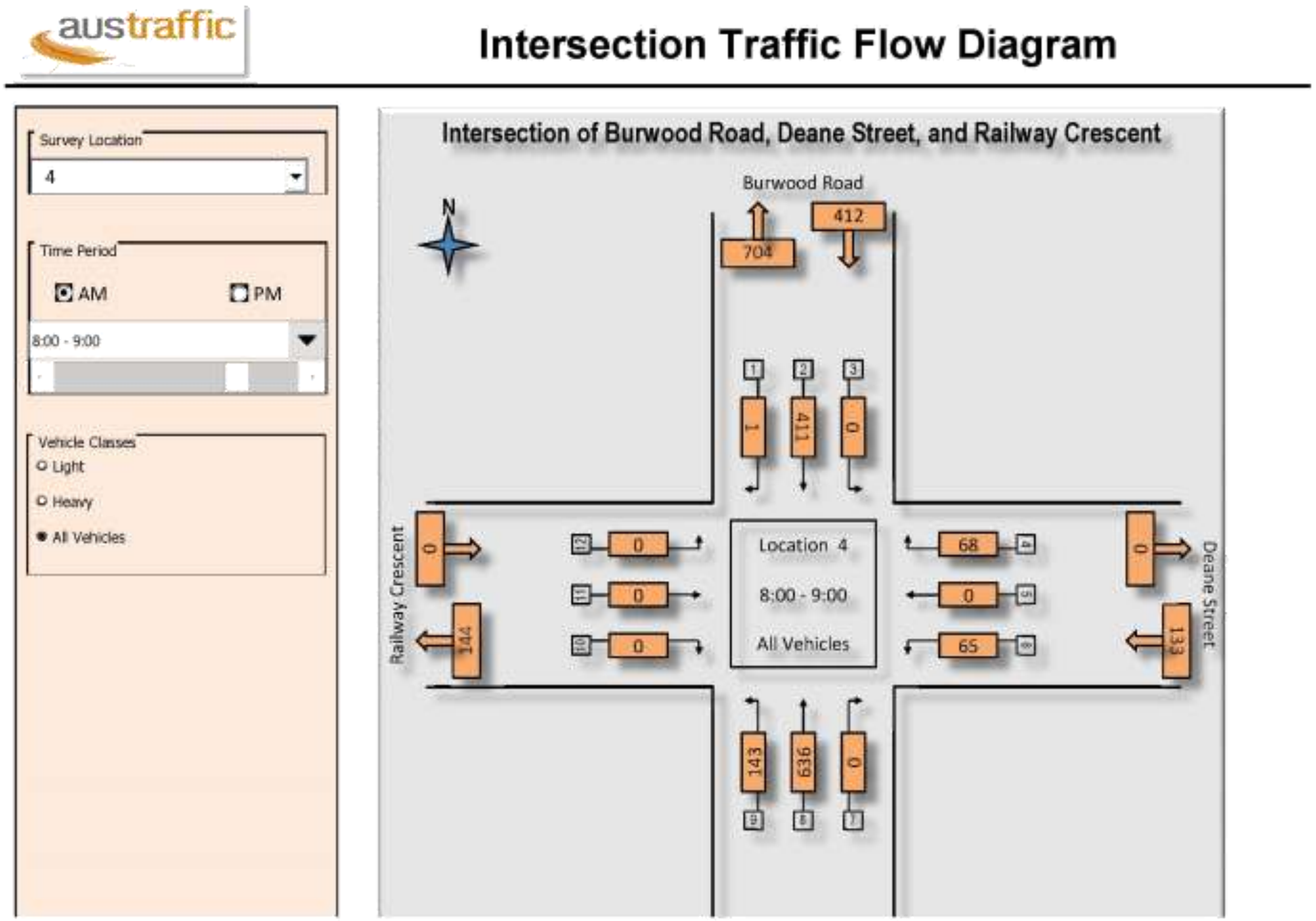

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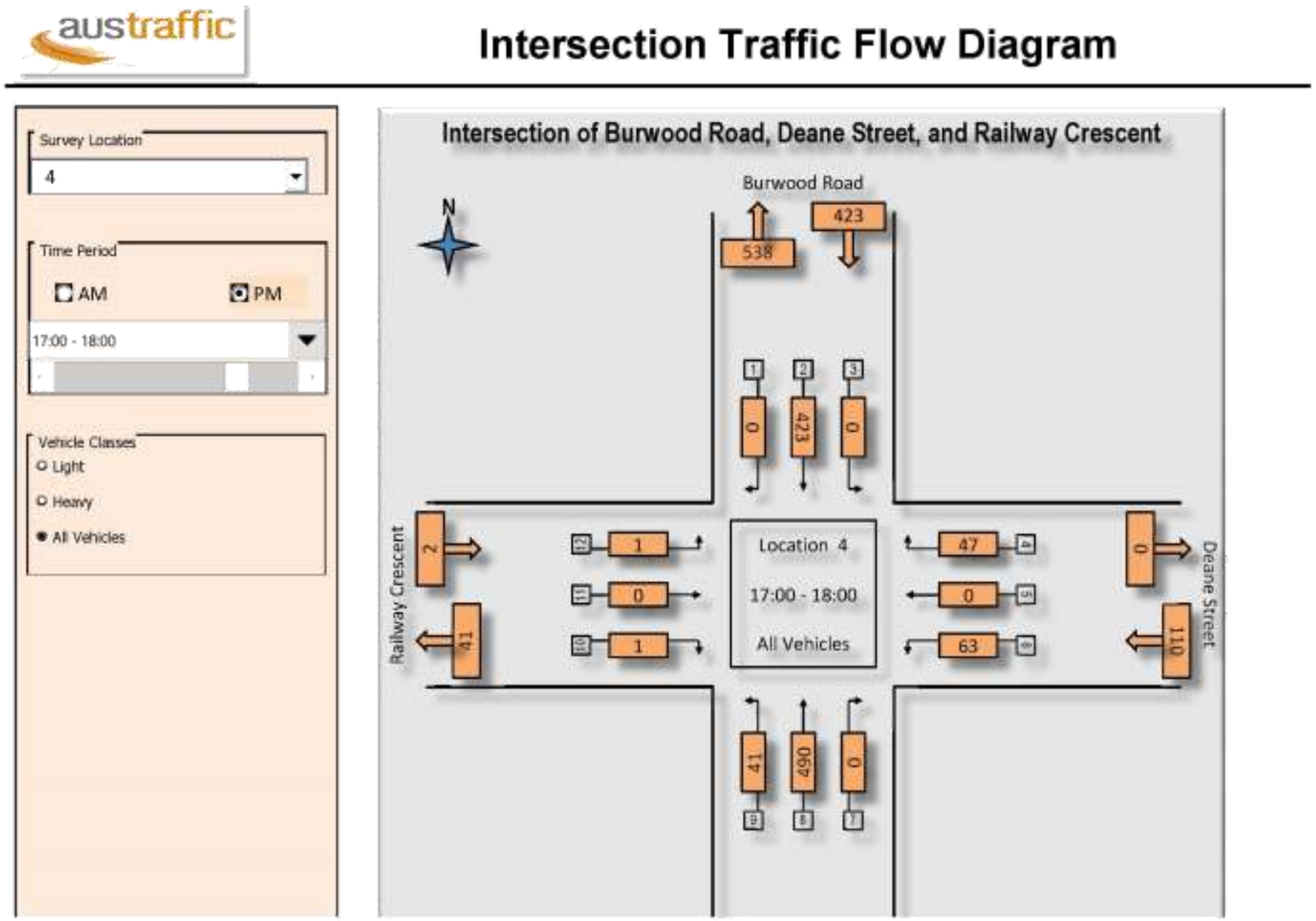

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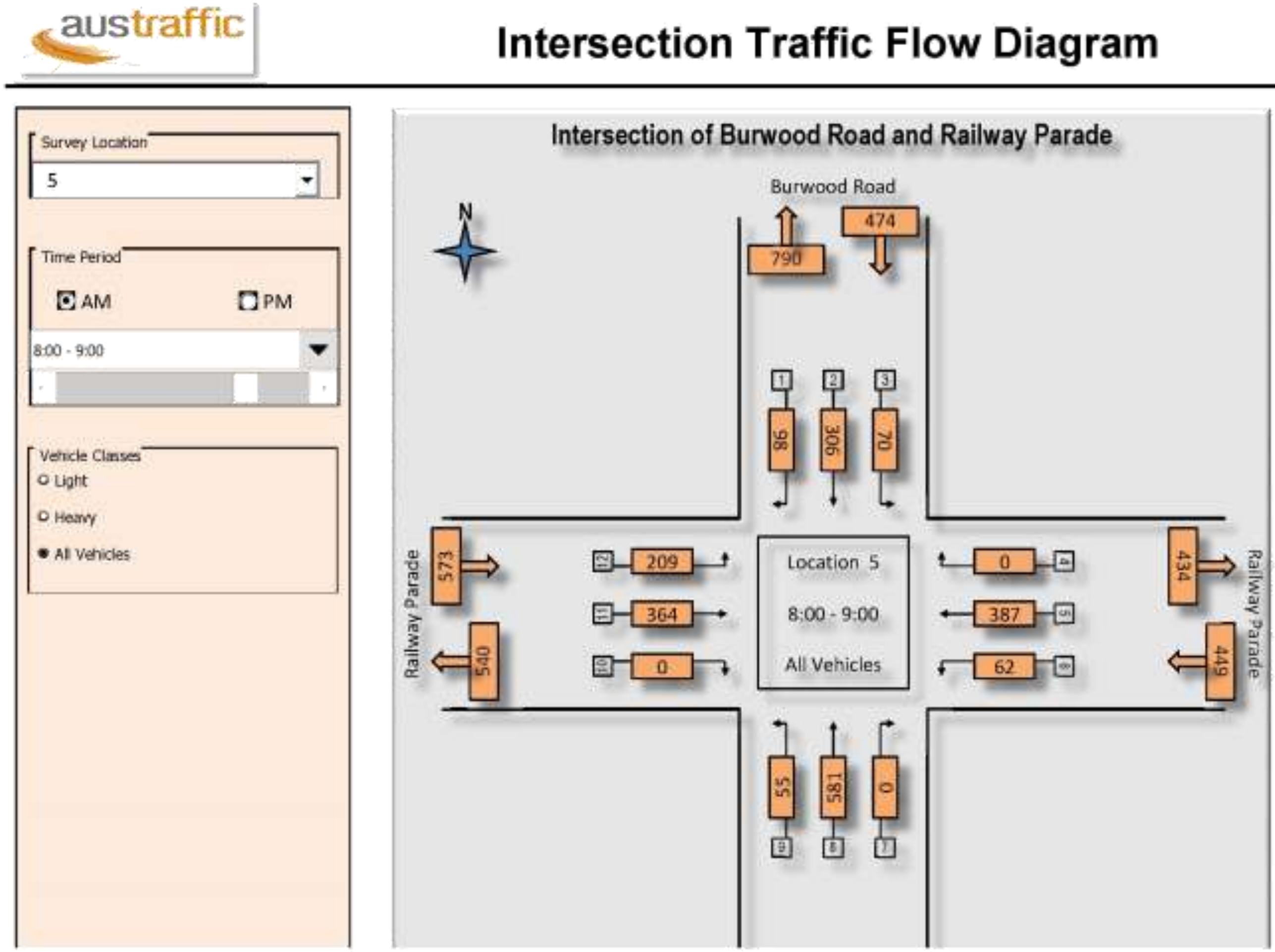
Intersection Traffic Flow Diagram



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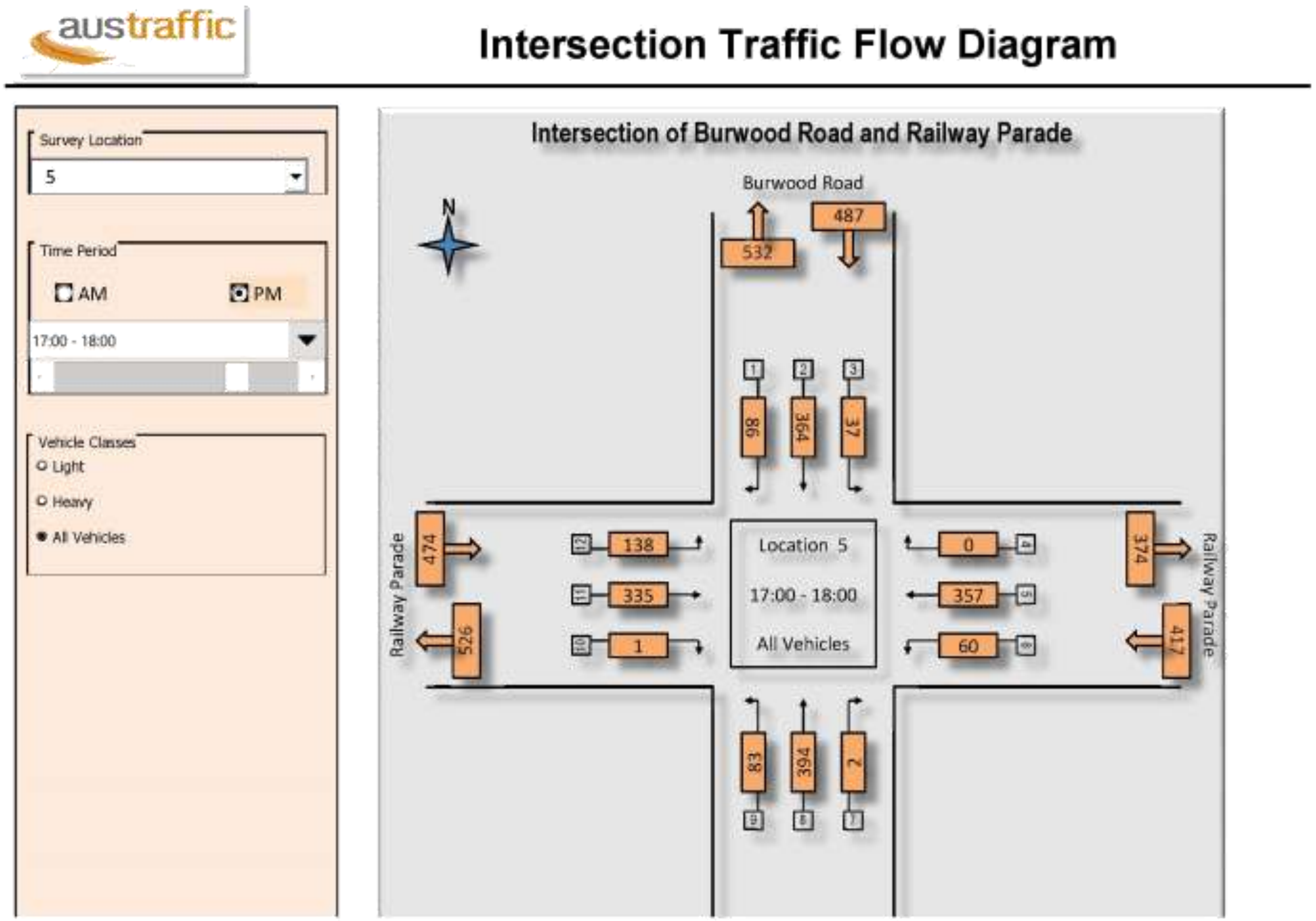

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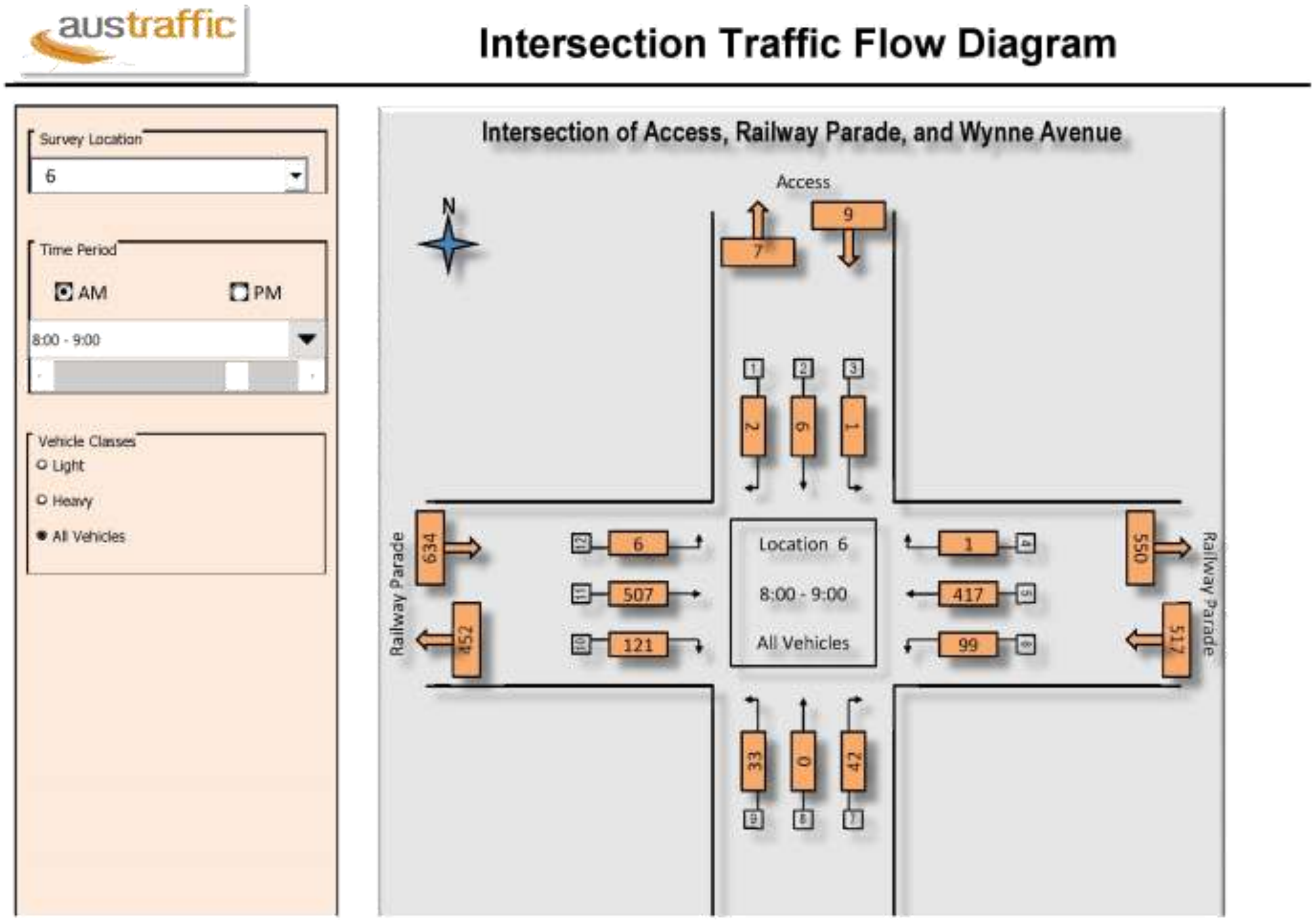

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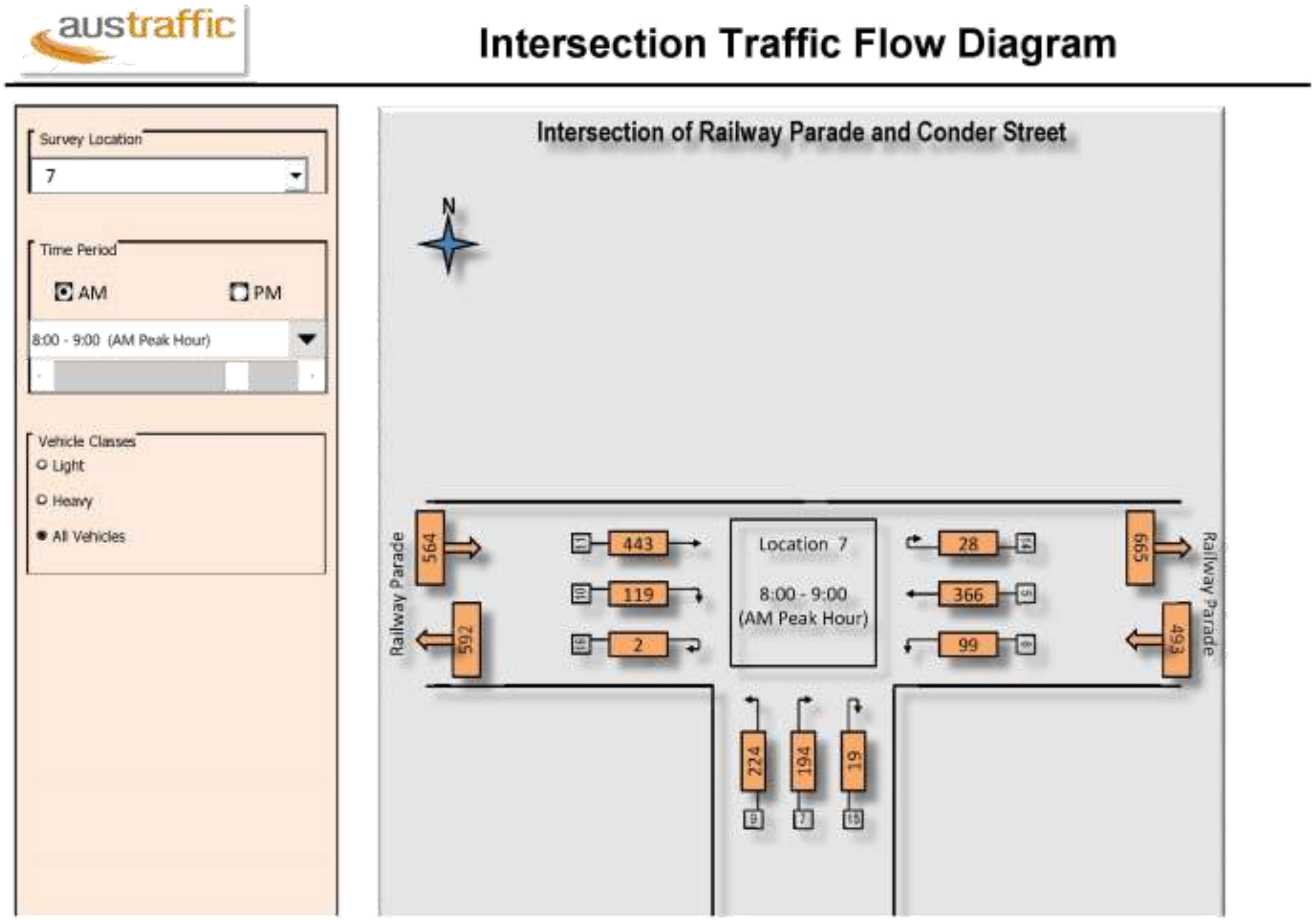

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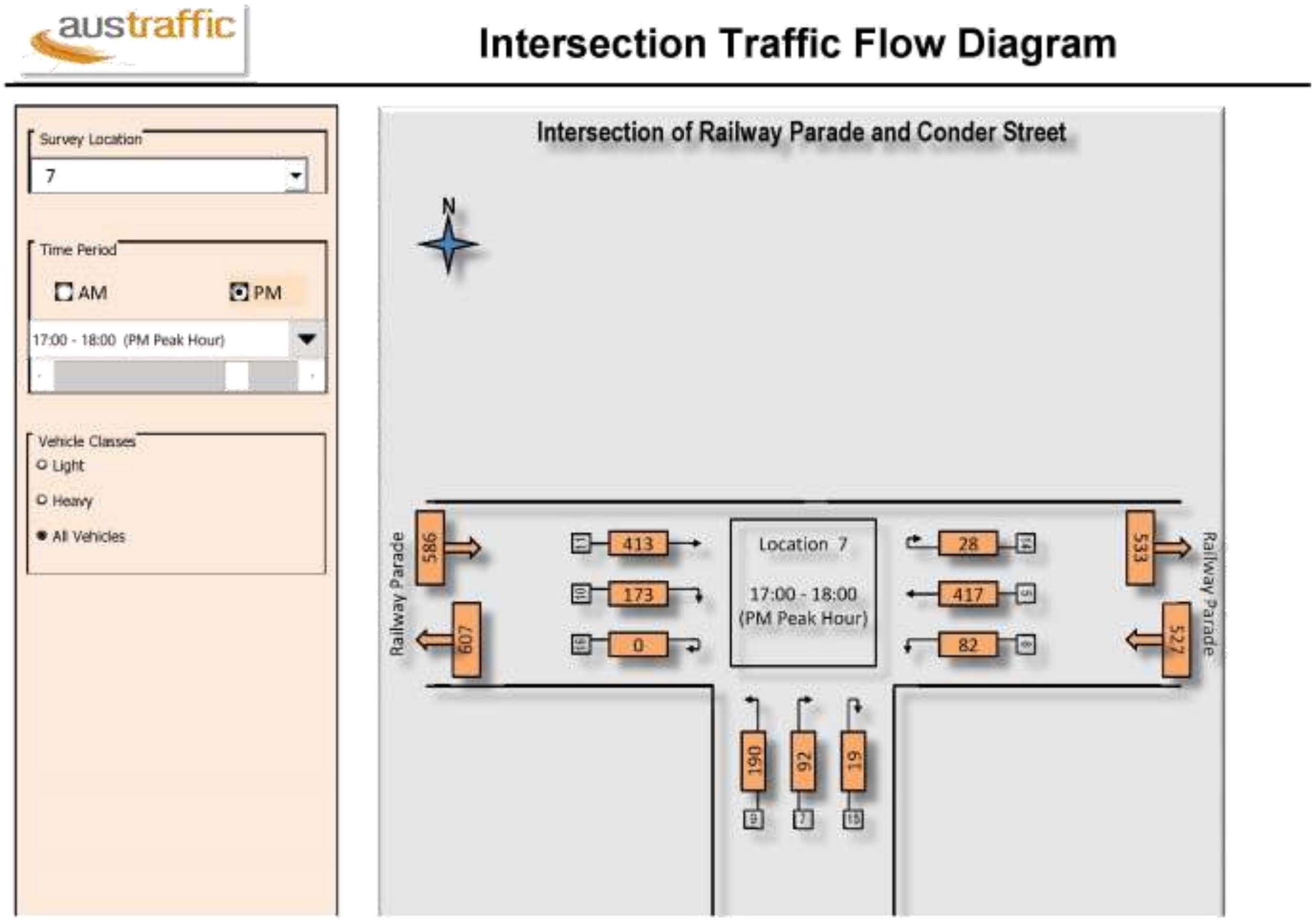

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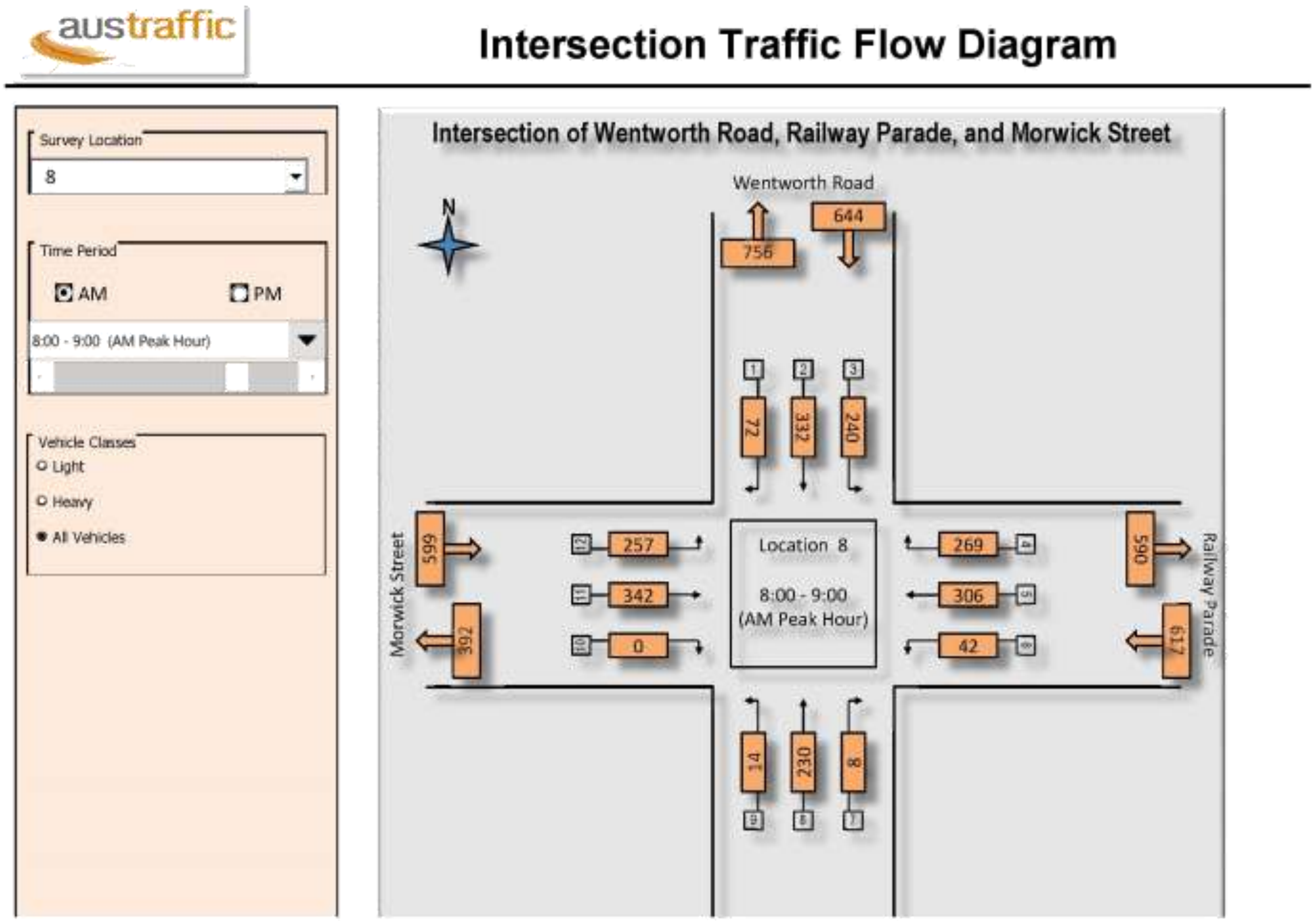

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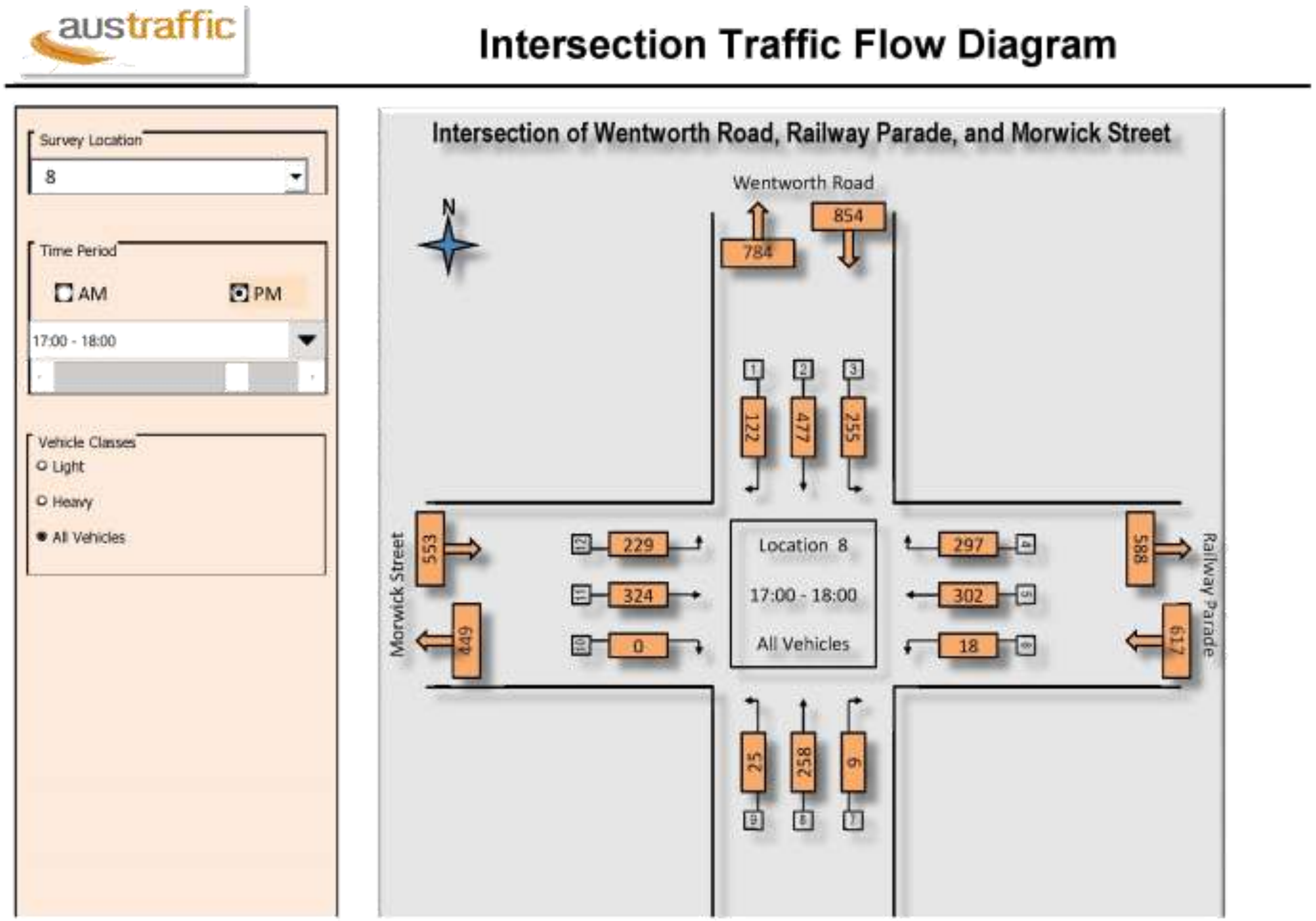

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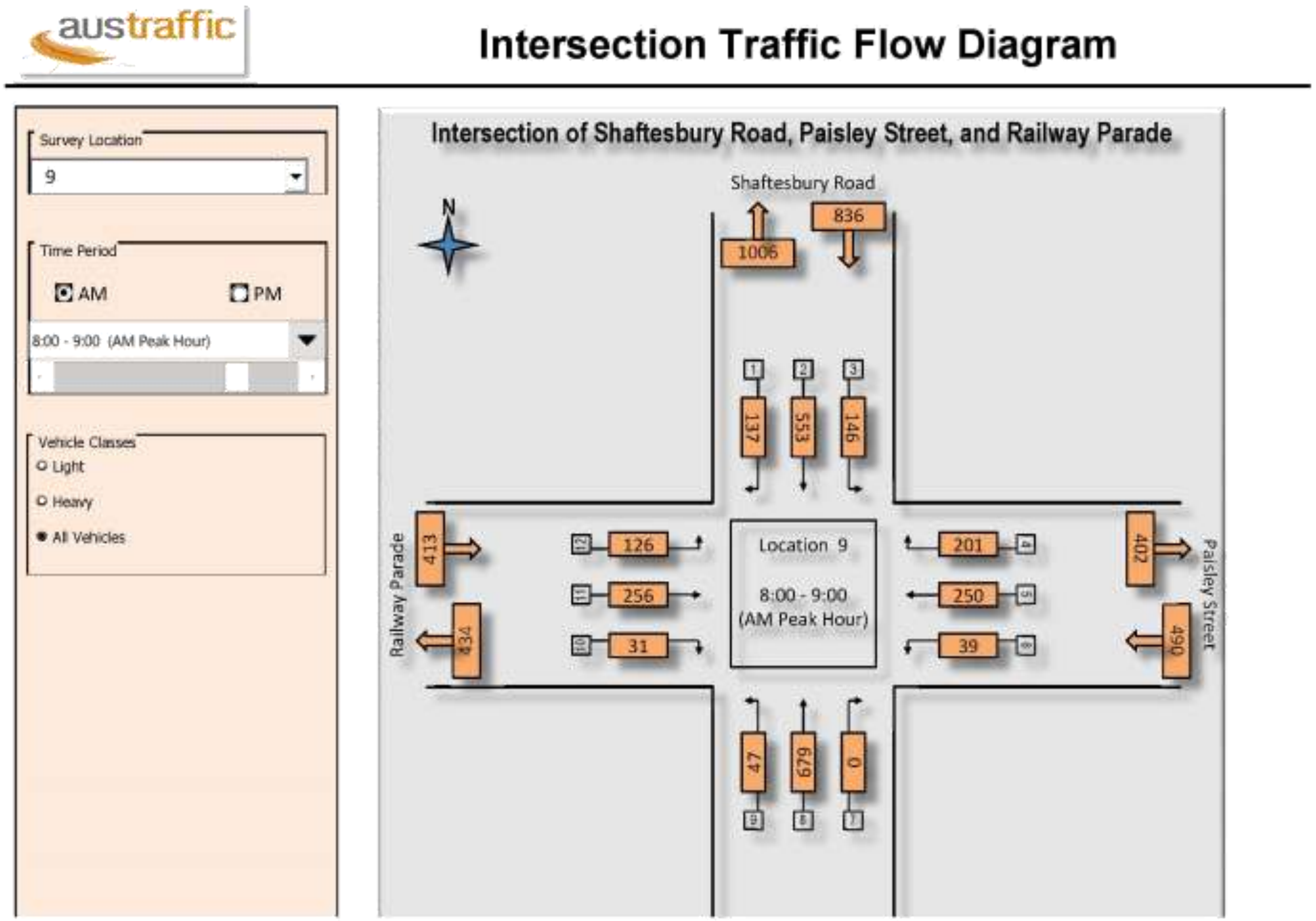

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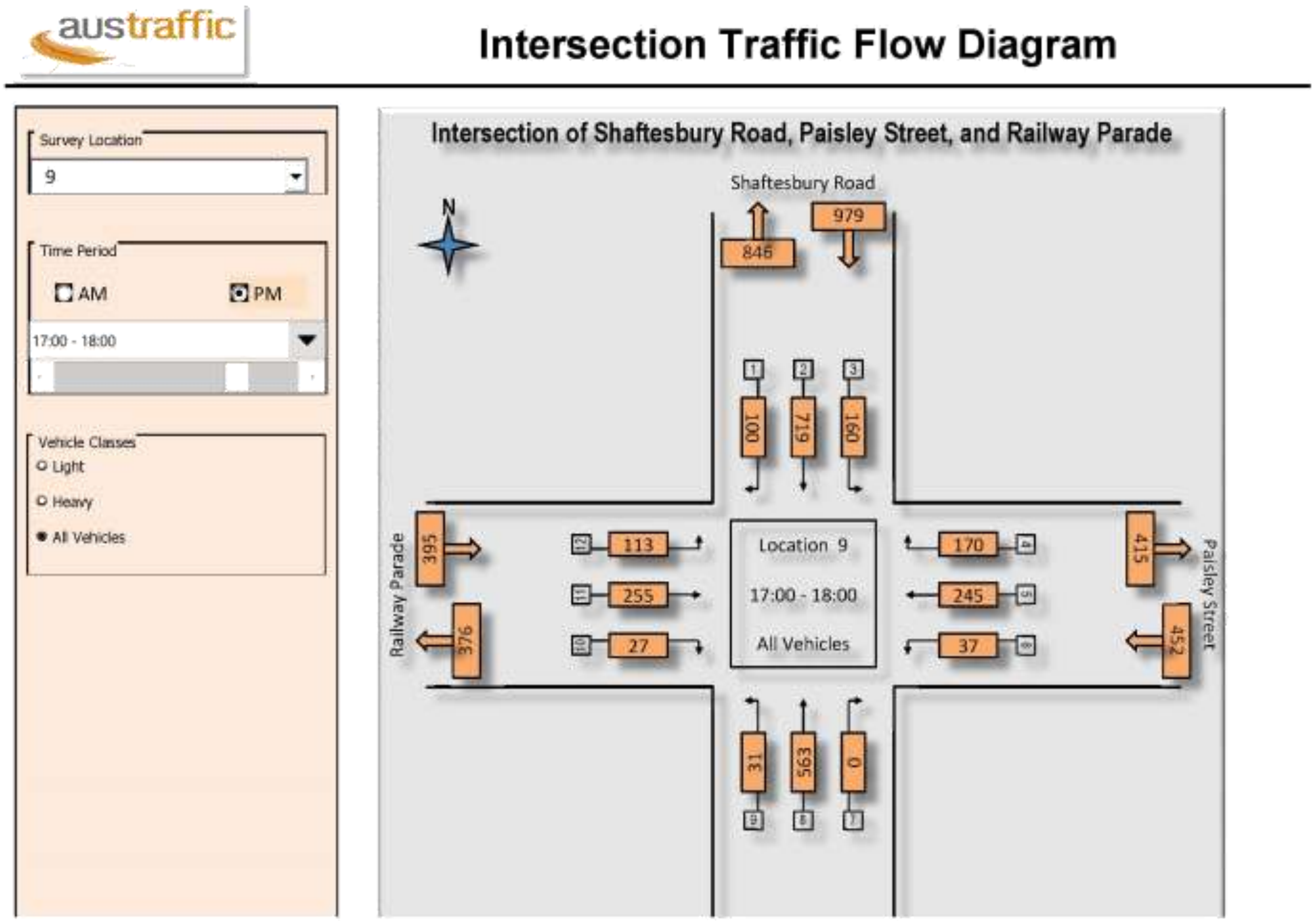

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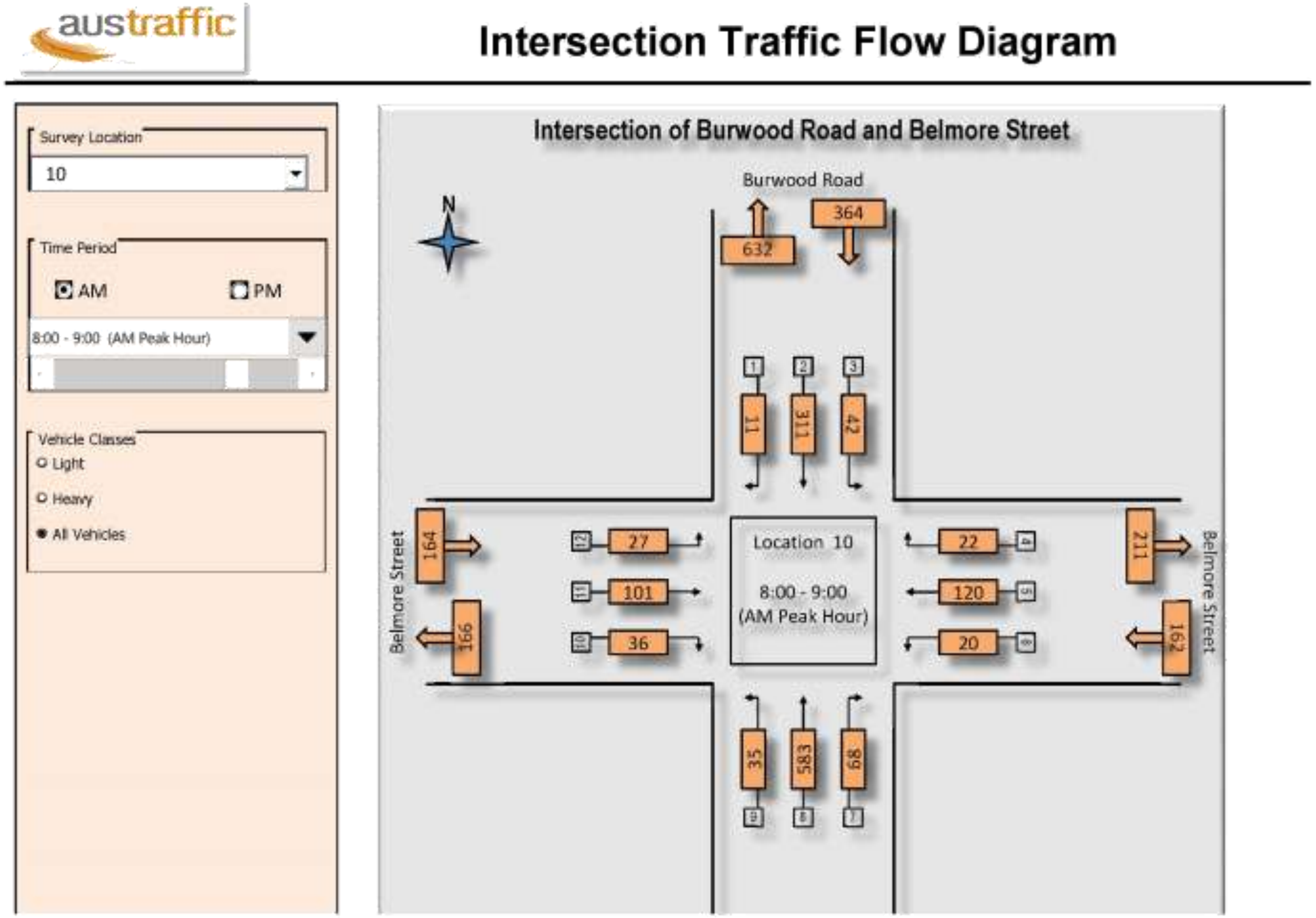

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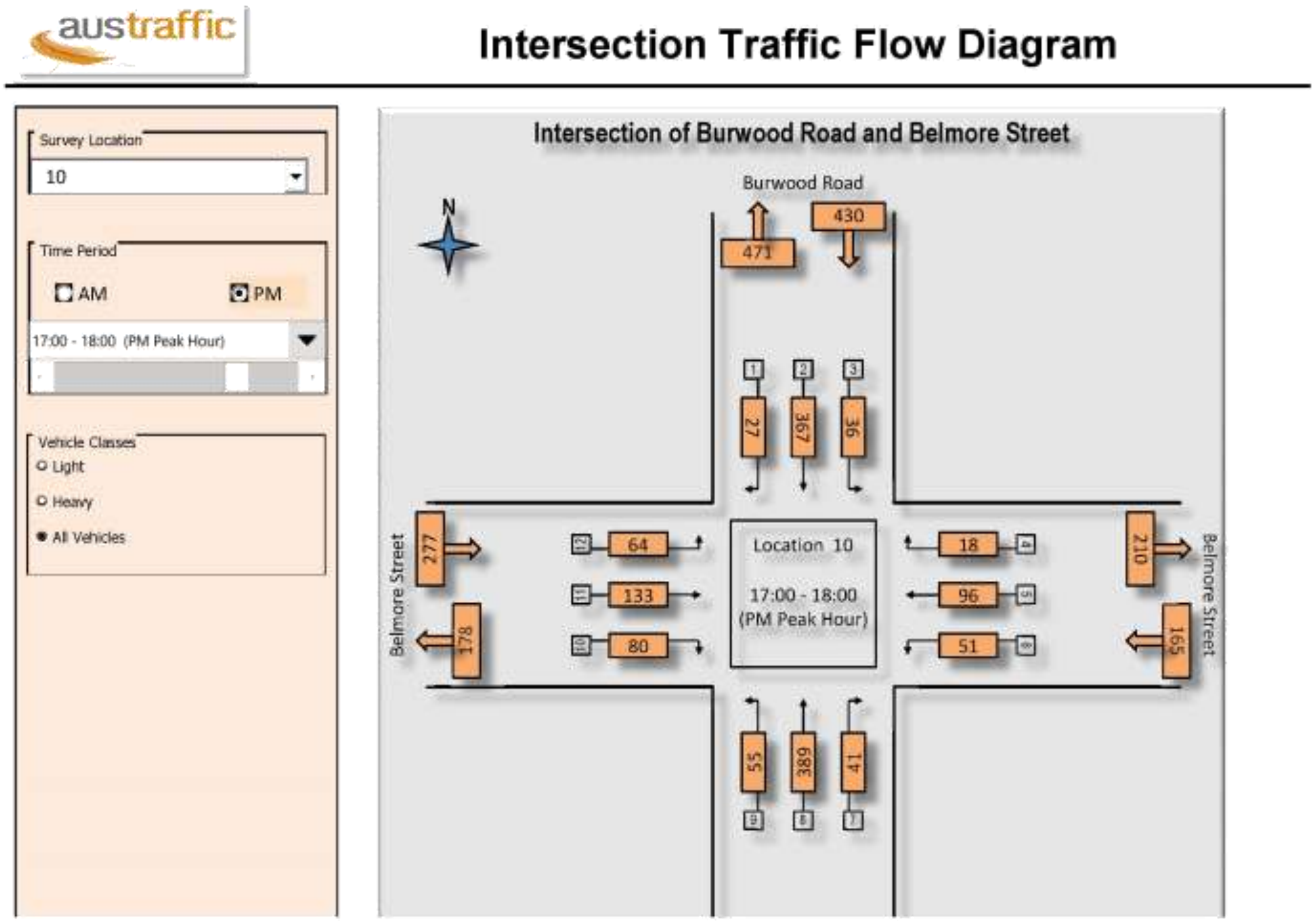

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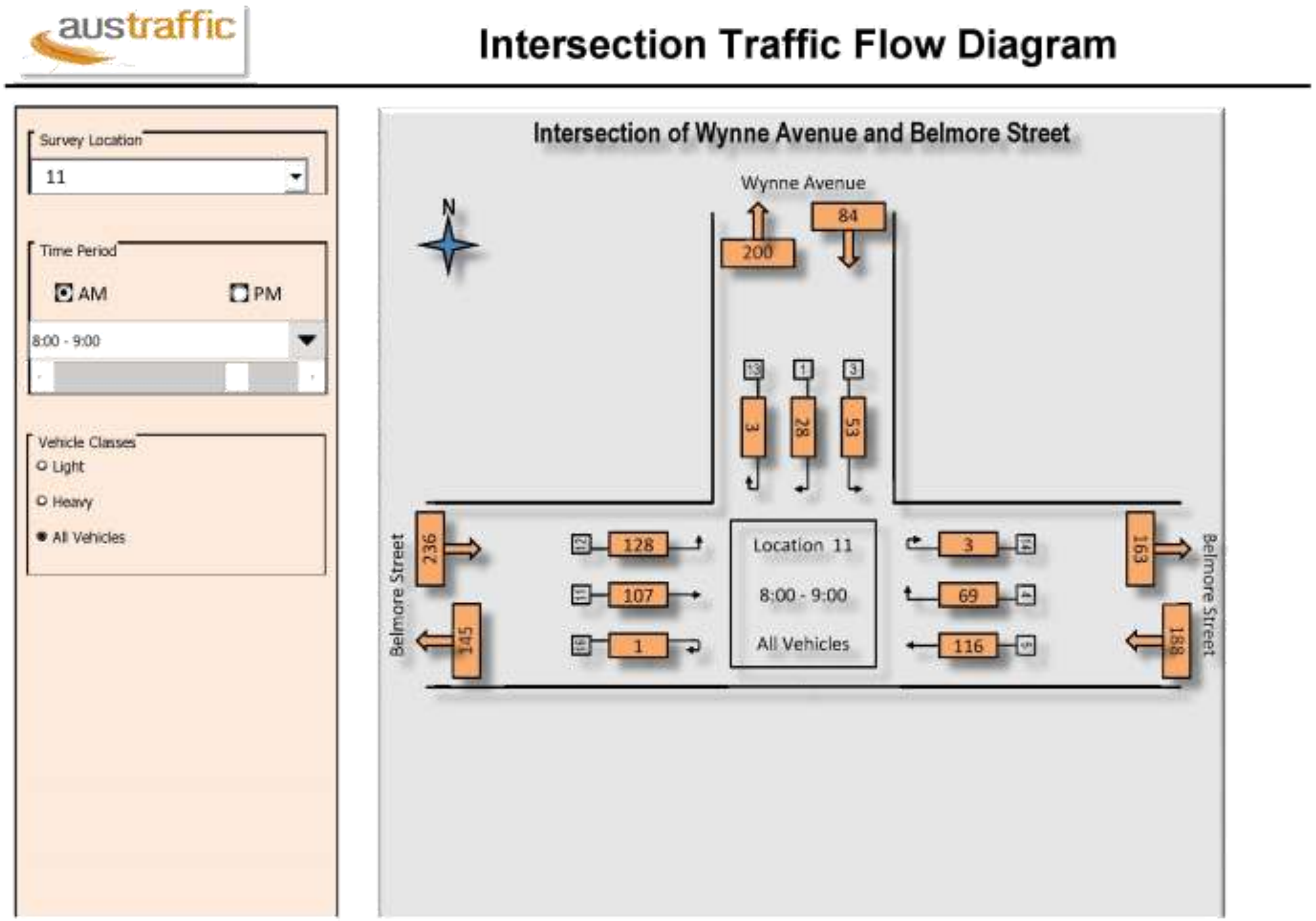

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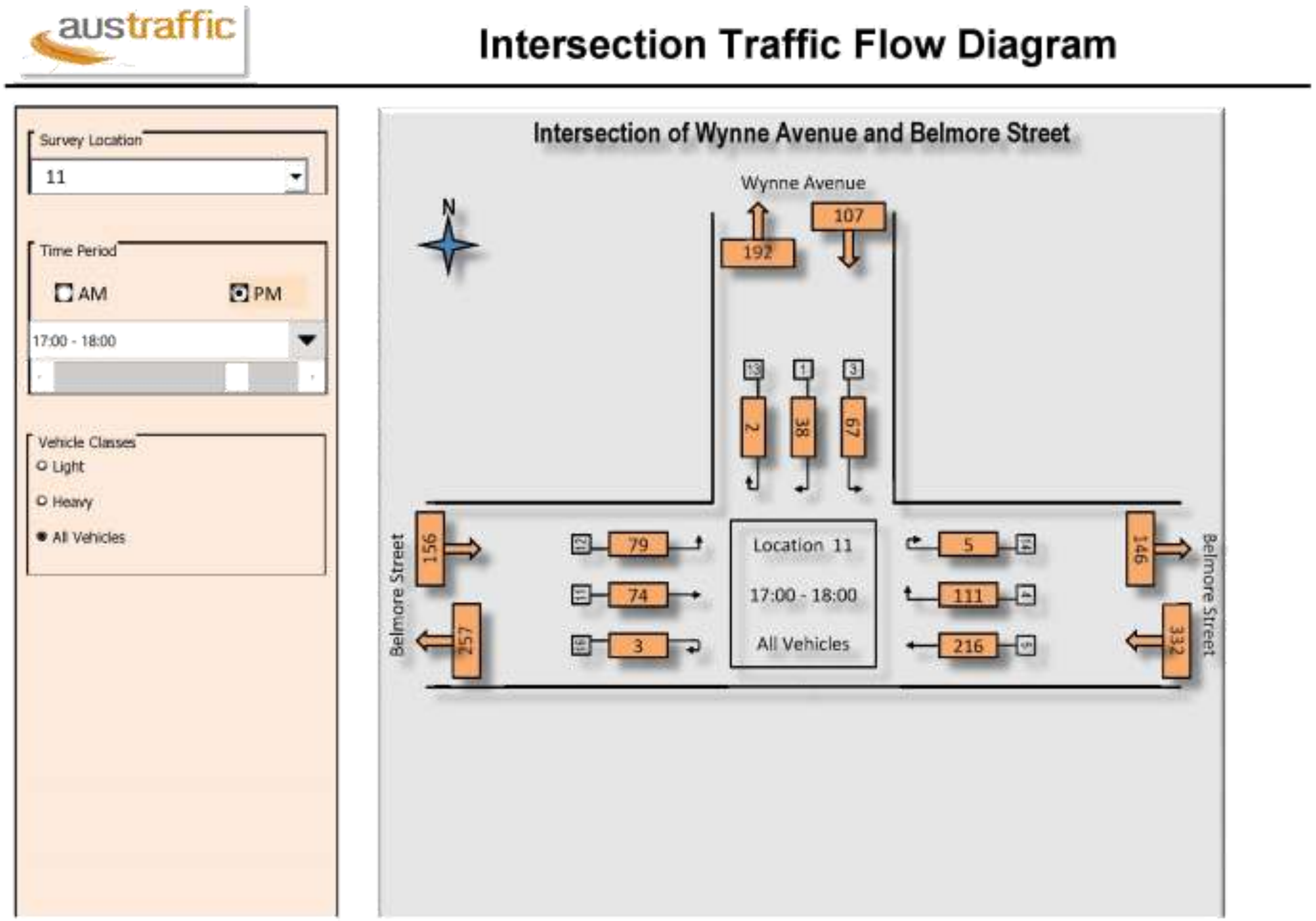

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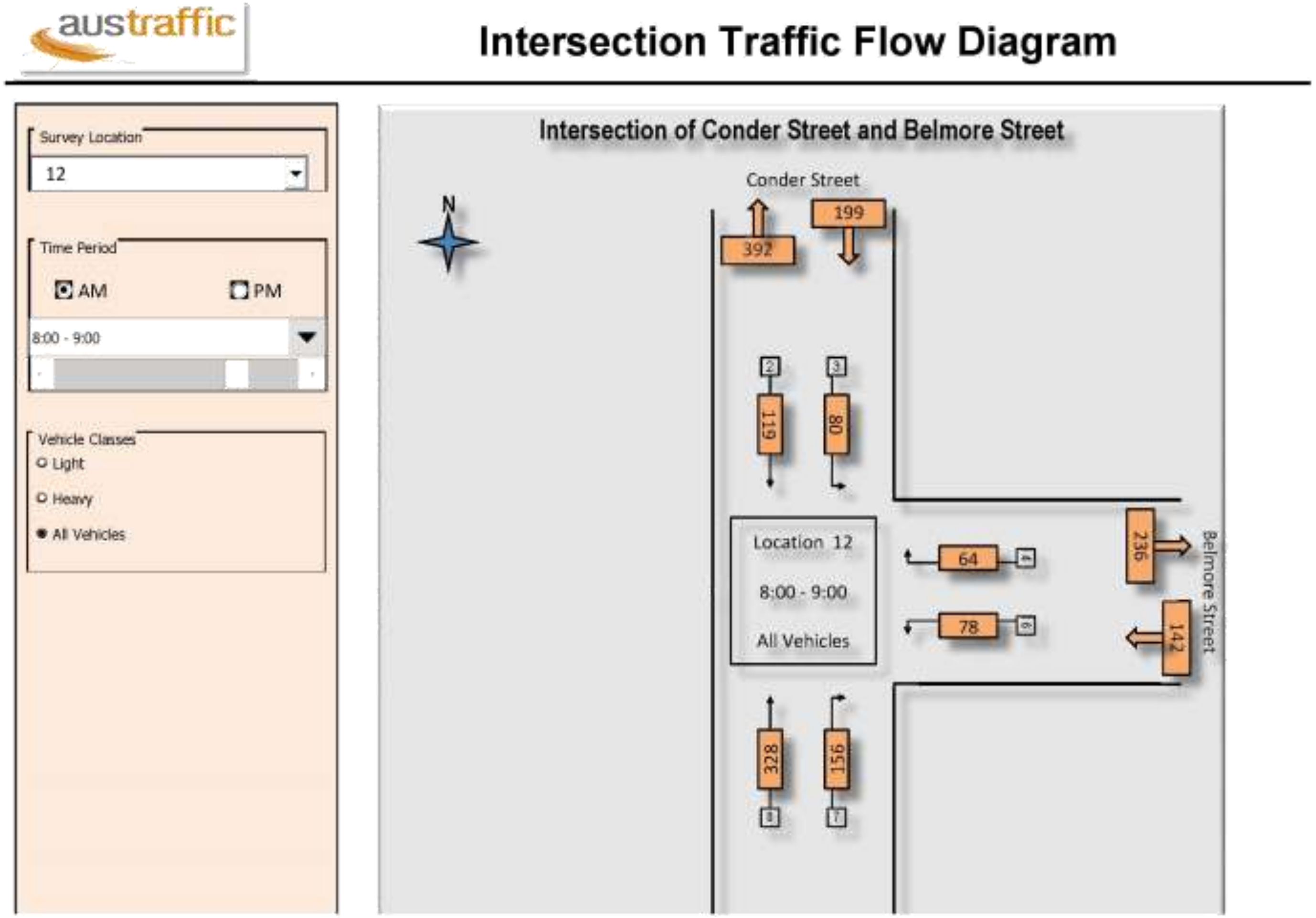
Intersection Traffic Flow Diagram



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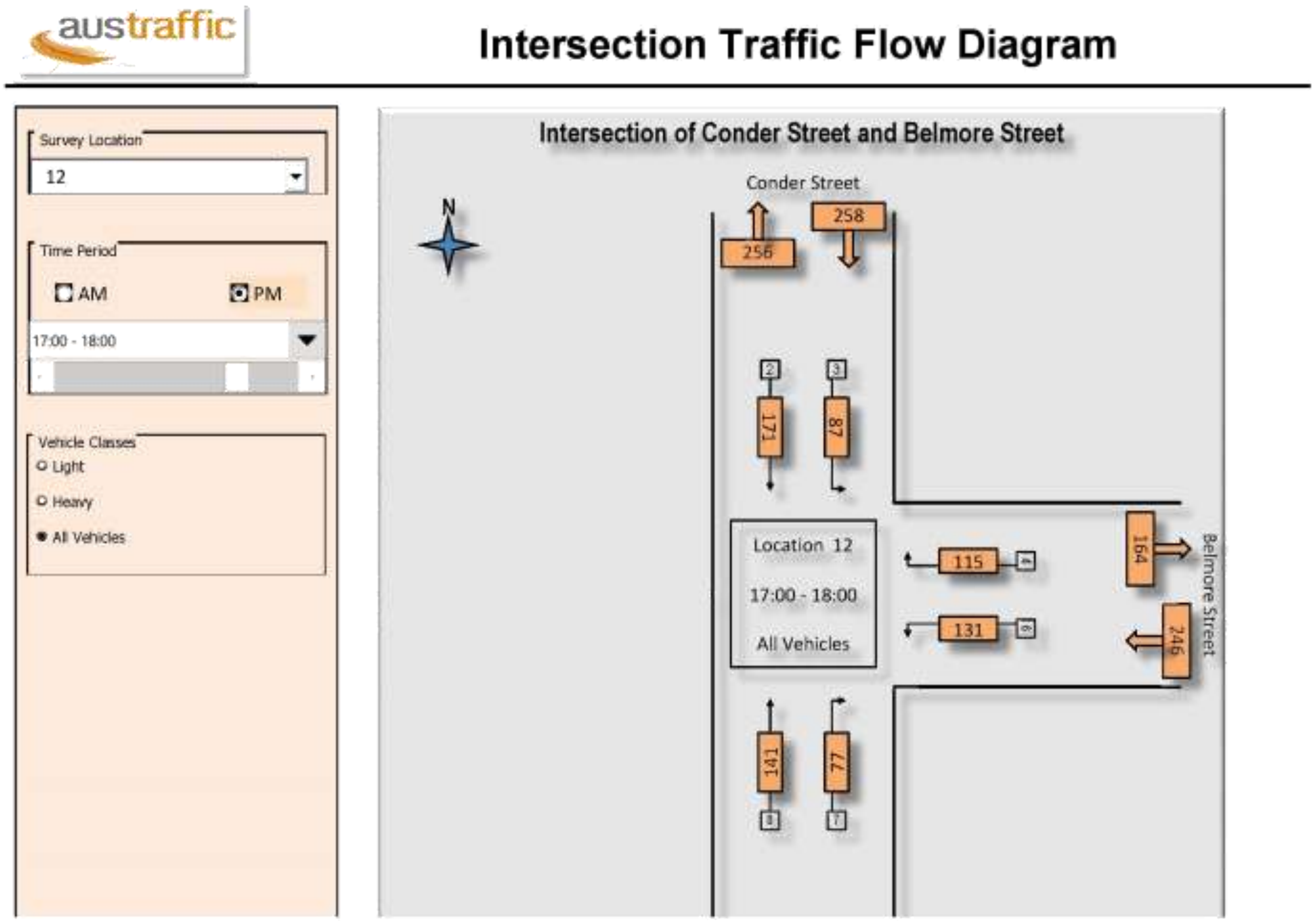

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APPENDIX B – PERFORMANCE INDICATORS

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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 requiring 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.

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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 9 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]

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Table 10 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.

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