planning consultants

APPENDIX 3

ROAD DELAY SOLUTIONS

GLADESVILLE SHOPPING VILLAGE

Planning Proposal

Traffic Impact Assessment

Prepared for...

ROBERTSON + MARKS PTY LTD

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INTRODUCTION

ABSTRACT

Road Delay Solutions Pty Ltd has been engaged by *Robertson + Marks Architects* to undertake investigation into the traffic implications associated with a Planning Proposal (PP) to amend the building heights and floor space ratio controls applying to the proposed mixed use redevelopment of the Gladesville Shopping Villiage (GSV).

Currently the GSV has two levels of retail floor space. Customers have access to two basement carpark levels.

The current retail operations comprises such businesses as follows…

- → *Coles Supermarket,*
- → *Liquorland,*
- → *De Costi's Seafood,*
- → *Leonards Chicken,*
- → *Fruit and vegetable shop,*
- → *Electrical appliance store,*
- → *Newsagent,*
- → *Japanese food outlet,*
- → *Bakery, and*
- → *Toy store.*

Currently, retail floor space occupies 4,962m^2 with the Coles Supermarket being 2,434m^2 and the remaining retail operations

This traffic report focuses on the proposed development and changes in vehicle generation incorporating each component of mixed use, and carpark utilisation.

LOCATION

Located on the eastern boundary of the Gladesville Town Centre, the site is generally bounded by Massey Street to the north, Flagstaff Street to the east, Cowell Street to the south and Victoria Road to the west.

To the west of the site is a right of way (ROW) running between Massey Street to the north and Cowell Steet to the south. The ROW provides access to parking provisions for retail businesses fronting Victoria Road to the west of the site and entry to the level 2 basement of the subject development site.

Further access to the retail operations of the GSV is achieved via two dedicated entries on Flagstaff Street to the east of the site.

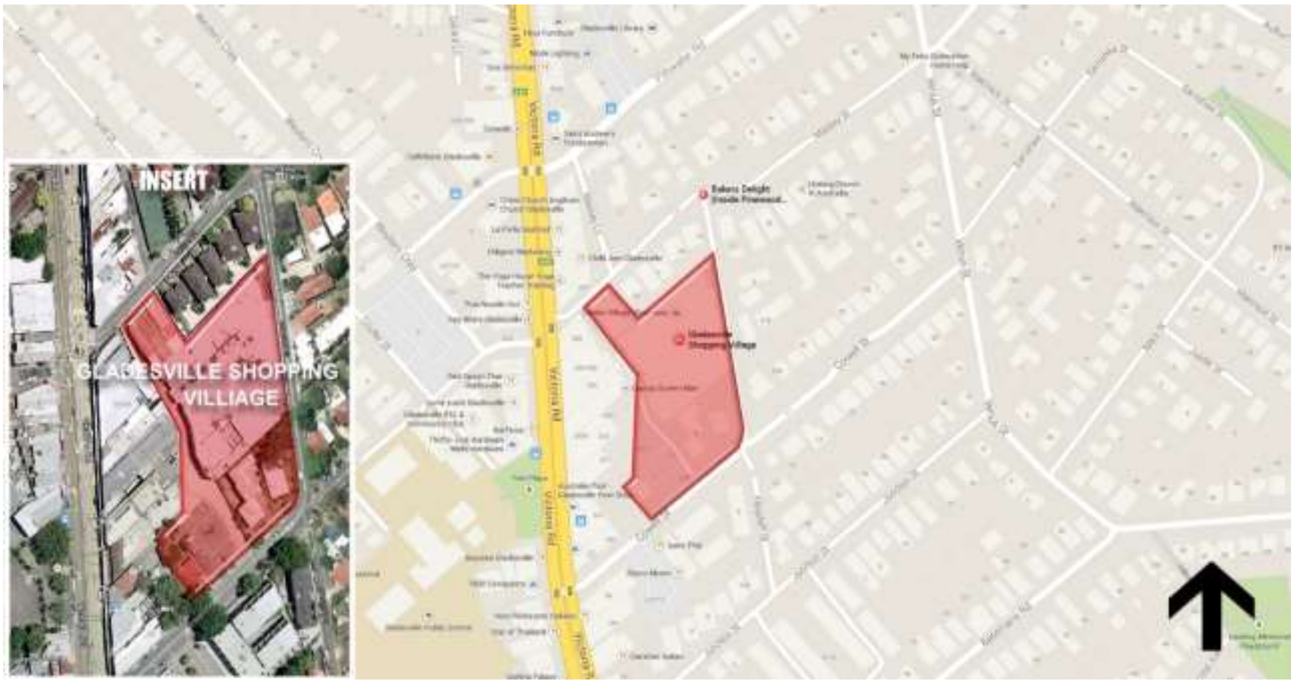

Figure 1 Site Context

Source Google Earth 2015

PURPOSE

The purpose of this study is to assess the traffic and transport implications associated with a Planning Proposal (PP) to amend the building heights and floor space ratio controls applying to the proposed mixed use redevelopment of the Gladesville Shopping Villiage (GSV) and identify measures to mitigate any highlighted adverse affects.

The assessment has been prepared with due regard to the traffic and transport related issues identified with the former Development Application (DA) submission, and subsequent withdrawal, in 2014.

The study has followed a formulated approach to developing a Traffic Management Solution for the Hunters Hill quadrant of the Gladesville Town Centre. The approach has involved…

- *The collection, collation and validation of field data such as traffic counts and travel times, etc… ,*
- *The development and calibration of a mesoscopic model for the current and future road network conditions,*
- *The formulation and design of a sustainable Traffic Management Solution, and*
- *The reporting of all aspects of the design process.*

EXISTING CONDITIONS

CURRENT ROAD NETWORK

The current GSV has frontages on both Cowell Street and Flagstaff Street. External travel to the site occurs primarily from Victoria Road with secondary feeders from Pittwater Road, Venus Street and Gladesville Road.

VICTORIA ROAD

Victoria Road is a major 60km/hr arterial road under the auspices of the *RMS* and a critical transport link in the Sydney Metropolitan Road Network. The corridor generally accommodates three (3) lanes in each direction with clearway conditions operating in the peak flow direction during the weekday commuter peak periods, where bus lanes permit. A raised central median separates the two carriageways.

Frequent bus services utilise Victoria Road the peak commuter periods with the morning peak (7am to 10am) accommodating the eastern kerbside lane, southbound, as a dedicated bus only lane.

Conversely, during the weekday PM period (3pm to 7pm) the western kerbside lane northbound is a trafficable lane, with clearway condition applied. Outside of the commuter peak periods the kerbside lane is available for on street parking.

PITTWATER ROAD

Pittwater Road is a 60km/hr sub arterial corridor which intersects with Victoria Road at Jordan Street. Providing considerable on street parking, the corridor generally provides single lane capacity in each direction. Local bus services utilise Pittwater Road between Gladesville and Chatswood.

Pittwater Road also provides access to Venus Street, to the east of Victoria Road, which allows the entry and exit to the residential precinct immediately to the east of the Gladesville Shopping Village.

COWELL STREET

Cowell Street, between Victoria Road and and Flagstaff Street, is a local road with one trafficable lane and permitted on street parking on each side of the carriageway (*subject to time restrictions*). Within this section, Cowell Street travels east and generally slopes downwards from Victoria Road. The regulated speed limit is 50km/hr. To the immediate east of Flagstaff Street, Cowell Street is regulated to one way, westbound, travel through a residential catchment.

FLAGSTAFF STREET

Flagstaff Street is a local road with one lane trafficable in each direction with travel separated by centre barrier lines. On street parking is not permitted on Flagstaff Street.

MASSEY STREET

Massey Street is a one way local road from Victoria Road to Flagstaff Street with one trafficable lane. On street parking is permitted on the north western side of Massey Street and is subject to time limits.

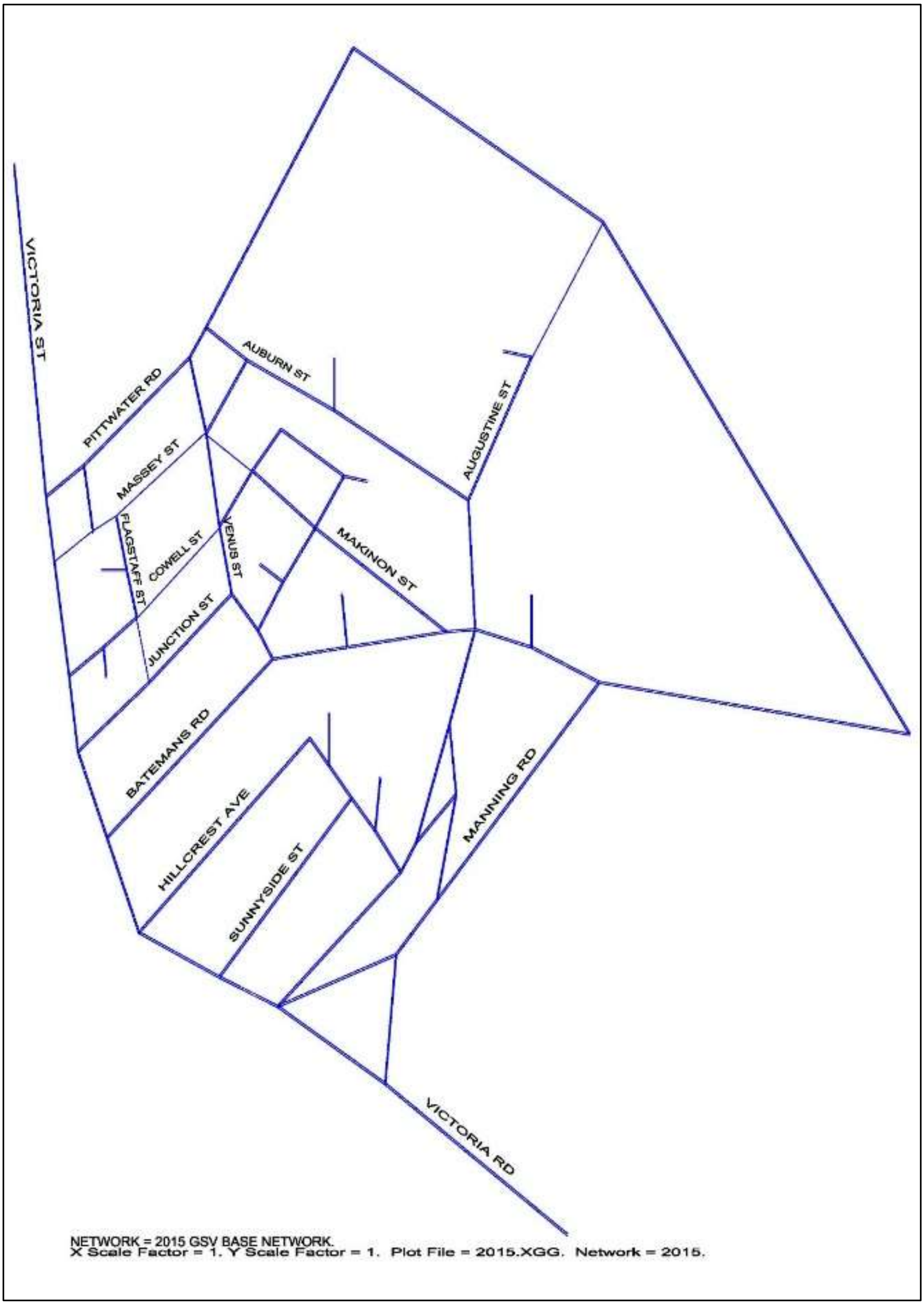

Figure 2 Gladesville Modelled Road Network Cordon

Source Road Delay Solutions, 2015

PUBLIC TRANSPORT

There are currently ten (10) regular bus services currently in operation within the study area including one MetroBus route (M52).

Routes 500X, 506X and 518X operate in the PM peak only. These routes operate as express services from the City, before resuming a normal stopping pattern through Hunters Hill and Gladesville. There is also a bus depot located on Buffalo Road near Cressy Road, operated by State Transit.

Figure 3 Current Bus Services

Source Sydney Buses

For modelling purposes, the majority of the bus services consist of through routes travelling on…

- → *Victoria Road to travel between Ryde and the Sydney CBD and/or the northern suburbs, and*
- → *Pittwater Road to travel to and from the Woolwich Peninsula.*

Some services commence locally, with two westbound services commencing at the bus depot on Buffalo Road (Route 287 and Route 510) and two local routes (536 and 538) travel south along Pittwater Road before terminating at Victoria Road.

ROUTE NUMBER	DESCRIPTION
→ *287*	*Ryde – Pacific Highway – North Sydney – Milsons Point*
→ *500 X00*	*Ryde – Drummoyne – City*
→ *501*	*West Ryde – Ryde – Pyrmont - City*
→ *506 X06*	*Macquarie University – Hunters Hills – Drummoyne - City*
→ *507*	*Macquarie University – Ryde – Putney - City*
→ *510*	*Ryde Depot – Gladesville – Drummoyne – City*
→ *518 X18*	*Macquarie University – Ryde – Drummoyne - City*
→ *536*	*Chatswood – Gladesville*
→ *538*	*Gladesville – Woolwich Wharf*
→ *M52*	*City – Rozelle – Ryde – Top Ryde – Ermington – Parramatta*

PARKING PROVISIONS

Customers of the existing GSV can park in the two basement car park levels that are accessed from Flagstaff Street and the internal ROW. Currently the site provides a total of 239 car parking spaces.

There is also a surface level car park that is accessed via Cowell Street and has accommodation for 30 vehicles.

The parking areas are subject to two hour time limits. As of 2013, the covered parking areas and the Cowell Street surface car parking areas have been designated for private customer car parking only.

BASEMENT LEVEL 1

This parking area has 100 car spaces with vehicle ingress and egress via the northern entry and exit on Flagstaff Street.

Figure 4 Existing Basement and Loading Dock Access from Flagstaff Street

Source Google Earth, 2015

BASEMENT LEVEL 2

The level 2 basement car park provides for 139 vehicles. Vehicle ingress and egress is via the northern entry and exit on Flagstaff Street and an entry only, running off the right of way (*near the Coles loading bay*).

The two basement level car parks are connected via an internal two-way ramp system.

COWELL STREET SURFACE LEVEL CAR PARK

This surface level car park has provision for 30 car spaces with access via the right of way that runs off Cowell Street and connects to Massey Street.

OCCUPANCY SURVEY

An occupancy survey of the available parking areas was undertaken by ML Traffic Engineers, during a typical school term for both a weekday and a Saturday.

			Weekday Occupancy			
	Car spaces	**Time Restriction**	**10am**	**Midday**	**2pm**	**4pm**
Cowell Street Surface Carpark	30	2P	23	30	30	25
			Saturday Occupancy			
			10am	**Midday**	**2pm**	**4pm**
	30	2P	29	30	30	26
			Weekday Occupancy			
	Car spaces	**Time Restriction**	**11am**	**1pm**	**2pm**	**4pm**
Basement Car Parking	239	2P	171	235	215	166
			Saturday Occupancy			
			10am	**Midday**	**2pm**	**4pm**
	239	2P	239	238	227	187

Figure 5 Existing Carpark Occupancy

Source ML Traffic Engineers, 2014

A site inspection of the car parks was undertaken by *Road Delay* Solutions to validate the occupancy rate. The site inspection confirmed…

→ *The surface level carpark, to the north of Cowell Street, exhibited a high level of occupancy on both a weekday and a Saturday. The majority of occupants however did not visit the Gladesville Shopping Village but rather other local businesses in close proximity, and*

→ *The covered basement car spaces show a high occupancy on a Saturday between 10am and 2pm. Weekend occupancy is marginally lower than the weekday. However, it was found the spaces were generally fully occupied around the lunchtime period between 12noon and 2pm.*

The occupancy survey was utilised in the determination of arrival and departure rates of vehicles to the shopping complex.

ON STREET PARKING

Minimal on street parking is available on Cowell Street. No vehicular parking is possible on Flagstaff Street.

Residential Parking is catered for in Cowell Street east of Flagstaff Street and Flagstaff Street south of Cowell Street.

A 30 vehicle public car park is provided on Cowell Street immediately to the west of the property 10 Cowell Street. The use of the public car park is not restricted to the Gladesville Shopping Village. It was found through investigation by *Road Delay Solutions* that some 31% of car park patrons visited businesses and establishments surrounding the Gladesville Shopping Village.

BASE YEAR MESOSCOPIC MODEL

DATA COLLECTION

As part of the assessment, the existing traffic data has been collated by R.O.A.R. Data on Thursday 26 May, 2015, for…

- → *The weekday AM commuter peak hour 8am till 9am, and*
- → *The weekday PM commuter peak hour 5pm till 6pm.*

The weekend peak on a Saturday, between 11am till 12 noon was collected and found to be relatively low. The Saturday peak field data has been omitted from this assessment.

The following figures present the current traffic volumes, in vehicles per hour, travelling on the surrounding road network. This data has been utilised in the calibration of the computer based mesoscopic model.

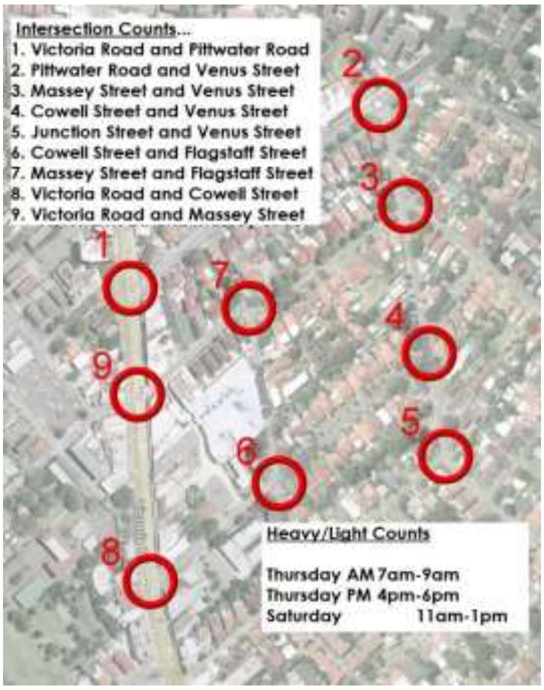

Figure 6 Traffic Count Locations

Source R.O.A.R. Data Thursday 26 March, 2015

Travel time surveys were undertaken over four days from Wednesday 25 March 2015 till Saturday 28 March to validate the base model. Results indicate a mean 0.5% difference between the collated field data and modelled travel times. RMS guidelines require average modelled travel times to to have a differential not greater than 15% or one (1) minute from the observed travel times for the entire route collected.

ROUTE	AVG SURVEYED TIME		MODEL 15AM4 TIME	
	TIME (minutes)	SPEED km/hr	TIME (minutes)	SPEED km/hr
Start Node 12674 - PITTWATER / VENUS	08:11.7			
PITTWATER / MASSEY LN	0.25	32	0.31	41.47
PITTWATER / VICTORIA	1.64		1.44	24.81
VICTORIA / MASSEY	1.95	51	1.89	30.23
VICTORIA / COWELL	2.73		2.21	47.27
VICTORIA / JUNCTION	3.17		3.22	50.23
VICTORIA / BATEMANS	3.27	57	3.31	55.66
HILLCREST AVE	3.38		3.25	55.33
SUNNYSIDE ST	3.49		3.33	55.82
	3.57	59	3.66	58.91
VICTORIA RD	3.73		3.81	59.34
	4.01	65	4.15	68.54
GLADESVILLE BRIDGE 4196	4.32	67	4.46	65.81
TOTALS	4.3 mins	55	4.5 mins	51
		Average km/h		
ROUTE	AVG SURVEYED TIME		MODEL 15PM7 TIME	
Start Node 4196 - GLADESVILLE BRIDGE	16:37.3			
	0.32	72	0.28	69.65
	0.71		0.64	67.5
VICTORIA RD	1.11		0.92	67.12
	1.18		1.07	66.99
SUNNYSIDE ST	1.32	63	1.15	59.94
HILLCREST AVE	1.43		1.26	56.99
VICTORIA / BATEMANS	1.57	59	1.37	56.93
VICTORIA / JUNCTION	2.68		2.33	54.74
VICTORIA / COWELL	2.75	49	2.58	52.09
VICTORIA / MASSEY	2.98		2.85	50.84
PITTWATER / VICTORIA	4.17	34	4.06	37.16
PITTWATER MASSEY LN	4.23		4.14	37.63
PITTWATER / VENUS 12674	4.56	42	4.39	38.96
TOTALS	4.3 mins	53	4.5 mins	55
		Average km/h		

NOTE: The modelled travel speeds are corrected, by the program, to reflect vehicle delay(s) at downstream intersections.

Figure 7 Travel Times

Source Road Delay Solutions, 2015

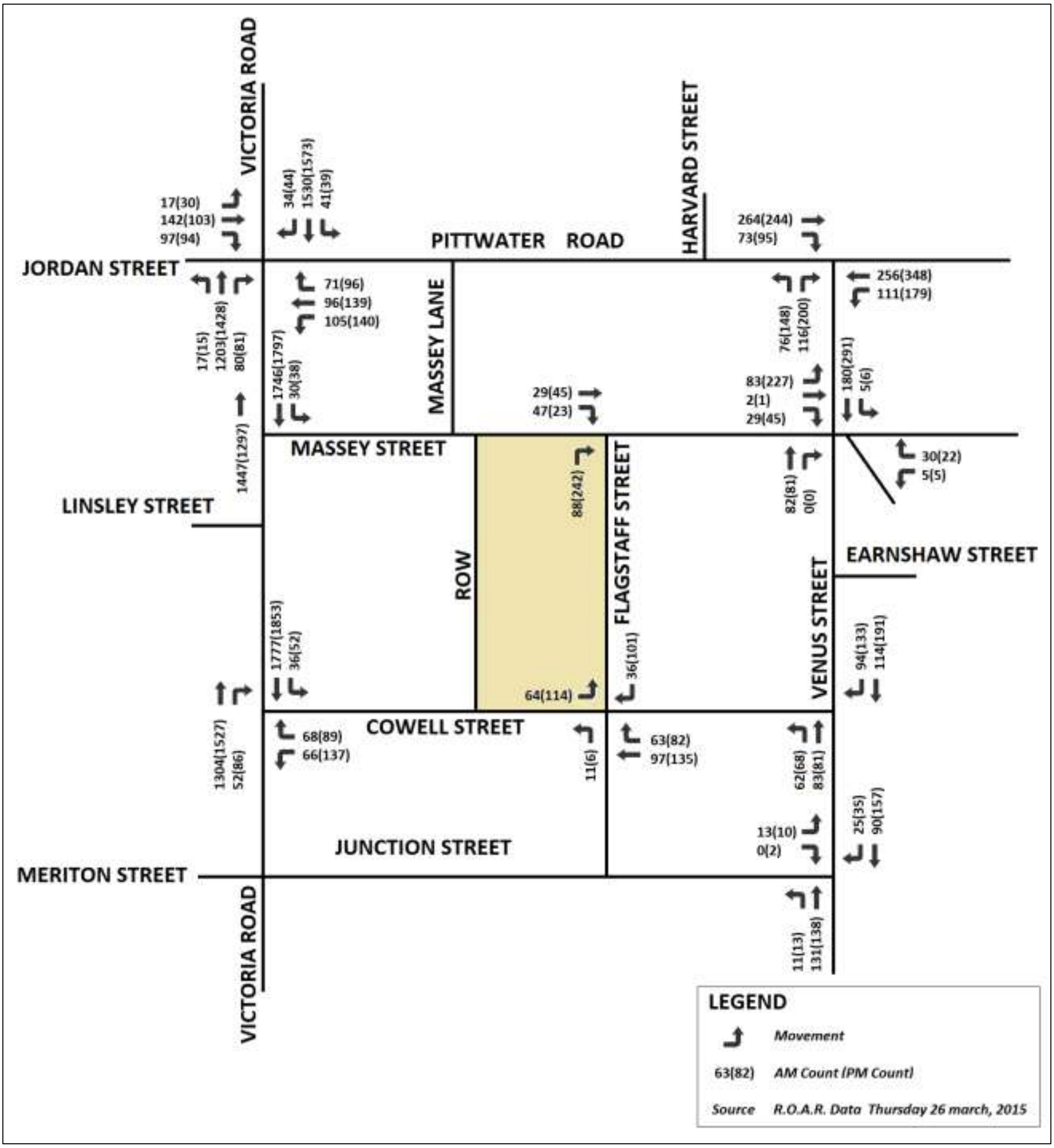

Figure 8 **Existing Commuter Peak Hour Traffic**

Source *R.O.A.R. Data Thursday 26 March, 2015*

2015 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 trips travelling from each zone, to every other zone, in the modelled area. The boundaries of these zones for the Sydney Metropolitan Area were defined in 1996, by the NSW Department of Transport's (*TPDC*), and have been generic across all traffic and transport modelling activities undertaken in Sydney. New boundaries were defined by TPDC in 2006 and again in 2011, with an equivalency table, prepared by the DoP, employed to rationalise the current projected land use and trip distribution patterns with the zonal structure presented in 1996.

The assignment process, described above, essentially determines the anticipated route selection made by motorists between the '*origin*' and '*destination*' zone 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 models the road network assignment over a 1hour period.

The base year 2015 trip matrix was originally developed in October 2012. Disagregation of the vehicle distribution and trip demand between zonal pairs has been undertaken by *Road Delay Solutions* to 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 2015 trip matrices, conform with those published by BTS and have been further advanced through numerous calibration processes throughout the Sydney Metropolitan area.

MODEL CALIBRATION

This section provides a concise framework for the verification, validation and calibration of the base year 2015 traffic model, assimilating the current study area road network and it's operational conditions.

DATA COLLATION

Intersection traffic count data has been utilised in the calibration procedure to align the projected model volumes with the current traffic flow and distribution, within the study area.

Field data, specifically intersection turn movements, were collected, at select intersection sites.

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

Generally, the network characteristics catalogued were…

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

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 Netanal software is based.

The Netanal software package produces traffic forecasts generally based upon travel time rather than distance or gravity principles. Netanal determines the invoked link and intersection delays, 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.

The Netanal model has been verified by the former *RTA*, with reference found in *Part 2* of the '*Economic Analysis Manual*'[1].

[1] '*Economic Assessment Manual*' Roads and Traffic Authority, N.S.W., 1999 – Revised May 2006.

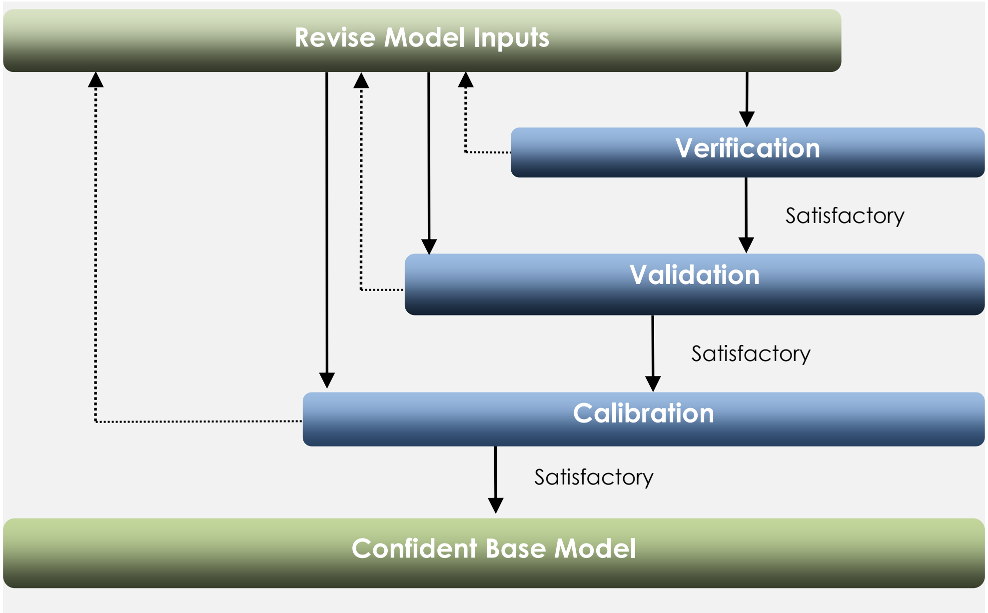

Figure 9 **The Correctness Procedure**

Source *Road Delay Solutions Pty Ltd, 2011*

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'[2] has beenemployed to rationalise the differential between the modelled and actual counted traffic volumes, on selected links.

[2] 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.

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, as depicted in *Figure 6*.

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

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

Figure 10   The GEH Statistic

A range of GEH targets have been realistically set to achieve the prescribed LoA, noted in the following section, '*Calibration*'. The targets highlight the percentage and weighted degree of difference between modelled volumes and the collected field data.

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

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

Figure 11   Typical GEH Targets

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 have been calibrated, individually, to ensure the integrity of the trip distribution and volume flows within the study area and surrounds.

The calibration report of traffic flows, on key routes, was used as output for the base Year 2015.

The trip matrices, currently employed in the base Netanal models, were originally developed by BTS, based upon the Year 2011 Census Data published as *LGA Community Profiles* by the *Australian Bureau of Statistics*.

The zonal information, contained within the matrices, has been disaggregated in accordance with data collated during studies conducted by *Sims Varley Traffic Systems Pty Ltd* and *Road Delay Solutions Pty Ltd*, generally yielding a mean absolute screen line calibration 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 in fact a mesoscopic demand model, which reflects the total volume of traffic on a link, including queued traffic at the end of the modelled one-hour time period (*residual queue*). 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.

Therefore, it is safe to assume, that a count location will report a lower traffic volume than those reported in the Netanal model, where significant vehicle queues exist at a site.

Discrepancies between adjacent intersection counts are to be expected and an error of some 3% was recorded in a number of locations within the collected field data.

CALIBRATION SYNOPSIS

Calibration Summary for Model 15AM3
Network = 2015 Trip Table = 15AM3
2015 AM Peak CALIBRATED GSV BASE MODEL
Observed Counts versus Modelled Volumes

Location..........	Node	Node	Count	Model	Diff	Diff%	GEH
PITTWATER WB E VICTORIA	12524	4175	372	375	3	1	0
VICTORIA SB N PITTWATER	4174	4175	1605	1937	332	21	8
VICTORIA NB S PITTWATEE	1365	4175	1300	1431	131	10	4
JUNCTION EB W VENUS	12511	1347	13	18	5	38	1
VENUS NB N JUNCTION	1347	12507	144	53	-91	-63	9
VENUS SB N JUNCTION	12507	1347	115	68	-47	-41	5
VENUS NB S JUNCTION	12340	1347	142	133	-9	-6	1
VENUS SB N COWELL	12505	12507	208	263	55	26	4
COWELL WB W VENUS	12507	12513	156	154	-2	-1	0
PITTWATER EB W VENUS	12524	12674	337	432	95	28	5
VENUS NB S PITTWATER	12505	12674	292	312	20	7	1
PITTWATER WB E VENUS	1116	12674	367	358	-9	-2	0
MASSEY EB E FLAGSTAFF	1159	12505	117	103	-14	-12	1
FLAGSTAFF NB S MASSEY	1356	1159	88	86	-2	-2	0
COWELL EB W FLAGSTAFF	1358	12513	64	49	-15	-23	2
FLAGSTAFF NB S COWELL	12511	12513	11	5	-6	-55	2
FLAGSTAFF SB N COWELL	1356	12513	36	27	-9	-25	2
VENUS SB S PITTWATER	12674	12505	185	262	77	42	5
VENUS SB S MASSEY	12505	12507	214	263	49	23	3
VENUS NB S MASSEY	12507	12505	82	53	-29	-35	4
MASSEY EB W VENUS	1159	12505	114	103	-11	-10	1
COWELL WB E VICTORIA	1358	12535	134	136	2	1	0
VICTORIA NB S COWELL	4179	12535	1356	1342	-14	-1	0
VICTORIA SB S COWELL	4179	12537	1843	1820	-23	-1	1
COWELL EB E VICTORIA	12535	1358	88	79	-9	-10	1

Summary of GEH Calibration Validation

	Counts	%
GEH <= 5 Target = > 60%	23	92
GEH <= 7 Target = > 80%	23	92
GEH <= 10 Target = > 95%	25	100
GEH <= 12 Target = 100%	25	100
GEH > 12 Target = 0%	0	0
Total Counts	25	

Note.... A Mean, a Mean Absolute Difference (MAD) & a MAD +/- 10% Count Variability Analysis is calculated and the results given below.

Observed Count Range	Mean %	MAD ABS %	MAD +-10% %	Counts No
0001 to 0500	-1.62	17.05	7.05	21
0501 to 1000	0.00	0.00	0.00	0
1001 to 1500	-4.41	5.46	0.00	2
1501 to 2000	10.96	10.30	0.30	2
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	-5.10	11.29	1.29	25
Total of Counts 0501 to Maximum Range	-6.98	8.19	0.00	4

Figure 12 Evening Peak Calibration Report

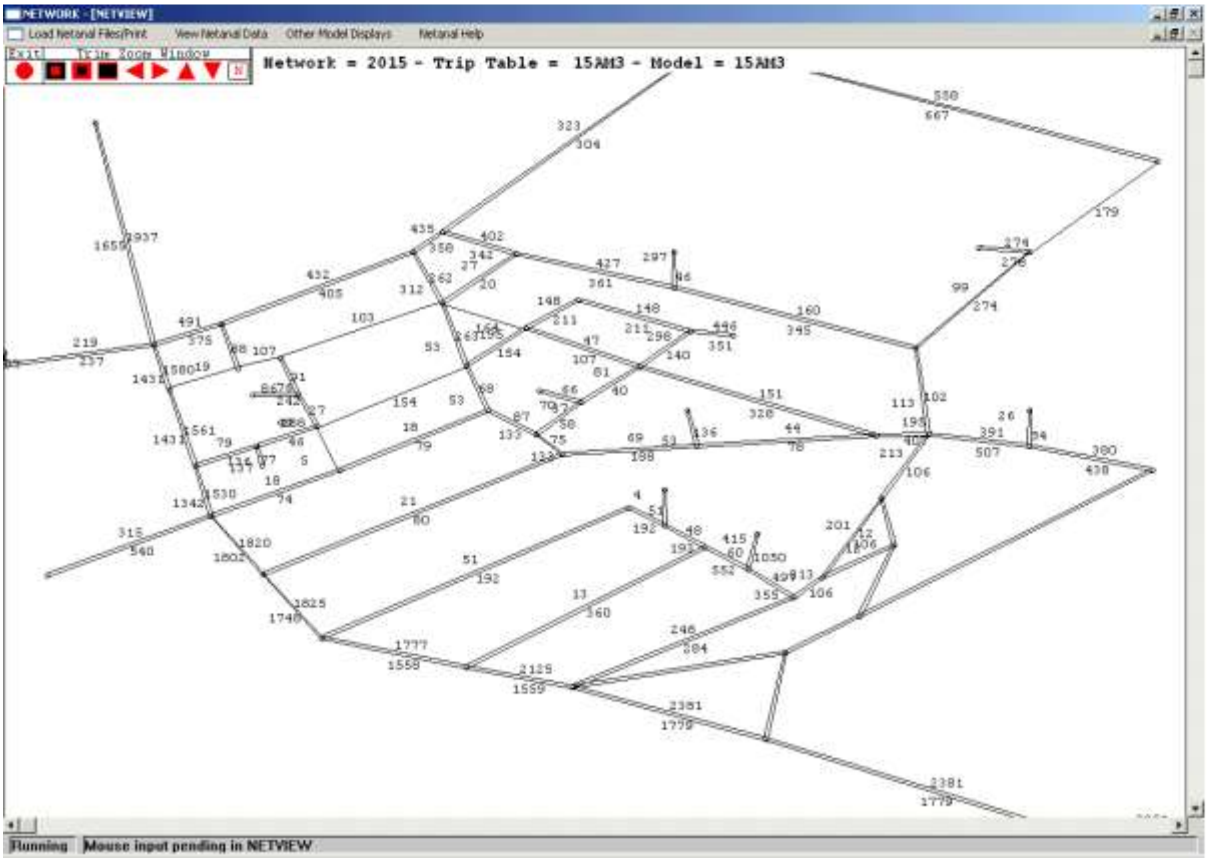

Figure 13 2015 Calibrated AM Peak Calibration Plot

Calibration Summary for Model 15PM10

Network = 2015 Trip Table = 15PM10

2015 PM Peak CALIBRATED GSV BASE MODEL

Observed Counts versus Modelled Volumes

Location..........	Node	Node	Count	Model	Diff	Diff%	GEH
PITTWATER WB E VICTORI	12524	4175	275	221	-54	-20	3
VICTORIA SB N PITTWATE	4174	4175	1656	1658	2	0	0
VICTORIA NB S PITTWATE	4179	12535	1524	1538	14	1	0
JUNCTION EB W VENUS	12511	1347	12	6	-6	-50	2
VENUS NB N JUNCTION	1347	12507	148	173	25	17	2
VENUS SB N JUNCTION	12507	1347	192	249	57	30	4
VENUS NB S JUNCTION	12340	1347	151	192	41	27	3
VENUS SB N COWELL	12505	12507	324	430	106	33	5
COWELL WB W VENUS	12507	12513	201	205	4	2	0
PITTWATER EB W VENUS	12524	12674	339	347	8	2	0
VENUS NB S PITTWATER	12505	12674	348	325	-23	-7	1
PITTWATER WB @ VENUS	4176	1116	527	445	-82	-16	4
MASSEY EB E FLAGSTAFF	1159	12505	287	296	9	3	1
FLAGSTAFF NB S MASSEY	1356	1159	242	266	24	10	2
COWELL EB W FLAGSTAFF	1358	12513	114	90	-24	-21	2
FLAGSTAFF NB S COWELL	12511	12513	6	0	-6	-100	3
FLAGSTAFF SB N COWELL	1356	12513	151	169	18	12	1
VENUS SB S PITTWATER	12674	12505	274	267	-7	-3	0
VENUS SB S MASSEY	12505	12507	341	430	89	26	5
VENUS NB S MASSEY	12507	12505	81	40	-41	-51	5
MASSEY EB W VENUS	1159	12505	273	296	23	8	1
COWELL WB E VICTORIA	1358	12535	256	331	75	29	4
VICTORIA NB S COWELL	4179	12535	1613	1538	-75	-5	2
VICTORIA SB S COWELL	4179	12537	1905	1951	46	2	1
COWELL EB E VICTORIA	12535	1358	138	146	8	6	1

Summary of GEH Calibration Validation

	Counts	%
GEH <= 5 Target = > 60%	25	100
GEH <= 7 Target = > 80%	25	100
GEH <= 10 Target = > 95%	25	100
GEH <= 12 Target = 100%	25	100
GEH > 12 Target = 0%	0	0
Total Counts	25	

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 No
0001 to 0500	-7.85	15.60	5.60	20
0501 to 1000	15.56	15.56	5.56	1
1001 to 1500	0.00	0.00	0.00	0
1501 to 2000	1.36	2.05	0.00	4
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	-2.03	7.62	0.00	25
Total of Counts 0501 to Maximum Range	1.31	3.03	0.00	5

Figure 14 Evening Peak Calibration Report

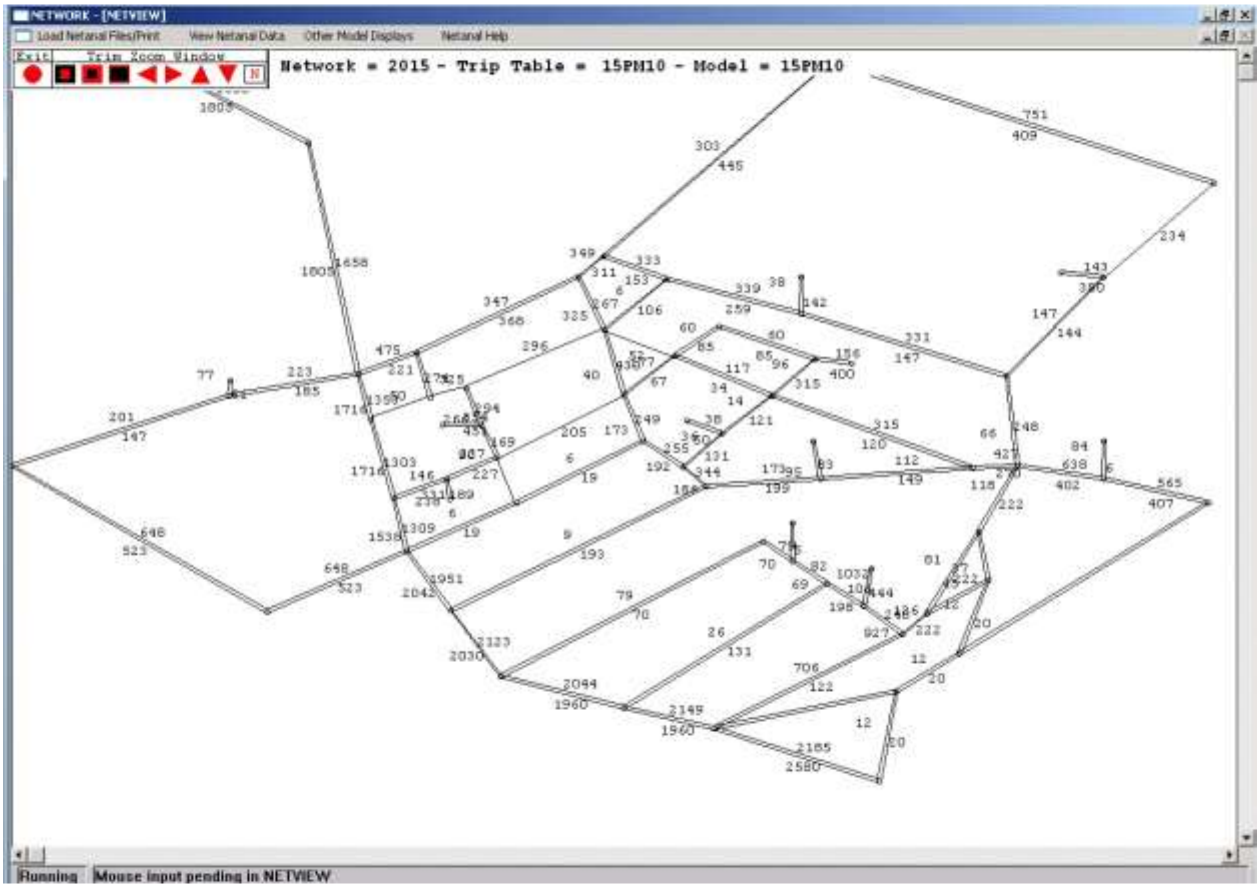

Figure 15 2015 Calibrated PM Peak Calibration Plot

FUTURE CONDITIONS

DRAFT SEPP 66 – INTEGRATION OF LAND USE AND TRANSPORT

This policy provides guiding provisions that aim to ensure the urban structure, building forms, land use locations, development design, subdivision and street layouts help achieve the following planning objectives...

- → *Improving accessibility to housing, employment and services by walking, bicycling and public transport,*
- → *Improving the choice of transport and reducing the dependancy on private vehicle usage,*
- → *Moderating growth in the demand for travel and the distances travelled, especially by car,*
- → *Supporting the efficient and viable operation of public transport services, and*
- → *Providing for the efficient movement of freight.*

THE DEVELOPMENT CONCEPT

A detailed description of the proposed development concept is provided in a separate submission, prepared by the proponent.

Construction to be undertaken for the redevelopment of the GSV is to generally achieve the following…

- → *250 residential apartments,*
- → *3,550m² Coles Supermarket,*
- → *5,730m² Retail floor space,*
- → *1,900m² of commercial floor space,*
- → *Some 383 Retail parking spaces,*
- → *Some 112 Commercial parking spaces, and*
- → *Some 397 Residential, disabled, visitor and car share spaces.*

TRIP GENERATION

Hunters Hill Council's DCP outlines the traffic generation rates to be applied when assessing the traffic implications associated with major developments. The DCP requires the vehicle generation rates applied in accordance with the *RMS Guide to Traffic Generating Developments*. The *RMS* traffic generation rates, pertaining to the operational requirements of the development, are commensurate with known operational characteristics of comparable facilities within the Sydney Metropolitan Area.

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 development will generate 14,593 vehicle trips daily, with 2,699 vehicle trips, including heavy vehicle trips, 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 bedroom, commercial and retail activities. The following presents comment on the generation rates applied during the assessment of the road network.

Spacial input data pertaining to metropolitan/local growth and trip distribution has been drawn from the Australian Bureau of Statistics (ABS) and Bureau of Transport Statistics (BTS). The data presented relates primarily to the defined Travel Zone (TZ) 1519 being Gladesville, as shown below.

Figure 16 Travel Zone 1519 Gladesville

Source BTS Travel Zone Explorer, 2015

VEHICLE GENERATION FOR THE PREFERRED OPTION						
Development Component	Area (Units/m²)	Daily RMS Trip Rate	AM Peak Hour RMS Trip Rate	PM Peak Hour RMS Trip Rate	PREFERRED OPTION	
					AM Peak Hour Generation *(vph)*	PM Peak Hour Generation *(vph)*
Residential 1 Bed	100	0.72/bedroom	0.09/bedroom	0.07/bedroom	9	7
Residential 2 Bed	138	0.72/bedroom	0.09/bedroom	0.07/bedroom	25	19
Residential 3 Bed	12	0.72/bedroom	0.09/bedroom	0.07/bedroom	3	3
Retail	5,730	121/100m² (GLFA)	13/100m² (GLFA)	13/100m² (GLFA)	745	745
Commercial	1,900	11/100m² (GFA)	1.6/100m² (GFA)	1.2/100m² (GFA)	30	23
Coles Supermarket	3,550	142/100m² (GLFA)	16/100m² (GLFA)	16/100m² (GLFA)	568	568
TOTAL	***36,300m²**	**12,363**			**1380**	**1365**

Figure 17 **GSV Vehicle Generation**

Source *RMS, August 2013*

RESIDENTIAL VEHICLE GENERATION

With respect to the high density residential component of the proposed development the *RMS* conducted ten (10) surveys in 2012, eight (8) within Sydney, and one (1) each in the Hunter and Illawarra regions. All developments were (i) close to public transport, (ii) greater than six storeys and (iii) almost exclusively residential in nature.

Analysis of the trip distribution from TZ 1519, it can be deduced that some 29% of the working residents taking up occupancy in the proposed units will work within the Hunters Hill/Ryde catchment and produce JTW trip lengths no greater than some 4.5kms.

Weekday Rates	Sydney Average	Sydney Range	Regional Average	Regional Range
AM peak (1 hour) vehicle trips per unit	0.19	0.07-0.32	0.53	0.39-0.67
AM peak (1 hour) vehicle trips per car space	0.15	0.09-0.29	0.35	0.32-0.37
AM peak (1 hour) vehicle trips per bedroom	0.09	0.03-0.13	0.21	0.20-0.22
PM peak (1 hour) vehicle trips per unit	0.15	0.06-0.41	0.32	0.22-0.42
PM peak (1hour) vehicle trips per car space	0.12	0.05-0.28	0.26	0.11-0.40
PM peak (1 hour) vehicle trips per bedroom	0.07	0.03-0.17	0.15	0.07-0.22
Daily vehicle trips per unit	1.52	0.77-3.14	4.58	4.37-4.78
Daily vehicle trips per car space	1.34	0.56-2.16	3.22	2.26-4.18
Daily vehicle trips per bedroom	0.72	0.35-1.29	1.93	1.59-2.26

Figure 18 RMS High Density Residential Vehicle Generation Rates

Source Extract RMS Technical Direction TDT 2013/04

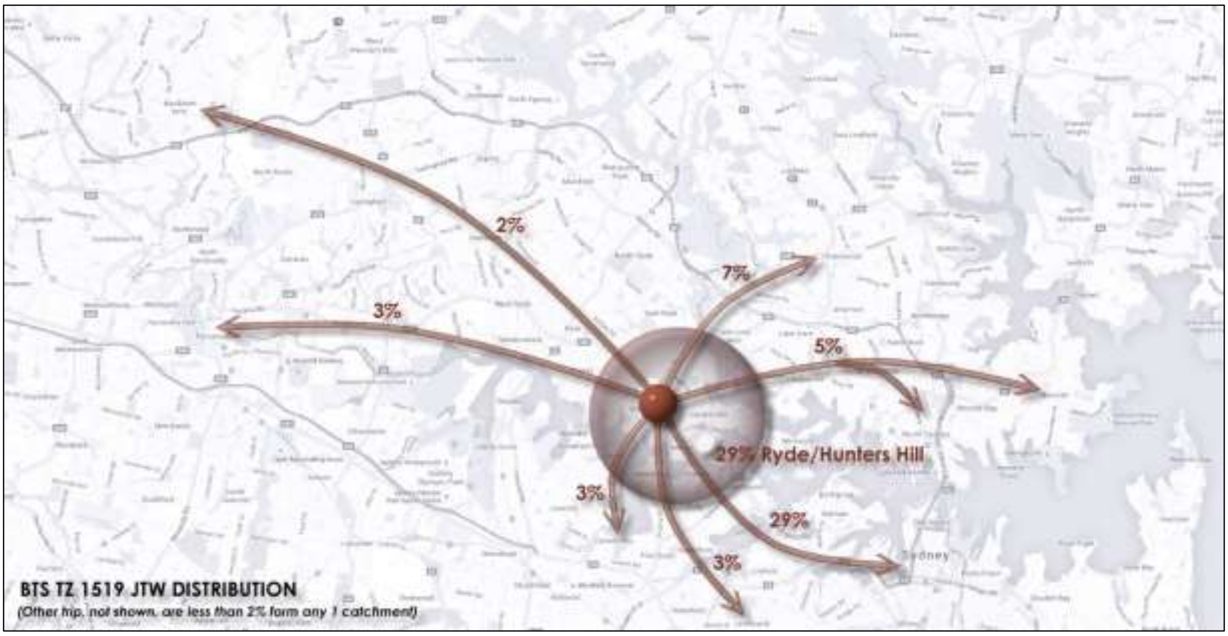

Figure 19 **Residential Journey To Work (JTW) Trip Distribution**

Source *Mesoscopic Netanal Model, Road Delay Solutions, 2015*

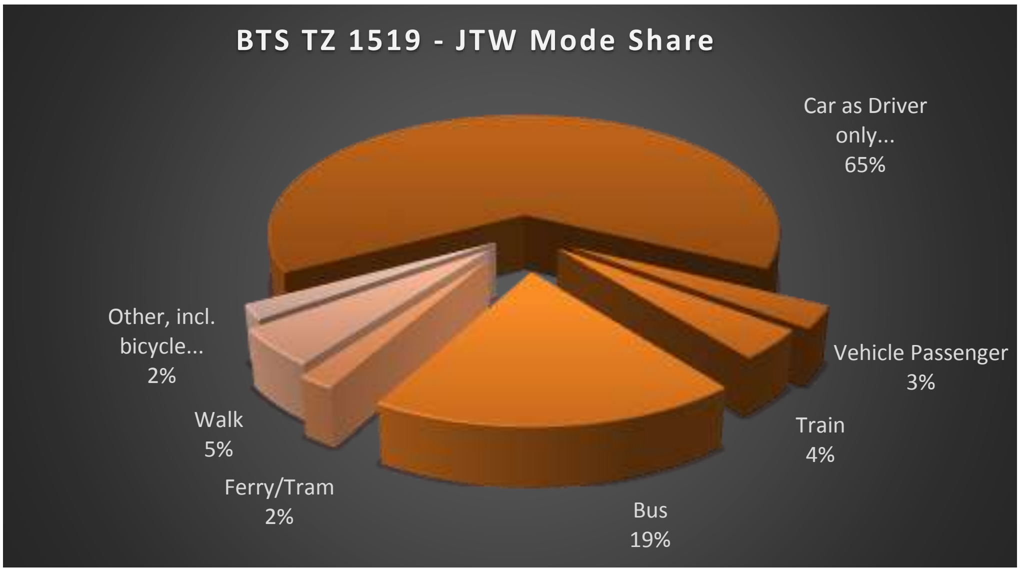

Figure 20 **Journey To Work (JTW) Mode Share**

Source *JTW Travel Zone Explorer, BTS, 2015*

SUPERMARKET (RETAIL) CATCHMENT GENERATION

Analysis of the current supermarket operations revealed the GSV generally attracts patrons from a radial catchment of less than 10 kilometres from the GTC. It was found that the Coles Supermarket at the GSV generally attracted some 72% of patrons from within a 1.5 kilometre radius of the site, a further 19% within 2kms and the majority of the remaining 8%, some 3.5kms. This distribution pattern has been applied within the trip matrices of the base year model.

The retail catchment was determined by a simple survey of 126 patrons entering the by vehicle into the basement carpark and observed heading to the Coles Supermarket. These patrons were asked to roughly estimated the distance they had travelled. The survey did not include pedestrian foot traffic entering via the ROW.

Some 25% of patrons surveyed commented that they frequently utilised competing supermarkets and that the Gladesville store was not their sole source of groceries.

The attraction of patrons, as outlined to the Coles Supermarket was adopted for all retail activities within the Netanal models, with one (1) significant inclusion.

The Woolwich Peninsula has immediate connectivity with the GSV via Gladesville Road. It has been suggested by residents that some 55 vehicle trips to and from the GSV during the evening commuter peak originate from the Woolwich Peninsula and these particular trips have been added to the current Netanal models. An origin survey will be undertaken prior to DA to confirm this statistic.

Range in Total Floor Area (GLFA – m^2)	Peak Hour Generation Rate (vehicles per 100m^2 GLFA)			
	Thursday (V(P)/A)	Friday (V(P)/A)	Saturday PVT (A)	Sunday
0 – 10,000	12.3	12.5	16.3	
10,000 – 20,000	7.6 (6.2)	6.2 (6.7)	7.5 (7.5)	(6.6)
20,000 – 30,000	5.9 (6.0)	5.6 (5.9)	7.5 (7.0)	(6.3)
30,000 – 40,000	4.6	3.7	6.1	
40,000 – 70,000	(4.4)	(4.4)	(5.5)	(4.6)
70,000+	(3.1)	(4.0)	(3.6)	(3.2)

**Figures shown in brackets refer to the 2011 surveys.*

Figure 21 RMS Shopping Centre Vehicle Generation Rates

Source Extract RMS Technical Direction TDT 2013/04

Extensive surveys of shopping centres were conducted by the *RMS* in 1978, 1990 and again in 2011. The latter survey involved ten (10) larger shopping centres, seven in the Sydney Metropolitan Area and one (1) each at Mittagong, Shellharbour and Tuggerah.

While the *RMS* generation rates have been adopted during the modelling, it is prudent to note that the quantum of traffic generated by the retail component of the development will invariably be less given the residential component. It is envisaged that some 10% of retail traffic will be drawn from the self contained residential component. While the available parking, yet to be determined, will permit the *RMS* vehicle generation rates to be achieved, the duration and level of full occupancy of the parking spaces may be reduced as a consequence.

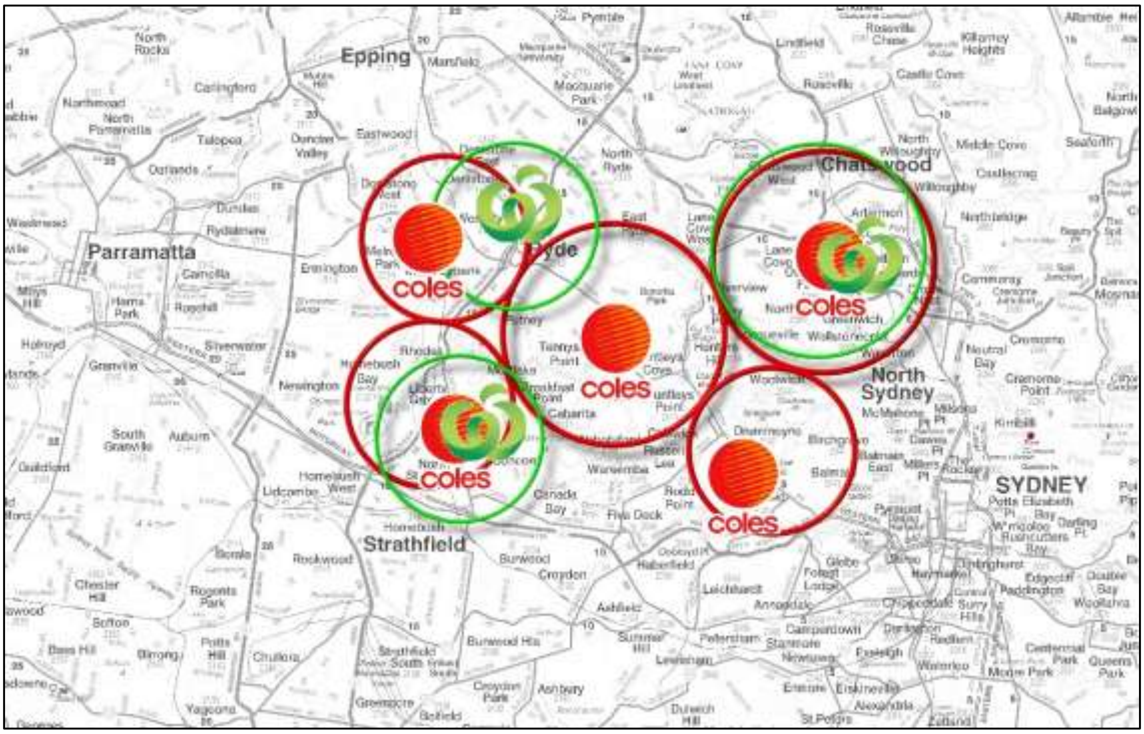

Figure 22 Supermarket Catchments

Source Road Delay Solutions, 2015

COMMERCIAL GENERATION

Finally with regard to commercial office activities, again, the *RMS* conducted ten (10) surveys in 2010 and derived the following generation rates.

Daily vehicle trips = 11 per 100 m^2 gross floor area
Morning peak hour vehicle trips = 1.6 per 100 m^2 gross floor area.
Evening peak hour vehicle trips = 1.2 per 100 m^2 gross floor area.

Figure 23 RMS Commercial Land Use Vehicle Generation Rates
Source Extract RMS Technical Direction TDT 2013/04

Applying the specific *RMS* vehicle generation rates for high density residential, retail and commercial activities the projected morning peak hour generation is 1,361vph while the evening is 1,338vph.

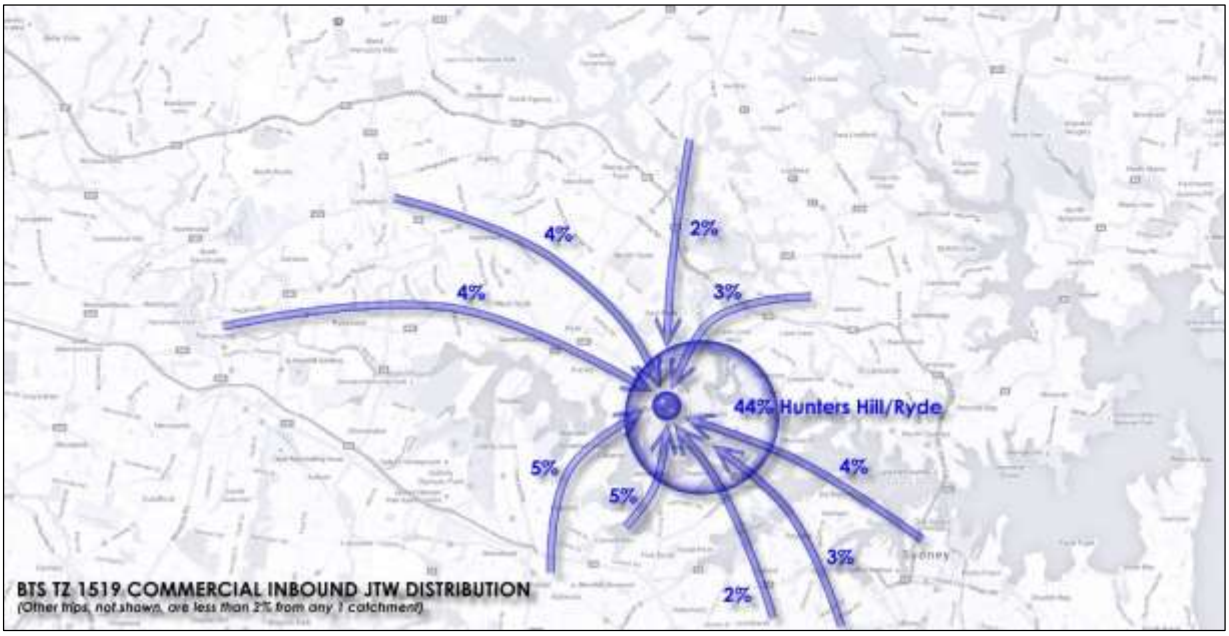

Figure 24 Commercial Inbound Journey To Work (JTW) Trip Distribution
Source Mesoscopic Netanal Model, Road Delay Solutions, 2015

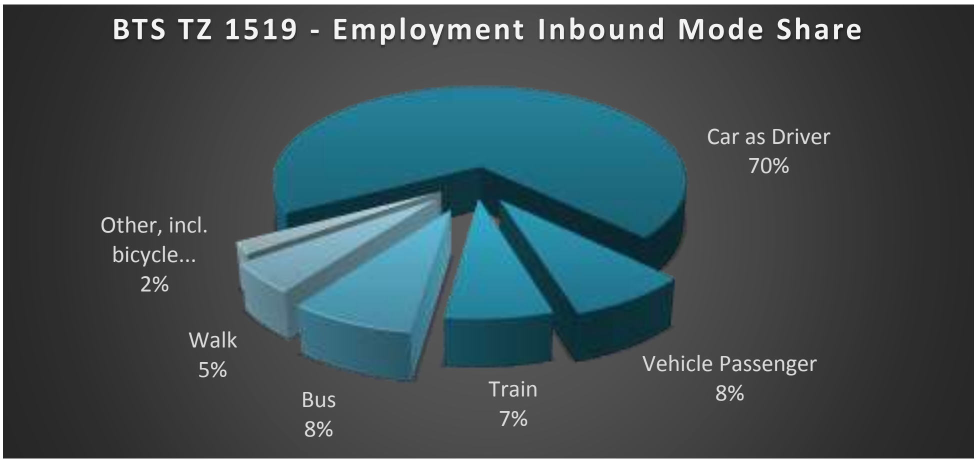

Figure 25 Commercial Employment Inbound Mode Share

Source JTW Travel Zone Explorer, BTS, 2015

PUBLIC CONSULTATION

Public consultation pertaining to traffic matters was conducted on Friday 14 and Tuesday the 18 August, 2015. Each evening consisted of two sessions with the public encouraged to express their opinions and concerns relating to traffic issues pertaining to the proposed development.

A number of key issues arose from the evenings. A brief outline of the issues raised and the assessment undertaken, follow.

Community Issue	Assessment Resolution
The full closure of Flagstaff Street would restrict the residents of Massey Street between Flagstaff Street to the west and Venus Street to east. Consider the possibility of two (2) way movement through this section of Massey Street	The closure of Flagstaff Street is intended to be partial only. Residents, including those from Massey Street, are intended to utilise the closure. The issue of illegal usage is to be addressed by the reinforcement of signposting, alignment and design form. The section of closure should take the form of a meandering, paved driveway. Landscaping is to be employed to narrow the passage and try to reduce a clear line of sight between Flagstaff Street and Massey Street
The illegal usage of the Flagstaff Street partial closure	It is conceded that enforcement of the closure by NSW Police is unlikely. It is considered that the majority of motorists will observe the signposting and the design treatment, as proposed with minimal illegal usage. A weight limit may also be imposed on Massey Street to deny heavy vehicle passage
The closure of Cowell Street will simply send traffic further south in Venus Street to Junction Street	Modelling suggests that only traffic heading to the GSV will continue on Venus Street to Junction Street and then onto Flagstaff Street. The models do not indicate the significant use of the corridor by through traffic given the restrictive carriageway widths. Non the less, it may be prudent to consider the introduction of a timed No Right Turn ban from Venus Street to Junction Street during the commuter peak periods. Further investigation into the operation of vehicles in Venus Street will be undertaken prior to DA
Concern over the traffic signal operation of the Victoria Road intersection at Cowell Street under increased traffic volumes	Sidra modelling indicates that the current traffic signals, with the introduction of an extended right turn bay to 149m on Victoria Road will result in a satisfactory level of service 'D' during the evening commuter peak hour
Will the car parking be adequate and what mix is to be employed	Parking arrangements are yet to be finalised but underground provision for some 892 vehicles is envisaged on the site. Consideration will be given to allocate residential and visitor parking on the bottom level, with commercial and retail parking occupying the upper levels
How will the entries and exits work in Flagstaff Street along with the loading docks	It is intended that all ingress (residential, retail and commercial) will occur below the egress in Flagstaff Street allowing for unimpeded traffic movement. Only residents of Flagstaff Street and Massey Street will be permitted to turn left from the site and utilise the partial closure. Signposting is to be employed to reinforce this action. The loading docks will pose the only conflicts. These conflicts are envisaged to be sporatic and not pose a significant risk, when managed correctly. Sufficient gaps will be available within the traffic stream for the movement of heavy vehicles to and from the loading docks. The movement of Heavy vehicles will be encouraged outside the peak commuter periods
How will traffic coming from the Woolwich Peninsula on Gladesville Road be impacted	Traffic from Gladesville Road and the Woolwich Peninsula, which currently utilises Cowell Street, will be directed to Flagstaff Street VIA Junction Street. This volume has been quantified and addressed within the model.
How will on street parking in Cowell Street and Massey Street be addressed	A level of on street parking currently exists in both streets, predominantly Massey Street. Consideration is being given to timed parking restrictions which will not impose on resident parking. This issue will be addressed after further talks with Council and prior to DA

Figure 26 **Public Consultation Matters for Assessment**

Source *Public Consultation Evenings, August 2015*

THE TRAFFIC MANAGEMENT SOLUTION

The proposed Traffic Management Solution for the redevelopment has been predicated on four (4) primary objectives…

- *Develop a clearly defined strategy to safely and efficiently manage the movement of anticipated vehicle classifications and pedestrians with the redevelopment of the GSV,*
- *Limit and/or reduce the impost on the surrounding residential precincts to ensure retention of local amenity,*
- *Provide adequate access and on site parking provisions, and*
- *Employ strategies to reduce the dependency on private vehicle usage.*

The formulation of the Traffic Management Solution for the redevelopment had to contend with a number of restrictive factors, being…

- *Limited street frontage,*
- *Steep road gradients, and*
- *Narrow road carriageways.*

The preferred Traffic Management Solution has addressed these issues and those presented during the public consultation period and has resulted in proposing that Cowell Street be adopted as the pincipal '*gateway*' to the redevelopment site.

TRAFFIC MANAGEMENT COMPONENTS

The preferred Traffic Management Solution for the GSV involves the construction and introduction of various measures to influence and compel traffic to utilise the arterial road network rather than the local road system.

These measures include…

- *Introduction and construction of a partial closure of Flagstaff Street, to the immediate south of Massey Street, to reduce the intrusion of traffic from the development,*
- *Closure of Cowell Street at Flagstaff Street,*

- → *Construction of a single lane circulating roundabout at the intersection of Cowell Street and Flagstaff Street,*
- → *Introduction of two (2) way vehicle movement in Cowell Street between the Cowell Street closure at Flagstaff Street to Venus Street,*
- → *Increasing the current 45m long right turn bay in Victoria Road northbound at Cowell Street to 65m,*
- → *Introduction of all vehicular access to the site from the Flagstaff Street,*
- → *Retention of the one (1) way movement, northbound, in Flagstaff Street, south, at Cowell Street,*
- → *Introduction of all permissible vehicle movements from Flagstaff Street to the south, through the roundabout on Cowell Street,*
- → *Introduction of marked pedestrian foot crossings in both Cowell Street and Flagstaff Street,*
- → *Introduction and construction of a set down bay in Cowell Street, with timed 15 minute parking restrictions, and*
- → *Introduction of a Shared Zone within the Right of Way (ROW) to the west of the site.*

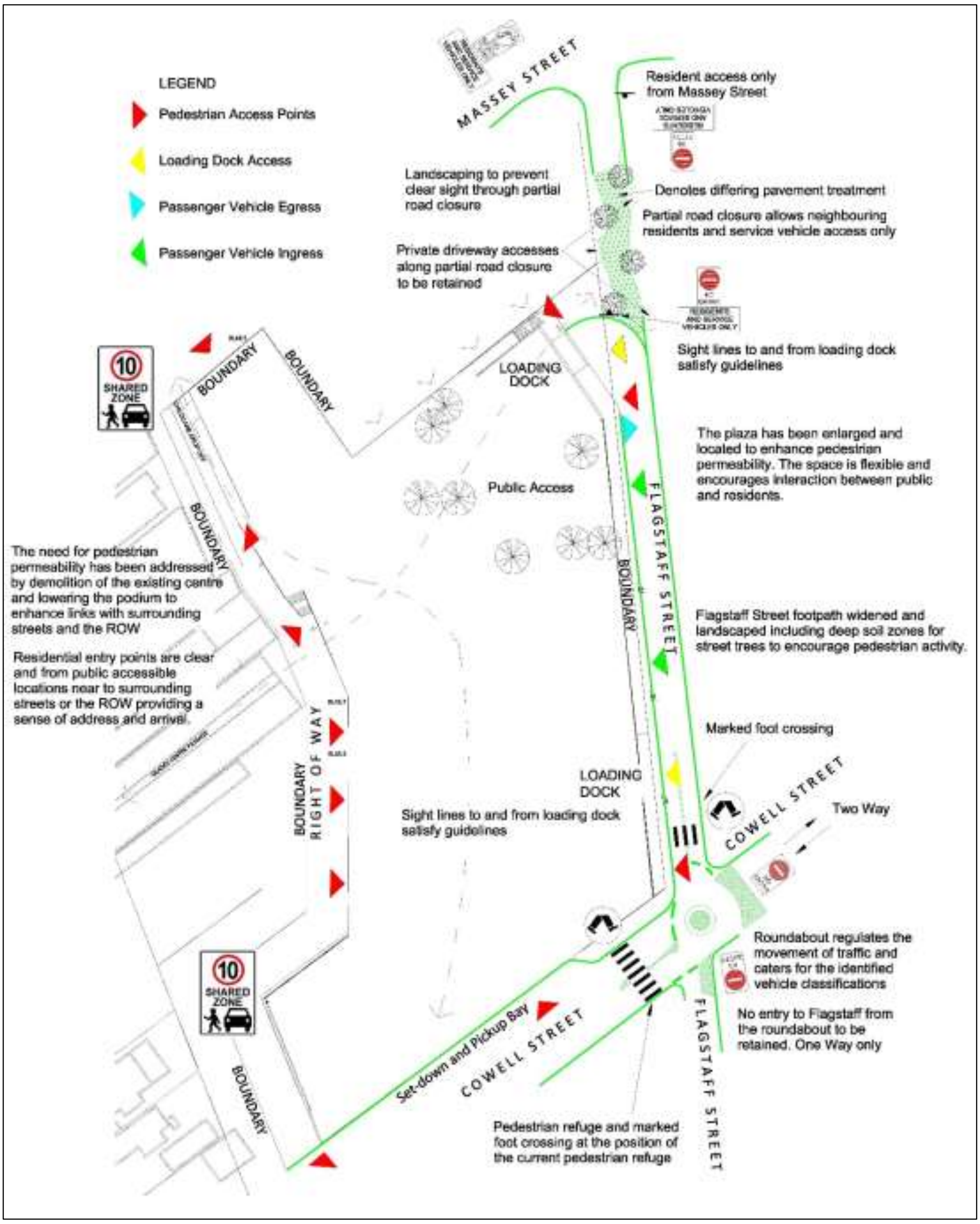

Figure 27 Proposed Traffic Management Solution

Source Road Delay Solutions, 2015

FLAGSTAFF STREET PARTIAL CLOSURE

The partial closure of Flagstaff Street is intended to eliminate traffic generated from the GSV, entering the residential precinct in Massey Street.

Figure 28 Impression of a Typical Landscaped Partial Closure

Source Road Delay Solutions, 2015

The closure is to adopt a curvilinear alignment, narrow carriageway, pavement treatment and landscaping to take on the appearance of a driveway. The carriageway is not to be kerbed and the wearing surface is to match the finished level of the adjoining verge area.

Signposting is to be adopted to deter motorists from entering. Signposting depicting the words… 'Private Road' – Residents and Guests Only' is proposed to enforce the closure.

Figure 29 Possible Signposting Treatment

Entry to the partial closure is to be via a standard vehicular layback to further promote the appearance of a residential driveway.

The partial closure is to be constructed so as to allow garbage trucks and service vehicle access.

COWELL STREET CLOSURE

The Cowell Street closure will remove both through traffic and those vehicles attracted to the GSV. The action improves the operation of the proposed roundabout at the Cowell intersection with Flagstaff Street by reducing the impedence with traffic exiting the GSV.

In combination with the partial closure of Flagstaff Street, it was found that the Cowell Street closure will eliminate some 165vph (*'rat runners'*) currently travelling through the precinct from Venus Street and which do not have an ultimate destination within the precinct.

The current angled on street parking in Cowell Street will require review as the intended two (2) way movement between Flagstaff Street and Venus Street will require a trafficable carriageway width of 6.6m.

The current meandering trafficable passage is no longer needed as the corridor is to be utilised by residents, guests and service vehicles only. A turning head in the closure is intended to enable service vehicles to turn around.

Timed parking restrictions are to be considered to deter the potential for patrons of the GSV from parking in Cowell Street and accessing the shopping complex on foot. Any such restrictions will consider the parking needs of residents and be presented in the DA submission.

Figure 30 Impression of Cowell Street Closure

Source Road Delay Solutions, 2015

ROUNDABOUT ON COWELL STREET AT FLAGSTAFF STREET

A single lane circulating roundabout is proposed on Cowell Street at Flagstaff Street. A roundabout will effectively manage the movement of vehicles through the intersection.

Reporting the only noteable average queue length of some 20m in Flagstaff Street, the roundabout will allow egressing traffic from the GSV virtually unimpeded movement and assist in achieving a modelled LoS 'A' in 2021.

Figure 31 Typical Single Lane Roundabout Treatment

Source Google Earth – Morrison Road and Meriton Street, 2015

The splitter island in the Cowell Street approach is to accomodate the construction of a marked pedestrian footcrossing. A further marked foot crossing is proposed in Flagstaff Street at the Cowell Street roundabout. Investigations into the quantum and anticipated movement of pedestrians in the vicinity will be further investigated prior to DA to ensure the anticipated pedestrian demand is adequately catered for.

RIGHT TURN BAY IN VICTORIA ROAD AT COWELL STREET

With the increased traffic associated with the redevelopment of the GSV it is necessary to increase capacity at the signalised Cowell Street intersection on Victoria Road. Sidra modelling indicates that increasing the length of the current northbound right turn bay in Victoria Road from 49m to 65m will achieve a satisfactory LoS 'D' in the morning peak and 'C' during the evening under full redevelopment traffic demands.

ALL VEHICULAR ACCESS IN FLAGSTAFF STREET

Vehicular access to the site is problematic given the limited street frontage and topography. The surface levels cause significant intrusion into the usable floor space at the podium level and care has been taken to effectively manage the access to and from the basement car park.

Dedicated retail and residential ingress points are proposed via driveways in Flagstaff Street, some 50m and 80m north of Cowell Street, respectively. Combined retail and residential egress is proposed in Cowell Street via a driveway some 90m north of Cowell Street. This action allows traffic entering and leaving the site to do so with minimal conflict from service vehicles accessing the northern loading dock.

Two (2) loading docks are proposed to the north and south of the frontage in Flagstaff Street.

The southern loading dock is intended for all retail and commercial operations, with the exception of the Coles Supermarket. The northen loading dock is to dedicated to the Cole Supermarket.

Both loading docks are to employ a turntable on which heavy vehicles may be turned within the loading docks to allow unloading and egress in a forward direction.

Confining access to the site from Flagstaff Street removes conflicting vehicle movements and footway crossings from Cowell Street. The action provides improved pedestrian safety within the footway area on Cowell Street, unencumbered by vehicle movements.

RETENTION OF ONE WAY MOVEMENT IN FLAGSTAFF STREET SOUTH

The northbound one way movement in Flagstaff , south, between Junction Street and Cowell Street, was introduced to reduce the intrusion of through traffic within the residential precinct. Retention of the one way movement maintains the status quo.

LEFT AND THROUGH MOVEMENT INTRODUCED FROM FLAGSTAFF STREET SOUTH

The introduction of a roundabout on Cowell Street necessitates the introduction of all permissible movements from the Flagstaff Street south approach.

This action attracts traffic into Flagstaff Street from Burns Bay Road and the Woolwich Peninsula viA Gladesville Road. While this traffic currently enters via Venus Street and Cowell Street, east, the closure of Cowell Street and the growth in catchments feeding the corridor, will see northbound traffic in Flagstaff Street increase from the current 15vph to some 500vph by 2021, with the majority going to the GSV.

SET DOWN BAY IN COWELL STREET

The elimination of vehicular access in Cowell Street provides the opportunity to introduce a timed, set down bay immediately to the south of the site. It is envisaged that parking be restricted to 15 minutes for the short stay delivery of patrons.

A 'No Parking' restriction was considered for the bay, given that…

- *The driver is permitted to drop off or pick up passengers or goods without leaving their vehicle,*
- *The driver must be within three metres of the vehicle at all times, and*
- *The driver must attend to their business promptly, within two minutes of stopping their vehicle.*

'No Parking' was believed to be too restrictive, but further discussion with Council will be undertaken prior to DA submission as to the most effective restriction to service the needs of the community.

INTRODUCTION OF A SHARED ZONE IN THE ROW

Council have defined the ROW within the Draft Hunters Hill Consolidated DCP, 2015, as a 'Shareway'. The Draft DCP details that the existing right-of-way be consolidated to collectively form the Shareway, a publicly accessible vehicular and pedestrian laneway between Massey Street and Cowell Street.

Building setbacks within the Shareway allow for a 9 metre wide laneway to include…

- → *6.5 metre wide, two way, regulated 10km/hr, trafficable carriageway, and*
- → *0.5 metre wide planting beds to the street side of a 2 metre wide footpath.*

The intention of the Shared Zone, as presented under the planning proposal, it is that the carriageway be '*shared*' by both pedestrians and vehicles. The Shared Zone is to have two (2) primary functions…

1. *Provide access to those properties fronting Victoria Road, and*
2. *Allow safe and direct pedestrian access to the GSV and those properties fronting Victoria Raod.*

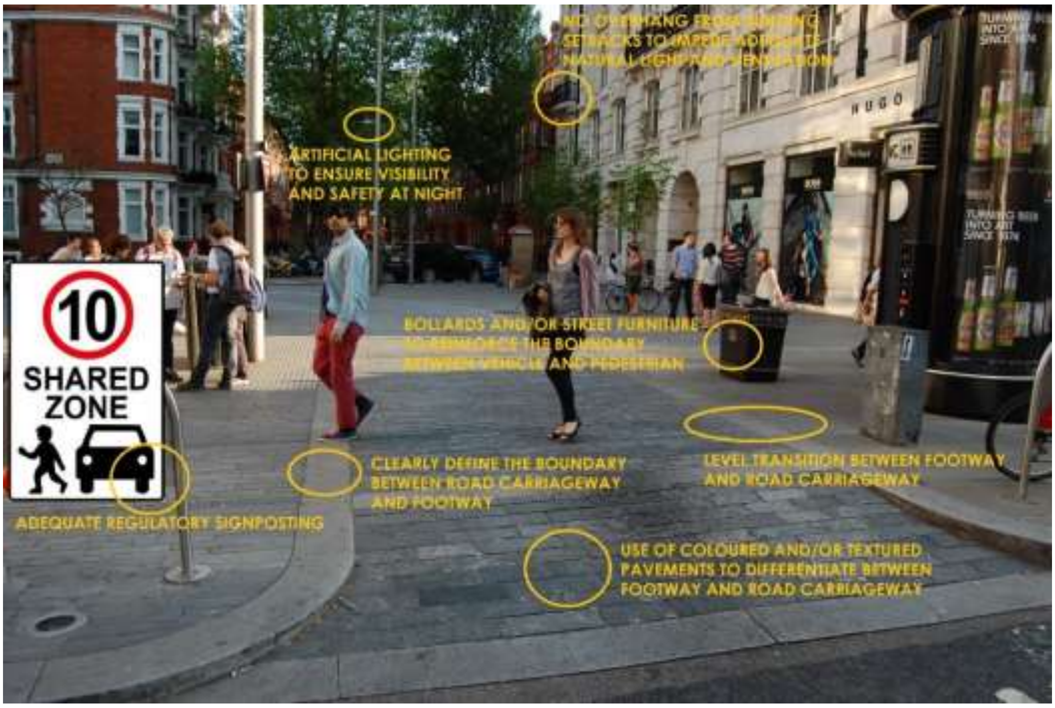

Figure 32 Typical Shared Zone Treatment

Source Shared Space Holbein Place - Sloane Square, London, 2015

It is not the intention of the proposal to permit vehicles access between Cowell Street and Massey Street. To achieve this, it is intended to install bollards within the shared zone, either side of the pedestrian thoroughfare between the current arcade and the GSV. This will permit vehicular access to the properties fronting Victoria Road but restrict vehicles from travelling between Cowell Street and Massey Street. A direct connection between the two streets is seen as detrimental to pedestrian movement.

With vehicle movement limited to 10km/hr, the Shared Zone should adopt a formalised road carriageway and footway utilising differing pavement textures, bollards and/or street furniture. The same finished surface level should be adopted for both roadway and footway allowing for a smooth transition between surfaces for pedestrians.

MODEL INPUTS

Investigations into the traffic impacts associated with the GSV redevelopment has required the preparation of a mesoscopic, computer based, model.

The overall population within the Hunters Hill LGA, as reported in the 2011 census, is 14,663. The area defined as TZ 1519 has a current population of some 2,236 persons which will increase to a projected 3,035 persons in year 2021.

To align the road network usage with the projected population, employment and vehicle generations from the GSV, this assessment has utilised the growth projection data sets published by the *BTS* in 2012.

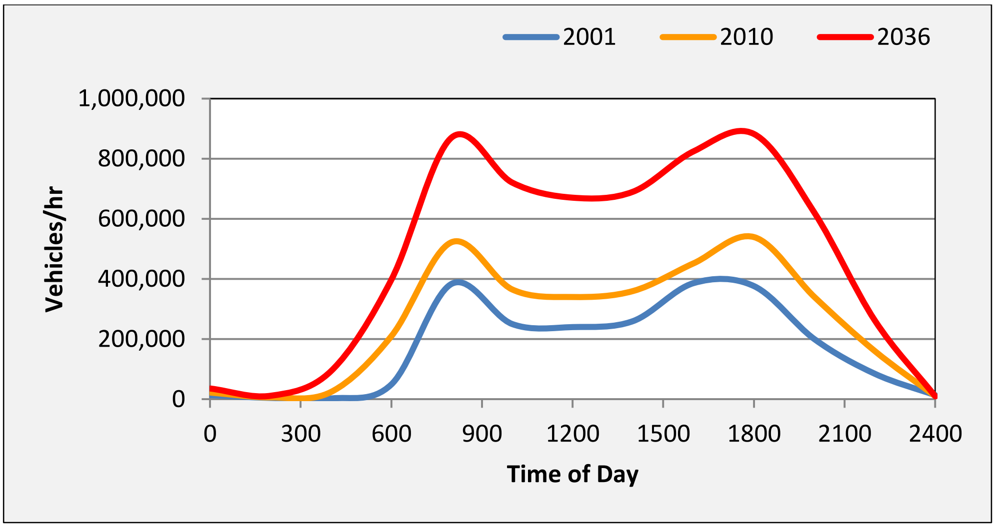

Figure 33 Projected Sydney Region Peak Hour Travel Demand

Source Road Delay Solutions, 2015

With the anticipated population growth within the Hunters Hill LGA and more specifically the Gladesville Town Centre, the projected level of vehicle trips on the Sydney Metropolitan road network, by time of day, are set to increase, as indicated above.

This assessment has considered the implications of future traffic demand under planned urban renewal and development growth. Particular focus has been directed to the

Gladesville Town Centre and the known development. In particular, the models have incorporated the Bunnings Development to the north, currently under assessment by Ryde Council.

Each road link and intersection has been diligently assessed, under differing control methods, to achieve a safe and efficient outcome under the burden of future traffic demands in year 2021.

To assess the performance of the projected year 2021 road network, all planned arterial infrastructure has been incorporated.

The modelled 2021 Sydney Metropolitan Road Network incorporates State, Regional, Arterial, Sub-arterial, Sydney CBD roads, Collector and some select local roads, as classified by the RMS and Local Government Councils.

Key Local Roads within the Hunters Hill LGA quadrant of the Gladesville Town Centre have been included in the networks for both the base and future year models.

The proposed GSV development is defined by the the *Bureau of Transport Statistics* (BTS) as part of TZ 1519, within the Hunters Hill LGA.

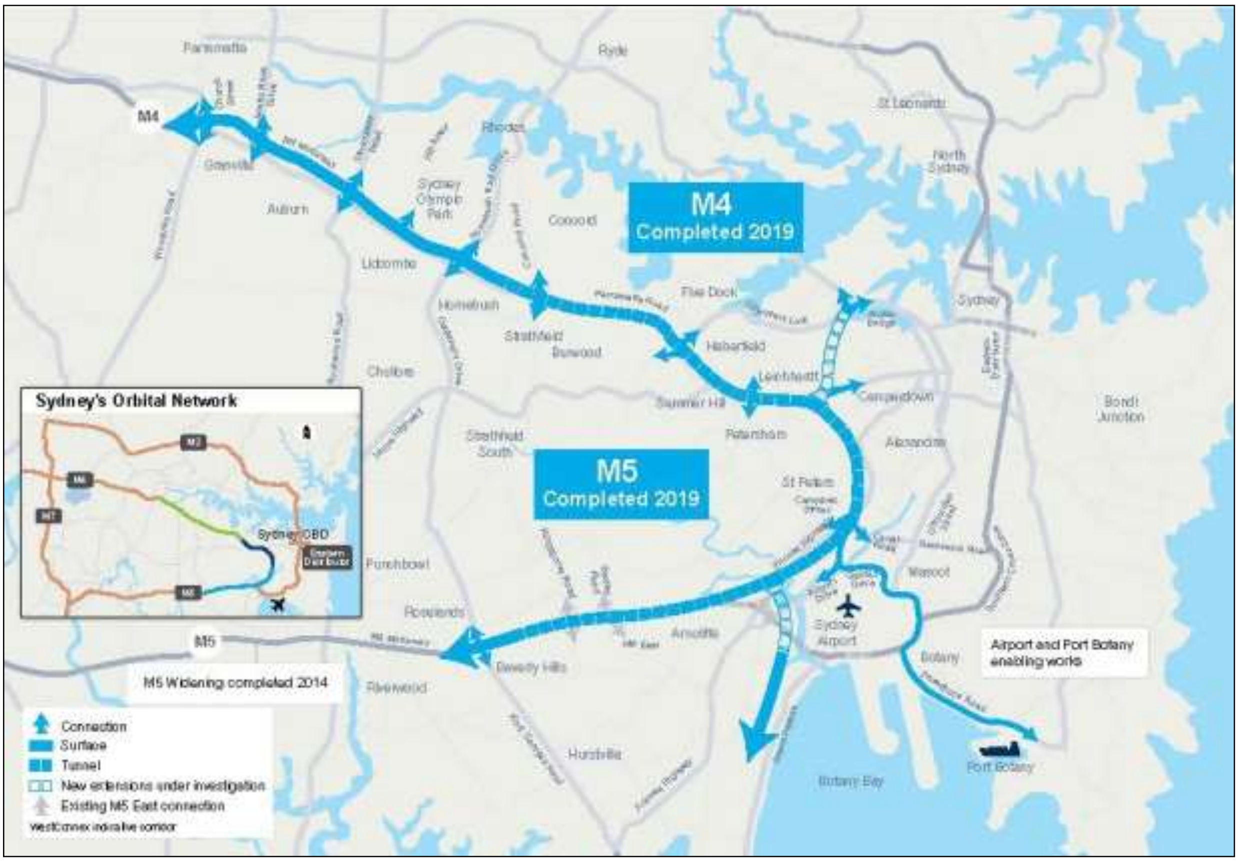

Figure 34 **Principal Road Infrastructure Projects**

Source *Sydney Roads Renewal – Fact Sheet 4 – June 2014*

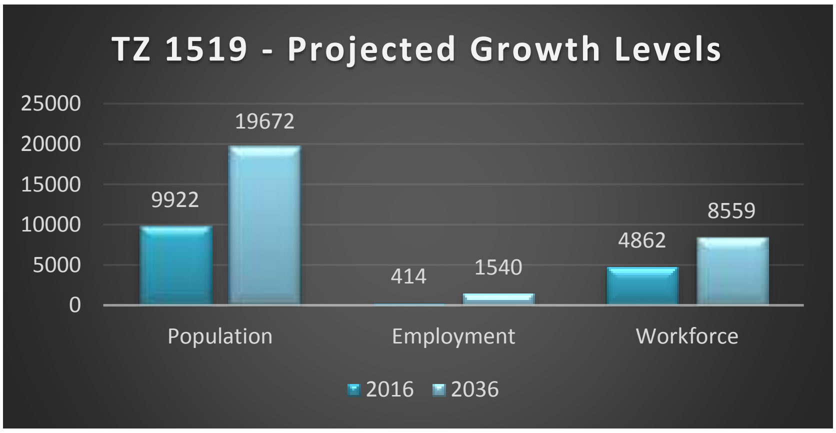

Figure 35 **Projected Growth Levels**

Source *BTS Travel Zone Exploer, 2015*

THE 2021 MODEL OUTCOMES WITH MITIGATION

The Traffic Management Solution (*mitigation*) has been modelled and found to deliver the outcomes necessary to sustain the redevelopment of the GSV.

The findings of the Sidra modelling are presented following table and report that the modelled intersections work at a satisfactory Level of Service (LoS). Queue lengths and vehicle delays generally increase through the study area.

GLADESVILLE TOWN CENTRE SIDRA ANALYSIS

	2015 Existing		2021 Full Development incl. GSV Mitigation	
	AM	**PM**	**AM**	**PM**
1. Victoria Road and Pittwater Road – Traffic Signals (*Current Split Approach Phasing @ 180sec CL*)				
DS	0.961	0.967	**0.916**	**0.906**
AVD *(sec)*	52.2	53.3	**110.5**	**102.9**
LOS	D	D	**D**	**D**
2. Victoria Road and Cowell Street – Traffic Signals (*Proposed RT bay extended to 65m*)				
DS	0.747	0.785	**0.972**	**0.957**
AVD *(sec)*	46.6	48.5	**45.4**	**40.9**
LOS	B	B	**D**	**C**
3. Cowell Street and Flagstaff Street – 2015 Sign Priority (*Current Layout*) / 2021 Roundabout (*Proposed Layout*)				
DS	0.161	0.161	**0.452**	**0.657**
AVD *(sec)*	8.0	8.0	**8.3**	**10.3**
LOS	A	A	**A**	**A**
4. Pittwater Road and Venus Street – Roundabout (*Current layout*)				
DS	0.402	0.402	**0.490**	**0.583**
AVD *(sec)*	6.4	6.4	**7.3**	**7.2**
LOS	A	A	**A**	**A**
5. Venus Street and Junction Street – Sign Priority (*Current layout*)				
DS	0.188	0.232	**0.484**	**0.470**
AVD *(sec)*	6.0	6.1	**4.2**	**5.5**
LOS	A	A	**A**	**A**

Figure 36 Intersection Operational Performances

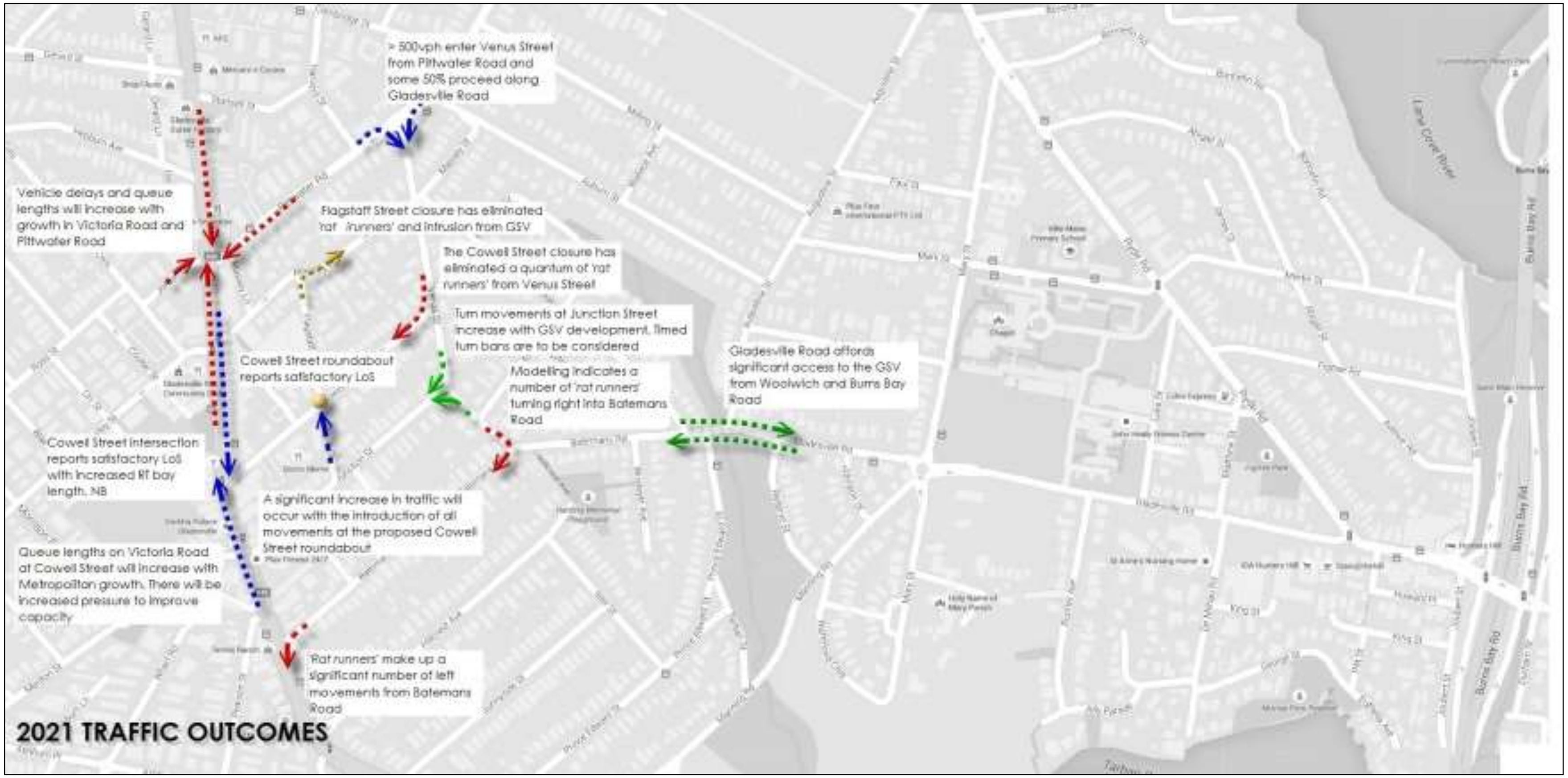

Figure 37 2021 PM Model Vehicle Projections – Full Development

Source Netanal Model, Road Delay Solution 2015

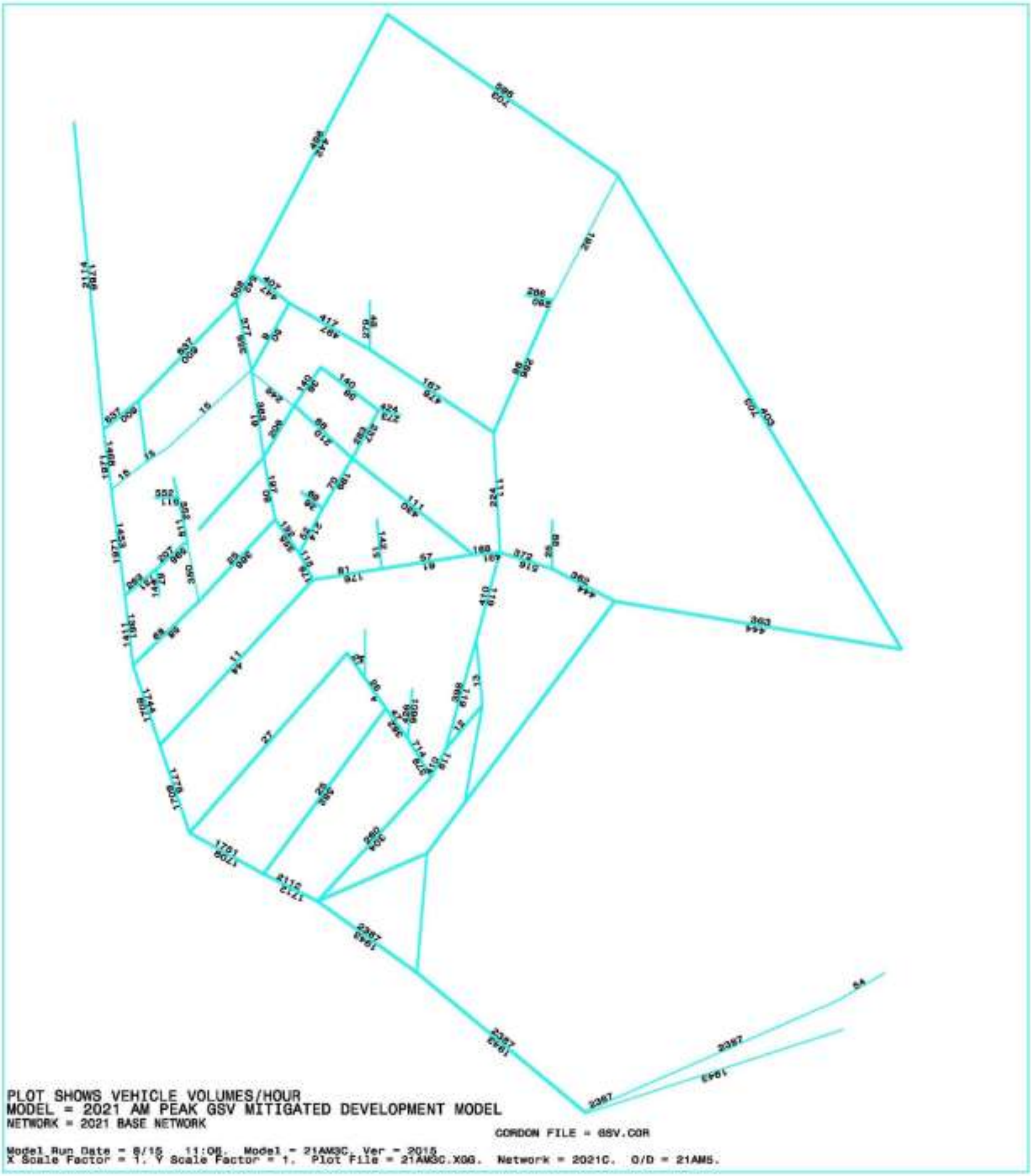

Figure 38 2021 AM Model Vehicle Projections – Full Development

Source Netanal Model, Road Delay Solution 2015

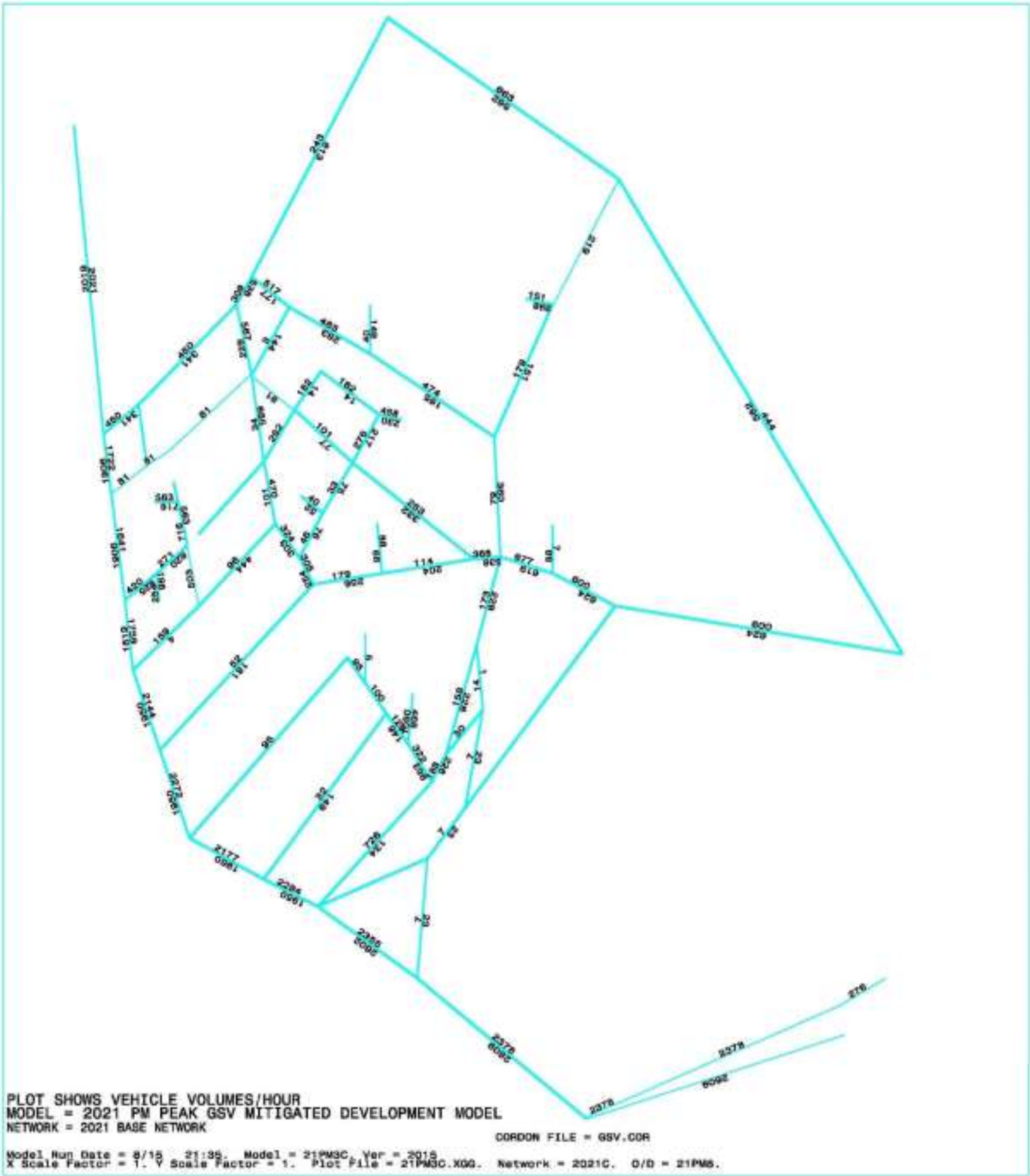

Figure 39 2021 PM Model Vehicle Projections – Full Development

Source Netanal Model, Road Delay Solution 2015

VICTORIA ROAD AND PITTWATER ROAD

The capacity of the intersection is impacted during the AM commuter peak by the utilisation of the southbound, kerbside lane, as a dedicated Bus Lane. During the evening peak the same lane facilitates on street parking.

The affects of both background and development growth through the intersection will impact significantly on vehicle delays and queue lengths. Sidra modelling does suggest that, while no spare capacity is available within the intersection, a LoS 'D' is achievable during both the AM and PM peak periods by employing the current split approach phasing in Pittwater Road while increasing the traffic signal Cycle Length to 180 seconds.

VICTORIA ROAD AND COWELL STREET

Victoria Road is subject to the impacts of Metropolitan growth. Currently operating at or near capacity, the model has indicated that traffic associated with the metropolitan Growth and redevelopment of the GSV will increase traffic demand in the peak flow direction by some 0.4% per annum.

The site accommodates a Bus Lane, southbound in Victoria Road during the AM peak period on street parking during the PM.

Future traffic through the Victoria Road intersection with Cowell Street has been tempered by…

- → *The introduction of the Flagstaff Street closure, eliminating some 122vph during the PM peak, northbound, travelling from Victoria Road to Pittwater Road via Massey Street, avoiding the Pittwater Road intersection,*
- → *The allowance of the northbound movement through the proposed roundabout from Flagstaff Street south at Cowell Street (currently left turn only is permitted from Flagstaff Street), and*
- → *The Cowell Street closure.*

As determined by comparative year 2021 models, the affects of the fore mentioned actions have only reduced traffic on Victoria Road by some 105vph, northbound. The closures have altered the pattern of traffic through the residential study area. Patrons accessing the GSV from Gladesville Road, will now be able to turn left into Junction Street then right into Flagstaff. This traffic formerly travelled northbound on Venus Street and turned left into Cowell Street.

Queue lengths on Victoria Road will increase as a consequence of the growth necessitating the need for increased capacity along the arterial corridor.

Under the affects of the Traffic Management Solution, the models indicate the right turn bay, northbound in Victoria Road must be increased in length to 65m. The maximum length of the bay is dictated by the current carriageway width and the downstream Meriton Street signalised intersection and is supported by the Sidra modelling.

PITTWATER ROAD AND VENUS STREET

Currently a single lane circulating roundabout, the intersection is reported to currently operate at a LoS 'A'. Under full Metropolitan vehicle growth demands by 2021, modelling suggests the intersection, in its current single lanr circulating form, will continue to operate at a good LoS 'A'.

VENUS STREET AND JUNCTION STREET

Concerns have been expressed that with the closure of Cowell Street, traffic currently utilising Cowell Street will simply '*transfer*' to the Junction Street intersection. Modelling suggests that indeed traffic bound for the GSV will certainly utilise the route. However, the same modelling does not indicate that '*rat runners*' will follow suit.

Venus Street is a narrow local road with on street parking and strategically located raised thresholds. These characteristics combine to lower the average vehicle speed along the corridor to 46km/h, as reported from the modelling and validated by the travel survey.

The transformation of Flagstaff Street south, and the northbound introduction of the through movement at the Cowell Street roundabout, will further add to the attractiveness of the intersection.

Modelling reports that while the total number of vehicles through the intersection increase, retaining the current sign control priority will result in a good LoS 'A' during the both the morning and evening commuter peak periods.

The projected hourly turn volumes exported from the year 2021 model are presented below.

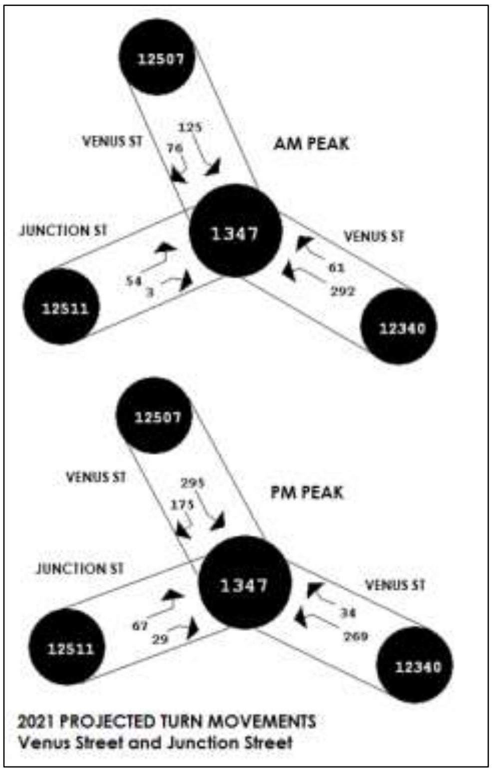

Figure 40 2021 Venus Street and Junction Street Turn Volumes

Source 2021 Netanal Model, Road Delay Solution 2015

PARKING

Passenger vehicle access to the site is via dedicated laybacks to underground, basement car parks on Flagstaff Street.

Council prescribe use of the *RMS* parking rates for major projects within the Hunters Hill LGA. The parking requirements prescribed by the *RMS* and *Council's DCP*, are indicative averages of simillar development across the Metropolitan Area. As outlined in the *RMS* guide, the prescribed rates should consider the particular requirements of the intended tenants and nature of business to be conducted. Accordingly, the following table outlines the adopted rates for the GSV redevelopment concept.

Land Use Component	GFA	Council DCP Major Developments (as per the RMS Guide)	
	(Units/m ^{2})	*Rate*	*Spaces*
Residential	100	0.4/1 bed	40
	138	0.7/2 bed	97
	12	1.2/3 bed	14
	Visitor	1/7 units	36
	SUBTOTALS		**187**
Retail	5,730	6.1/100m^2	350
Commercial	1,900	1/40m^2	48
Supermarket	3,550	7/100m^2	249
	TOTALS		**832**

Figure 41 Parking Rates by Land Use for Major Developments

Source Hunters Hill Council and RMS, 2013

It proposed to allocate some 892 car parking spaces within the confines of the underground carpark on site. The current 30 spaces within the Cowell Street surface car parkcar park are to be reinstated within the retail section of the proposed underground car park.

It is envisaged that the basement car parks will be partitioned to allocate dedicated parking to residents and visitors , commercial activities and retail.

To be finalised prior to DA submission, four (4) basement car parking levels are currently under consideration with an approximate apportionment…

- *397 for residents and visitors,*
- *112 spaces for commercial, and*
- *383 spaces fro retail.*

CAR PARKING DESIGN

The proposed development parking layout, must be designed in accordance with Council's DCP, *AS2890.1-2004* and disabled parking in accordance with *AS2890.6-2009*. The interpretation of the standards employed in the proposed development must adhere to the following guidelines…

- ***Aisle Width*** *– >6.3m*
- ***Parking Bays*** *– With the exception of the disabled parking bays, each of the remaining bays is 2.4m wide with an additional 300mm for those spaces located adjacent to any side walls or obstructions. Each bay is to be 5.4m deep.*
- ***Driveway Gradient for User Class 1, 1A or 2 (Long term parking)*** *– The proposed access for passenger vehicles must meet the required sight lines to pedestrian activity within the footway areas and comply with under carriage clearance and overhang requirements. The proposed access must cater for a sight triangle in excess of 2m by 2.5m upon departure onto Flagstaff Street.*
- ***Space identification*** *– In accordance with Figure 3.1 of AS2890.6, the allocated disabled parking bays will be clearly identified.*

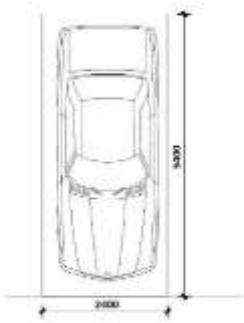

Figure 42 Typical Paking Bay Layout

Source Road Delay Solution 2015

HEAVY VEHICLES

Heavy vehicle access is proposed from Flagstaff Street with driveway accesses to two (2) dedicated loading docks proposed to the north and south of the site.

The docks are intended for use by 12.5m rigid trucks. No articulated vehicles are to be employed in the daily operation of the GSV. Coles has indicated their compliance with this directive.

A loading dock management plan will be prepared prior to DA submission.

The northern loading dock is to be assigned to the Coles Supermarket while the southern is for general retail and commercial purposes.

The ingress gradients to the loading docks must ensure sufficient undercarriage and overhang clearances when enetering and leaving the site in a forward direction.

The heavy vehicle access and internal manoeuvrability provide the capacity for vehicles to enter and leave the docks in a forward direction. This has been achieved by employment of a rotating platform located within the loading docks. No turning or reversing manoeuvres are anticipated on Flagstaff Street.

A heavy vehicle movement swept path analysis of the prescribed design vehicles will be undertaken prior to DA submission.

Level 1 Length (indicative) Type	Level 2 Axles and Axle Groups: Axles	Level 2 Axles and Axle Groups: Groups	Level 3 Vehicle Type: Typical Description	AUSTROADS Classification: Class	AUSTROADS Classification: Parameters	AUSTROADS Classification: Typical Configuration
			LIGHT VEHICLES			
Short up to 5.5m		1 or 2	Short Sedan, Wagon, 4WD, Utility, Light Van, Bicycle, Motorcycle, etc	1	d(1) ≤ 3.2m and axles = 2	
Medium 5.5m to 14.5m	3, 4 or 5	3	Short - Towing Trailer, Caravan, Boat, etc	2	groups = 3 d(1) ≥ 2.1m, d(1) ≤ 3.2m, d(2) ≥ 2.1m and axles = 3, 4 or 5	
			HEAVY VEHICLES			
Medium 5.5m to 14.5m	2	2	Two Axle Truck or Bus	3	d(1) > 3.2m and axles = 2	
	3	2	Three Axle Truck or Bus	4	axles = 3 and groups = 2	
	> 3	2	Four Axle Truck	5	axles > 3 and groups = 2	
Long 11.5m to 19.0m	3	3	Three Axle Articulated Three axle articulated vehicle, or Rigid vehicle and trailer	6	d(1) > 3.2m, axles = 3 and groups = 3	
	4	> 2	Four Axle Articulated Four axle articulated vehicle, or Rigid vehicle and trailer	7	d(2) < 2.1m or d(1) < 2.1m or d(1) > 3.2m axles = 4 and groups > 2	
	5	> 2	Five Axle Articulated Five axle articulated vehicle, or Rigid vehicle and trailer	8	d(2) < 2.1m or d(1) < 2.1m or d(1) > 3.2m axles = 5 and groups > 2	
	≥ 6	> 2	Six Axle Articulated Six axle articulated vehicle, or Rigid vehicle and trailer	9	axes = 6 and groups > 2 or axles > 6 and groups = 3	
Medium Combination 17.5m to 36.5m	> 6	4	B Double B Double, or Heavy truck and trailer	10	groups = 4 and axles > 6	
	> 6	5 or 6	Double Road Train Double road train, or Medium articulated vehicle and one dog trailer (M.A.D.)	11	groups = 5 or 6 and axles > 6	
Large Combination Over 33.0m	> 6	> 6	Triple Road Train Triple road train, or Heavy truck and three trailers	12	groups > 6 and axles > 6	

Definitions:
Group: Axle group, where adjacent axles are less than 2.1m apart
Groups: Number of axle groups
Axles: Number of axles (maximum axle spacing of 10.0m)
d(1): Distance between first and second axle
d(2): Distance between second and third axle

Light to medium trucks (class 3-5)

Heavy Trucks (class 6-9)

B-doubles (class 10-11)

Figure 43 Vehicle Classification Chart

Source AUSTROADS, 2012

PUBLIC TRANSPORT CHOICE

The Metropolitan Strategy, under the auspices of '*Draft SEPP 66 – Integration of Land Use and Transport*', prescribes guiding provisions that aim to ensure the urban structure, building forms, land use locations, development design, subdivision and street layouts to help achieve the following planning objectives...

- *Improving accessibility to housing, employment and services by walking, bicycling and public transport,*
- *Improving the choice of transport and reducing the dependancy on private vehicle usage,*
- *Moderating growth in the demand for travel and the distances travelled, especially by car,*
- *Support the efficient and viable operation of public transport services, and*
- *Providing for the efficient movement of freight.*

The provision seeks to influence mode choice made by community and business. This assessment has reviewed the current, predominant, available transport mode choices for JTW, as determined by the Department of Planning and Infrastructure. These have been formulated manually, external to the Netanal model, for all the available modes within, or adjacent to, the Gladesville Shopping Village and commercial operations, as defined within the *BTS* TZ 1519.

The four (4) dominant mode choices available are…

- *Private motor vehicle,*
- *Motor bike,*
- *Bus, and*
- *Walking/cycling.*

Public transport choice is made possible through frequent bus services and provisions on Victoria Road, some 300m to the west of the development site.

Public transport accessibility to the GSV has been improved and is under further investigation, at this time.

In support of a reduced dependency on private vehicle usage with the proposed development, a *Sustainable Travel Plan* will be prepared, prior to DA submission, outlining the public transport, car share, car pooling and alternative transport options servicing the site.

CONCLUSION

Road Delay Solutions Pty Ltd has been engaged by *Robertson + Marks Architects* and *GSV Developments Pty Ltd* to undertake investigation into the traffic implications associated with a Planning Proposal (PP) requesting variation to building heights and Floor Space Ratios within the current LEP for the proposed mixed use redevelopment of the Gladesville Shopping Villiage.

This assessment, incorporating computer based mesoscopic and operational modelling, has considered the existing year 2015 and projected future year 2021 traffic growth within the Hunters Hill quadrant of the Gladesville Town Centre. The proposed Traffic Management Solution for the redevelopment has been predicated on four (4) primary objectives…

- → *Develop a clearly defined strategy to safely and efficiently manage the movement of anticipated vehicle classifications and pedestrians with the redevelopment of the GSV,*
- → *Limit and/or reduce the impost on the surrounding residential precincts to ensure retention of local amenity,*
- → *Provide adequate access and on site parking provisions, and*
- → *Employ strategies to reduce the dependency on private vehicle usage.*

To achieve these objectives it was clear that bold and decisive traffic management measures were required. The partial closure of Flagstaff Street, the closure of Cowell Street, east, and the construction of a roundabout at the intersection of Cowell Street and Flagstaff Street form the '*core*' of the Traffic Management Solution.

These three (3) recommended actions along have the greatest impact on controlling the movement of traffic and achieving a sustainable outcome for the community.

APPENDIX A – INTERSECTION CONFIGURATIONS

APPENDIX B – INTERSECTION MOVEMENT SUMMARIES

MOVEMENT SUMMARY

Site: 2015 AM Cowell St and Flagstaff St

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Flagstaff Street											
1	L2	12	0.0	0.008	5.9	LOS A	0.0	0.2	0.23	0.53	52.9
Approach		12	0.0	0.008	5.9	LOS A	0.0	0.2	0.23	0.53	52.9
East: Cowell Street											
5	T1	102	0.0	0.161	7.9	LOS A	0.6	4.4	0.14	0.97	51.7
6	R2	66	0.0	0.161	8.1	LOS A	0.6	4.4	0.14	0.97	51.3
Approach		168	0.0	0.161	8.0	LOS A	0.6	4.4	0.14	0.97	51.5
North: Flagstaff Street											
9	R2	38	2.0	0.021	5.5	LOS A	0.0	0.0	0.00	0.60	53.0
Approach		38	2.0	0.021	5.5	NA	0.0	0.0	0.00	0.60	53.0
West: Cowell Street											
10	L2	67	2.0	0.037	5.6	LOS A	0.0	0.0	0.00	0.58	53.5
Approach		67	2.0	0.037	5.6	NA	0.0	0.0	0.00	0.58	53.5
All Vehicles		285	0.7	0.161	7.0	NA	0.6	4.4	0.09	0.81	52.2

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

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MOVEMENT SUMMARY

Site: 2015 AM Pittwater Rd and Venus St

New Site
Roundabout

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Venus Street											
1	L2	80	0.0	0.201	6.4	LOS A	1.1	7.8	0.47	0.67	51.4
3	R2	122	0.0	0.201	9.4	LOS A	1.1	7.8	0.47	0.67	51.8
Approach		202	0.0	0.201	8.3	LOS A	1.1	7.8	0.47	0.67	51.6
East: Pittwater Road											
4	L2	117	0.0	0.295	5.3	LOS A	1.9	13.3	0.28	0.50	53.0
5	T1	269	0.0	0.295	5.3	LOS A	1.9	13.3	0.28	0.50	53.9
Approach		386	0.0	0.295	5.3	LOS A	1.9	13.3	0.28	0.50	53.6
West: Pittwater Road											
11	T1	278	0.0	0.294	5.6	LOS A	1.9	13.3	0.36	0.55	53.1
12	R2	77	0.0	0.294	8.6	LOS A	1.9	13.3	0.36	0.55	52.7
Approach		355	0.0	0.294	6.2	LOS A	1.9	13.3	0.36	0.55	53.0
All Vehicles		943	0.0	0.295	6.3	LOS A	1.9	13.3	0.35	0.56	53.0

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

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MOVEMENT SUMMARY

Site: 2015 AM Venus St and Junction St

New Site
Giveway / Yield (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Venus Street											
1	L2	12	0.1	0.188	5.5	LOS A	0.0	0.0	0.00	0.05	57.9
2	T1	138	0.1	0.188	0.0	LOS A	0.0	0.0	0.00	0.05	59.5
Approach		149	0.1	0.188	0.5	NA	0.0	0.0	0.00	0.05	59.4
North: Venus Street											
8	T1	95	0.0	0.136	0.1	LOS A	0.1	1.0	0.11	0.13	58.4
9	R2	26	0.0	0.136	6.0	LOS A	0.1	1.0	0.11	0.13	56.3
Approach		121	0.0	0.136	1.4	NA	0.1	1.0	0.11	0.13	57.9
West: Junction Street											
10	L2	14	0.0	0.010	5.9	LOS A	0.0	0.3	0.22	0.54	52.9
12	R2	1	0.0	0.010	6.3	LOS A	0.0	0.3	0.22	0.54	52.4
Approach		15	0.0	0.010	6.0	LOS A	0.0	0.3	0.22	0.54	52.9
All Vehicles		285	0.1	0.188	1.1	NA	0.1	1.0	0.06	0.11	58.4

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

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MOVEMENT SUMMARY

Site: 2015 AM Victoria Rd and Cowell St

Victoria Rd and Cowell St, Gladesville
Signals - Fixed Time Isolated   Cycle Time = 80 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Victoria Road South											
2	T1	1373	4.3	0.621	10.8	LOS A	17.5	127.2	0.68	0.61	51.0
3	R2	55	2.1	0.399	46.6	LOS D	2.2	15.7	0.99	0.74	33.6
Approach		1427	4.2	0.621	12.1	LOS A	17.5	127.2	0.69	0.62	50.0
East: Cowell Street											
4	L2	69	2.0	0.095	21.6	LOS B	1.7	12.0	0.65	0.71	43.4
6	R2	72	1.0	0.155	31.1	LOS C	2.2	15.6	0.82	0.74	39.1
Approach		141	1.5	0.155	26.4	LOS B	2.2	15.6	0.74	0.72	41.1
North: Victoria Road North											
7	L2	38	2.5	0.747	21.6	LOS B	16.4	119.4	0.71	0.66	46.2
8	T1	1871	4.5	0.747	19.0	LOS B	21.1	153.7	0.83	0.76	45.7
Approach		1908	4.5	0.747	19.1	LOS B	21.1	153.7	0.83	0.76	45.7
All Vehicles		3477	4.2	0.747	16.5	LOS B	21.1	153.7	0.77	0.70	47.1

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

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P2	East Full Crossing	53	18.3	LOS B	0.1	0.1	0.68	0.68
P3	North Full Crossing	53	34.3	LOS D	0.1	0.1	0.93	0.93
All Pedestrians		105	26.3	LOS C			0.80	0.80

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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MOVEMENT SUMMARY

Site: 2015 AM Victoria Road and Pittwater Road

Pittwater Road
Signals - Fixed Time Isolated Cycle Time = 150 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Victoria Road											
1	L2	17	0.1	0.631	34.5	LOS C	32.2	233.2	0.76	0.70	22.1
2	T1	1203	4.1	0.631	27.0	LOS B	32.2	233.2	0.74	0.68	41.6
3	R2	80	0.8	0.542	45.3	LOS D	3.5	24.9	1.00	0.76	34.0
Approach		1300	3.8	0.631	28.2	LOS B	32.2	233.2	0.76	0.69	40.7
East: Pittwater Road											
4	L2	111	0.0	0.499	44.2	LOS D	8.2	58.7	0.95	0.80	34.8
5	T1	101	7.1	0.499	51.4	LOS D	8.4	61.5	0.96	0.79	23.8
6	R2	75	4.0	0.499	71.8	LOS F	8.4	61.5	0.98	0.79	27.8
Approach		286	3.6	0.499	53.9	LOS D	8.4	61.5	0.96	0.79	29.3
North: Victoria Road											
7	L2	41	2.2	0.162	21.9	LOS B	2.7	28.4	0.61	0.55	45.1
8	T1	1530	11.6	0.961	69.6	LOS E	69.1	515.9	0.96	1.07	28.3
9	R2	34	1.0	0.461	86.7	LOS F	2.6	18.4	1.00	0.72	17.2
Approach		1605	11.1	0.961	68.7	LOS E	69.1	515.9	0.95	1.05	28.0
West: Jordan Street											
10	L2	18	0.1	0.527	70.0	LOS E	9.5	66.7	0.98	0.79	20.7
11	T1	149	0.2	0.527	65.6	LOS E	9.5	66.7	0.98	0.79	21.1
12	R2	102	0.1	0.527	70.9	LOS F	9.1	64.1	0.98	0.80	20.0
Approach		269	0.2	0.527	67.9	LOS E	9.5	66.7	0.98	0.79	20.7
All Vehicles		3461	6.9	0.961	52.2	LOS D	69.1	515.9	0.88	0.87	31.4

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

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	South Full Crossing	53	69.3	LOS F	0.2	0.2	0.96	0.96
P2	East Full Crossing	53	28.3	LOS C	0.1	0.1	0.61	0.61
P3	North Full Crossing	53	69.3	LOS F	0.2	0.2	0.96	0.96
P4	West Full Crossing	53	21.4	LOS C	0.1	0.1	0.53	0.53
All Pedestrians		211	47.0	LOS E			0.77	0.77

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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MOVEMENT SUMMARY

Site: 2015 PM Cowell St and Flagstaff St

New Site
Stop (Two-Way)

Movement Performance - Vehicles												
Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Flagstaff Street											
1	L2	6	0.0	0.005	6.3	LOS A	0.0	0.1	0.31	0.54	52.6
Approach		6	0.0	0.005	6.3	LOS A	0.0	0.1	0.31	0.54	52.6
East: Cowell Street											
5	T1	142	0.0	0.240	8.3	LOS A	1.0	6.9	0.28	0.94	51.4
6	R2	86	0.0	0.240	9.2	LOS A	1.0	6.9	0.28	0.94	51.0
Approach		228	0.0	0.240	8.6	LOS A	1.0	6.9	0.28	0.94	51.3
North: Flagstaff Street											
9	R2	106	2.0	0.058	5.5	LOS A	0.0	0.0	0.00	0.60	53.0
Approach		106	2.0	0.058	5.5	NA	0.0	0.0	0.00	0.60	53.0
West: Cowell Street											
10	L2	120	2.0	0.066	5.6	LOS A	0.0	0.0	0.00	0.58	53.5
Approach		120	2.0	0.066	5.6	NA	0.0	0.0	0.00	0.58	53.5
All Vehicles		461	1.0	0.240	7.1	NA	1.0	6.9	0.14	0.76	52.3

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

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MOVEMENT SUMMARY

Site: 2015 PM Pittwater Rd and Venus St

New Site
Roundabout

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Venus Street											
1	L2	156	0.0	0.399	7.5	LOS A	2.6	18.4	0.64	0.75	50.7
3	R2	211	0.0	0.399	10.5	LOS A	2.6	18.4	0.64	0.75	51.1
Approach		366	0.0	0.399	9.2	LOS A	2.6	18.4	0.64	0.75	50.9
East: Pittwater Road											
4	L2	188	0.0	0.432	5.5	LOS A	3.4	23.6	0.38	0.52	52.6
5	T1	366	0.0	0.432	5.5	LOS A	3.4	23.6	0.38	0.52	53.5
Approach		555	0.0	0.432	5.5	LOS A	3.4	23.6	0.38	0.52	53.2
West: Pittwater Road											
11	T1	257	0.0	0.336	6.2	LOS A	2.3	15.9	0.51	0.62	52.5
12	R2	100	0.0	0.336	9.2	LOS A	2.3	15.9	0.51	0.62	52.2
Approach		357	0.0	0.336	7.1	LOS A	2.3	15.9	0.51	0.62	52.4
All Vehicles		1278	0.0	0.432	7.0	LOS A	3.4	23.6	0.49	0.62	52.3

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

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MOVEMENT SUMMARY

Site: 2015 PM Venus St and Junction St

New Site
Giveway / Yield (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Venus Street											
1	L2	14	0.1	0.200	5.5	LOS A	0.0	0.0	0.00	0.05	57.8
2	T1	145	0.1	0.200	0.0	LOS A	0.0	0.0	0.00	0.05	59.4
Approach		159	0.1	0.200	0.5	NA	0.0	0.0	0.00	0.05	59.3
North: Venus Street											
8	T1	165	0.0	0.232	0.1	LOS A	0.2	1.6	0.11	0.11	58.6
9	R2	37	0.0	0.232	6.1	LOS A	0.2	1.6	0.11	0.11	56.4
Approach		202	0.0	0.232	1.2	NA	0.2	1.6	0.11	0.11	58.2
West: Junction Street											
10	L2	11	0.0	0.010	5.9	LOS A	0.0	0.2	0.23	0.55	52.9
12	R2	2	0.0	0.010	6.7	LOS A	0.0	0.2	0.23	0.55	52.4
Approach		13	0.0	0.010	6.1	LOS A	0.0	0.2	0.23	0.55	52.8
All Vehicles		374	0.0	0.232	1.1	NA	0.2	1.6	0.07	0.10	58.5

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

MOVEMENT SUMMARY

Site: 2015 PM Victoria Rd and Cowell St

Victoria Rd and Cowell St, Gladesville
Signals - Fixed Time Isolated Cycle Time = 80 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Victoria Road South											
2	T1	1607	4.3	0.736	11.9	LOS A	23.3	169.4	0.75	0.69	50.2
3	R2	91	2.1	0.660	48.5	LOS D	3.8	27.0	1.00	0.82	33.0
Approach		1698	4.2	0.736	13.9	LOS A	23.3	169.4	0.77	0.69	48.8
East: Cowell Street											
4	L2	144	2.0	0.197	22.4	LOS B	3.7	26.1	0.69	0.74	43.0
6	R2	94	1.0	0.203	31.5	LOS C	2.9	20.7	0.83	0.75	39.0
Approach		238	1.6	0.203	26.0	LOS B	3.7	26.1	0.74	0.75	41.3
North: Victoria Road North											
7	L2	55	2.5	0.785	28.1	LOS B	23.6	171.3	0.92	0.87	42.7
8	T1	1951	4.5	0.785	22.5	LOS B	23.7	172.0	0.92	0.87	43.8
Approach		2005	4.4	0.785	22.6	LOS B	23.7	172.0	0.92	0.87	43.7
All Vehicles		3941	4.2	0.785	19.1	LOS B	23.7	172.0	0.84	0.78	45.6

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

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P2	East Full Crossing	53	18.3	LOS B	0.1	0.1	0.68	0.68
P3	North Full Crossing	53	34.3	LOS D	0.1	0.1	0.93	0.93
All Pedestrians		105	26.3	LOS C			0.80	0.80

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: 2015 PM Victoria Road and Pittwater Road

Pittwater Road
Signals - Fixed Time Isolated   Cycle Time = 150 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Victoria Road											
1	L2	15	0.1	0.742	37.1	LOS C	41.6	301.7	0.84	0.78	21.6
2	T1	1428	4.2	0.742	29.4	LOS C	41.6	301.7	0.82	0.75	40.5
3	R2	81	0.8	0.548	45.3	LOS D	3.6	25.3	1.00	0.76	34.0
Approach		1524	4.0	0.742	30.3	LOS C	41.6	301.7	0.83	0.75	39.8
East: Pittwater Road											
4	L2	147	0.0	0.693	54.0	LOS D	13.2	94.1	0.99	0.85	31.9
5	T1	146	7.1	0.693	58.0	LOS E	13.2	94.1	1.00	0.85	22.3
6	R2	101	4.0	0.693	74.7	LOS F	12.2	89.2	1.00	0.84	27.3
Approach		395	3.7	0.693	60.7	LOS E	13.2	94.1	0.99	0.85	27.4
North: Victoria Road											
7	L2	39	2.0	0.193	28.6	LOS C	6.4	47.5	0.63	0.59	41.9
8	T1	1573	7.8	0.967	70.7	LOS F	69.7	521.0	0.94	1.07	27.8
9	R2	44	1.0	0.597	87.8	LOS F	3.4	24.1	1.00	0.76	17.1
Approach		1656	7.5	0.967	70.2	LOS E	69.7	521.0	0.93	1.05	27.7
West: Jordan Street											
10	L2	32	0.1	0.544	70.2	LOS E	9.9	69.6	0.98	0.80	20.6
11	T1	149	0.2	0.544	65.9	LOS E	9.9	69.6	0.98	0.80	21.0
12	R2	99	0.1	0.544	71.1	LOS F	9.5	66.6	0.98	0.80	20.0
Approach		280	0.2	0.544	68.2	LOS E	9.9	69.6	0.98	0.80	20.6
All Vehicles		3855	5.2	0.967	53.3	LOS D	69.7	521.0	0.90	0.89	31.1

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

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P1	South Full Crossing	53	69.3	LOS F	0.2	0.2	0.96	0.96
P2	East Full Crossing	53	28.3	LOS C	0.1	0.1	0.61	0.61
P3	North Full Crossing	53	69.3	LOS F	0.2	0.2	0.96	0.96
P4	West Full Crossing	53	21.4	LOS C	0.1	0.1	0.53	0.53
All Pedestrians		211	47.0	LOS E			0.77	0.77

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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MOVEMENT SUMMARY

Site: 2021 AM Cowell St and Flagstaff St

New Site
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Flagstaff Street											
1	L2	48	0.0	0.452	10.0	LOS A	3.1	21.5	0.73	0.84	50.2
2	T1	319	0.0	0.452	10.0	LOS A	3.1	21.5	0.73	0.84	51.0
Approach		367	0.0	0.452	10.0	LOS A	3.1	21.5	0.73	0.84	50.9
North: Flagstaff Street											
9	R2	581	0.0	0.343	7.8	LOS A	0.0	0.0	0.00	0.68	52.2
Approach		581	0.0	0.343	7.8	LOS A	0.0	0.0	0.00	0.68	52.2
West: Cowell Street											
10	L2	219	0.0	0.236	6.8	LOS A	1.5	10.2	0.57	0.67	52.3
Approach		219	0.0	0.236	6.8	LOS A	1.5	10.2	0.57	0.67	52.3
All Vehicles		1167	0.0	0.452	8.3	LOS A	3.1	21.5	0.34	0.73	51.8

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

MOVEMENT SUMMARY

Site: 2021 AM Pittwater Rd and Venus St

New Site
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Venus Street											
1	L2	271	0.0	0.393	7.5	LOS A	2.6	18.2	0.64	0.74	51.4
3	R2	89	0.0	0.393	10.5	LOS A	2.6	18.2	0.64	0.74	51.8
Approach		360	0.0	0.393	8.2	LOS A	2.6	18.2	0.64	0.74	51.5
East: Pittwater Road											
4	L2	226	0.0	0.473	5.7	LOS A	3.7	26.5	0.44	0.54	52.5
5	T1	360	2.0	0.473	5.8	LOS A	3.7	26.5	0.44	0.54	53.3
Approach		586	1.2	0.473	5.8	LOS A	3.7	26.5	0.44	0.54	53.0
West: Pittwater Road											
11	T1	562	2.6	0.524	5.6	LOS A	4.8	34.4	0.42	0.53	52.9
12	R2	122	0.0	0.524	8.5	LOS A	4.8	34.4	0.42	0.53	52.6
Approach		684	2.1	0.524	6.1	LOS A	4.8	34.4	0.42	0.53	52.8
All Vehicles		1631	1.3	0.524	6.4	LOS A	4.8	34.4	0.47	0.58	52.6

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

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MOVEMENT SUMMARY

Site: 2021 AM Venus St and Junction St

New Site
Giveway / Yield (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Venus Street											
1	L2	307	0.1	0.484	5.5	LOS A	0.0	0.0	0.00	0.48	54.1
2	T1	64	0.1	0.484	0.0	LOS A	0.0	0.0	0.00	0.48	55.5
Approach		372	0.1	0.484	4.8	NA	0.0	0.0	0.00	0.48	54.4
North: Venus Street											
8	T1	132	0.0	0.231	0.7	LOS A	0.6	3.9	0.33	0.25	56.8
9	R2	80	0.0	0.231	7.1	LOS A	0.6	3.9	0.33	0.25	54.8
Approach		212	0.0	0.231	3.1	NA	0.6	3.9	0.33	0.25	56.0
West: Junction Street											
10	L2	57	0.0	0.040	5.7	LOS A	0.2	1.1	0.14	0.55	53.2
12	R2	3	0.0	0.040	7.2	LOS A	0.2	1.1	0.14	0.55	52.7
Approach		60	0.0	0.040	5.8	LOS A	0.2	1.1	0.14	0.55	53.2
All Vehicles		643	0.1	0.484	4.2	NA	0.6	3.9	0.12	0.41	54.8

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

MOVEMENT SUMMARY

Site: 2021 AM Victoria Rd and Cowell St

Victoria Rd and Cowell St, Gladesville
Signals - Fixed Time Isolated Cycle Time = 150 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Victoria Road South											
2	T1	1624	4.8	0.641	10.4	LOS A	32.2	234.5	0.53	0.49	51.3
3	R2	162	3.8	0.961	106.4	LOS F	14.6	105.8	1.00	1.04	21.7
Approach		1786	4.7	0.961	19.1	LOS B	32.2	234.5	0.57	0.54	45.6
East: Cowell Street											
4	L2	406	2.0	0.679	52.3	LOS D	25.6	182.0	0.93	0.85	31.8
6	R2	344	1.0	0.966	102.4	LOS F	31.9	225.1	1.00	1.04	22.2
Approach		751	1.5	0.966	75.3	LOS F	31.9	225.1	0.96	0.94	26.5
North: Victoria Road North											
7	L2	243	3.5	0.537	19.7	LOS B	3.2	28.4	0.48	0.60	45.2
8	T1	1928	9.1	0.972	61.3	LOS E	98.0	713.4	0.87	1.01	30.2
Approach		2172	8.5	0.972	56.5	LOS E	98.0	713.4	0.83	0.96	31.1
All Vehicles		4708	5.9	0.972	45.4	LOS D	98.0	713.4	0.75	0.80	34.3

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

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P2	East Full Crossing	53	16.8	LOS B	0.1	0.1	0.47	0.47
P3	North Full Crossing	53	60.9	LOS F	0.2	0.2	0.90	0.90
All Pedestrians		105	38.9	LOS D			0.69	0.69

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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MOVEMENT SUMMARY

Site: 2021 AM Victoria Road and Pittwater Road

Pittwater Road
Signals - Fixed Time Isolated Cycle Time = 180 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Victoria Road											
1	L2	54	0.1	0.816	44.0	LOS D	58.8	425.3	0.89	0.85	20.1
2	T1	1476	4.1	0.816	35.3	LOS C	58.8	425.3	0.85	0.79	37.9
3	R2	184	0.8	0.780	86.6	LOS F	16.0	112.4	1.00	0.86	24.6
Approach		1714	3.6	0.816	41.1	LOS C	58.8	425.3	0.86	0.80	35.3
East: Pittwater Road											
4	L2	13	0.0	0.687	90.2	LOS F	12.8	94.8	1.00	0.84	24.8
5	T1	138	7.1	0.687	84.7	LOS F	12.8	94.8	1.00	0.84	18.0
6	R2	164	4.0	0.780	93.5	LOS F	14.7	106.4	1.00	0.87	23.6
Approach		315	5.2	0.780	89.5	LOS F	14.7	106.4	1.00	0.85	21.5
North: Victoria Road											
7	L2	134	2.2	0.699	34.4	LOS C	3.1	28.4	0.62	0.64	38.4
8	T1	1632	11.6	1.038	133.8	LOS F	110.7	826.7	0.98	1.25	19.2
9	R2	48	1.0	0.276	88.5	LOS F	4.0	28.1	0.97	0.75	17.0
Approach		1814	10.6	1.038	125.1	LOS F	110.7	826.7	0.96	1.19	19.5
West: Jordan Street											
10	L2	53	0.1	0.168	69.9	LOS E	4.2	29.7	0.88	0.74	20.0
11	T1	34	0.2	0.168	75.4	LOS F	4.2	29.7	0.93	0.71	19.2
12	R2	9	0.1	0.168	81.9	LOS F	3.0	21.0	0.94	0.71	18.6
Approach		96	0.1	0.168	73.0	LOS F	4.2	29.7	0.90	0.73	19.6
All Vehicles		3939	6.9	1.038	84.5	LOS F	110.7	826.7	0.92	0.98	24.5

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

Movement Performance - Pedestrians								
Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P1	South Full Crossing	53	84.3	LOS F	0.3	0.3	0.97	0.97
P2	East Full Crossing	53	30.7	LOS D	0.2	0.2	0.58	0.58
P3	North Full Crossing	53	84.3	LOS F	0.3	0.3	0.97	0.97
P4	West Full Crossing	53	24.1	LOS C	0.1	0.1	0.52	0.52
All Pedestrians		211	55.8	LOS E			0.76	0.76

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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MOVEMENT SUMMARY

Site: 2021 PM Cowell St and Flagstaff St

New Site
Roundabout

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Flagstaff Street											
1	L2	60	0.0	0.657	14.0	LOS A	6.8	47.6	0.85	1.03	47.6
2	T1	469	0.0	0.657	14.0	LOS A	6.8	47.6	0.85	1.03	48.3
Approach		529	0.0	0.657	14.0	LOS A	6.8	47.6	0.85	1.03	48.2
North: Flagstaff Street											
9	R2	593	0.0	0.350	7.8	LOS A	0.0	0.0	0.00	0.68	52.2
Approach		593	0.0	0.350	7.8	LOS A	0.0	0.0	0.00	0.68	52.2
West: Cowell Street											
10	L2	219	0.0	0.278	7.9	LOS A	1.8	12.7	0.70	0.76	51.6
Approach		219	0.0	0.278	7.9	LOS A	1.8	12.7	0.70	0.76	51.6
All Vehicles		1341	0.0	0.657	10.3	LOS A	6.8	47.6	0.45	0.83	50.5

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

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MOVEMENT SUMMARY

Site: 2021 PM Pittwater Rd and Venus St

New Site
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Venus Street											
1	L2	202	0.0	0.532	9.0	LOS A	4.4	31.0	0.78	0.84	49.7
3	R2	249	0.0	0.532	12.0	LOS A	4.4	31.0	0.78	0.84	50.1
Approach		452	0.0	0.532	10.6	LOS A	4.4	31.0	0.78	0.84	50.0
East: Pittwater Road											
4	L2	304	0.0	0.633	6.6	LOS A	6.1	43.5	0.67	0.63	51.7
5	T1	417	2.0	0.633	6.7	LOS A	6.1	43.5	0.67	0.63	52.5
Approach		721	1.2	0.633	6.6	LOS A	6.1	43.5	0.67	0.63	52.2
West: Pittwater Road											
11	T1	286	2.4	0.467	6.8	LOS A	3.6	25.6	0.63	0.68	51.9
12	R2	187	0.0	0.467	9.7	LOS A	3.6	25.6	0.63	0.68	51.6
Approach		474	1.5	0.467	8.0	LOS A	3.6	25.6	0.63	0.68	51.8
All Vehicles		1646	0.9	0.633	8.1	LOS A	6.1	43.5	0.69	0.70	51.4

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

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MOVEMENT SUMMARY

▽ Site: 2021 PM Venus St and Junction St

New Site
Giveway / Yield (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Venus Street											
1	L2	283	0.1	0.417	5.5	LOS A	0.0	0.0	0.00	0.51	53.9
2	T1	36	0.1	0.417	0.0	LOS A	0.0	0.0	0.00	0.51	55.3
Approach		319	0.1	0.417	5.0	NA	0.0	0.0	0.00	0.51	54.1
North: Venus Street											
8	T1	184	0.0	0.470	1.9	LOS A	3.0	20.7	0.56	0.47	54.8
9	R2	311	0.0	0.470	7.8	LOS A	3.0	20.7	0.56	0.47	52.9
Approach		495	0.0	0.470	5.6	NA	3.0	20.7	0.56	0.47	53.6
West: Junction Street											
10	L2	71	0.0	0.091	5.6	LOS A	0.3	2.4	0.08	0.58	52.7
12	R2	31	0.0	0.091	9.0	LOS A	0.3	2.4	0.08	0.58	52.2
Approach		101	0.0	0.091	6.7	LOS A	0.3	2.4	0.08	0.58	52.6
All Vehicles		915	0.0	0.470	5.5	NA	3.0	20.7	0.31	0.50	53.7

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

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MOVEMENT SUMMARY

Site: 2021 PM Victoria Rd and Cowell St

Victoria Rd and Cowell St, Gladesville
Signals - Fixed Time Isolated Cycle Time = 150 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Victoria Road South											
2	T1	1778	4.8	0.737	14.7	LOS B	43.4	316.5	0.65	0.61	48.3
3	R2	162	3.8	0.897	59.2	LOS E	9.4	67.9	1.00	0.94	30.1
Approach		1940	4.7	0.897	18.5	LOS B	43.4	316.5	0.68	0.63	46.0
East: Cowell Street											
4	L2	458	2.0	0.605	42.1	LOS C	25.9	184.2	0.84	0.84	34.9
6	R2	412	1.0	0.957	95.9	LOS F	37.5	264.4	1.00	1.02	23.1
Approach		869	1.5	0.957	67.6	LOS E	37.5	264.4	0.92	0.93	28.1
North: Victoria Road North											
7	L2	334	2.5	0.247	8.9	LOS A	4.2	30.0	0.34	0.67	51.0
8	T1	1533	4.5	0.949	61.1	LOS E	77.2	561.1	0.92	1.01	30.0
Approach		1866	4.1	0.949	51.8	LOS D	77.2	561.1	0.81	0.95	32.4
All Vehicles		4676	3.9	0.957	40.9	LOS C	77.2	561.1	0.78	0.81	35.8

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

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P2	East Full Crossing	53	23.6	LOS C	0.1	0.1	0.56	0.56
P3	North Full Crossing	53	55.6	LOS E	0.2	0.2	0.86	0.86
All Pedestrians		105	39.6	LOS D			0.71	0.71

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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MOVEMENT SUMMARY

Site: 2021 PM Victoria Road and Pittwater Road

Pittwater Road
Signals - Fixed Time Isolated   Cycle Time = 170 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Victoria Road											
1	L2	75	0.1	0.765	36.9	LOS C	51.1	369.7	0.82	0.79	21.5
2	T1	1556	4.2	0.765	29.4	LOS C	51.1	369.7	0.81	0.76	40.4
3	R2	53	0.8	0.407	86.9	LOS F	4.4	30.7	0.99	0.74	24.5
Approach		1684	3.9	0.765	31.5	LOS C	51.1	369.7	0.81	0.76	38.7
East: Pittwater Road											
4	L2	47	0.0	0.651	76.5	LOS F	11.7	85.5	1.00	0.83	27.1
5	T1	108	7.1	0.651	71.0	LOS F	11.7	85.5	1.00	0.83	20.0
6	R2	202	4.0	0.906	100.5	LOS F	18.8	136.3	1.00	0.96	22.6
Approach		358	4.4	0.906	88.4	LOS F	18.8	136.3	1.00	0.91	22.5
North: Victoria Road											
7	L2	143	2.0	0.180	28.0	LOS B	9.4	68.3	0.57	0.65	41.2
8	T1	1594	7.8	0.898	45.2	LOS D	61.9	462.0	0.89	0.88	34.4
9	R2	52	1.0	0.799	102.9	LOS F	4.7	33.3	1.00	0.85	15.3
Approach		1789	7.2	0.898	45.5	LOS D	61.9	462.0	0.87	0.86	34.1
West: Jordan Street											
10	L2	52	0.1	0.322	75.7	LOS F	6.4	44.9	0.94	0.76	19.2
11	T1	96	0.2	0.322	72.9	LOS F	6.4	44.9	0.95	0.75	19.7
12	R2	15	0.1	0.322	78.4	LOS F	5.9	41.2	0.96	0.75	19.2
Approach		162	0.2	0.322	74.3	LOS F	6.4	44.9	0.95	0.75	19.5
All Vehicles		3993	5.3	0.906	44.6	LOS D	61.9	462.0	0.86	0.82	33.8

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

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	South Full Crossing	53	79.3	LOS F	0.2	0.2	0.97	0.97
P2	East Full Crossing	53	26.0	LOS C	0.1	0.1	0.56	0.56
P3	North Full Crossing	53	79.3	LOS F	0.2	0.2	0.97	0.97
P4	West Full Crossing	53	19.8	LOS B	0.1	0.1	0.48	0.48
All Pedestrians		211	51.1	LOS E			0.74	0.74

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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APPENDIX C – INTERSECTION AVG QUEUE LENGTHS

QUEUE DISTANCE (AVER)

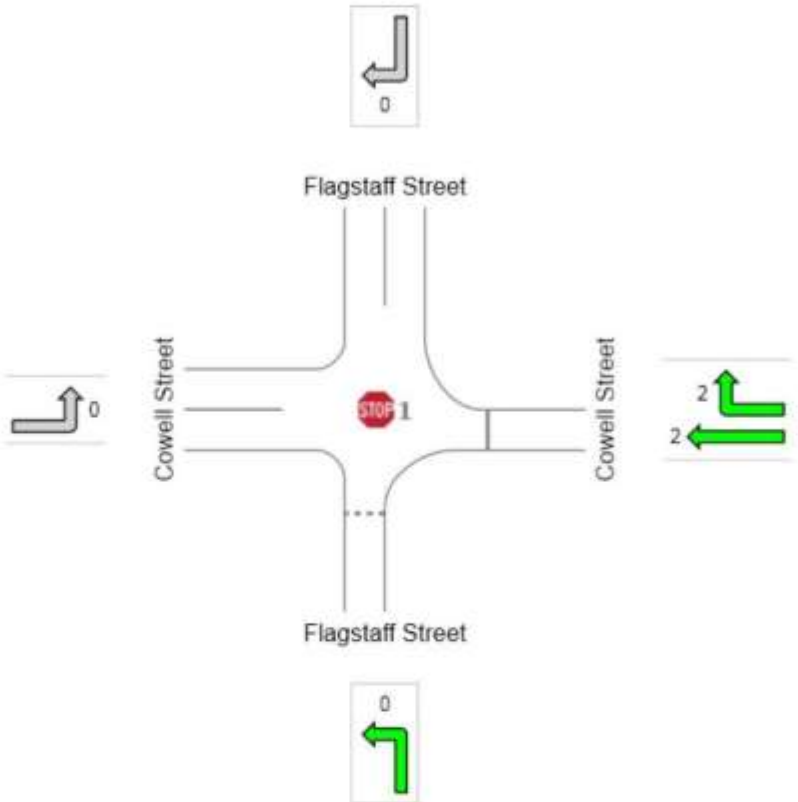
Average Back of Queue for any lane used by movement (metres)

Site: 2015 AM Cowell St and Flagstaff St

New Site
Stop (Two-Way)

All Movement Classes

	South	East	North	West	Intersection
	0	2	0	0	2



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QUEUE DISTANCE (AVER)

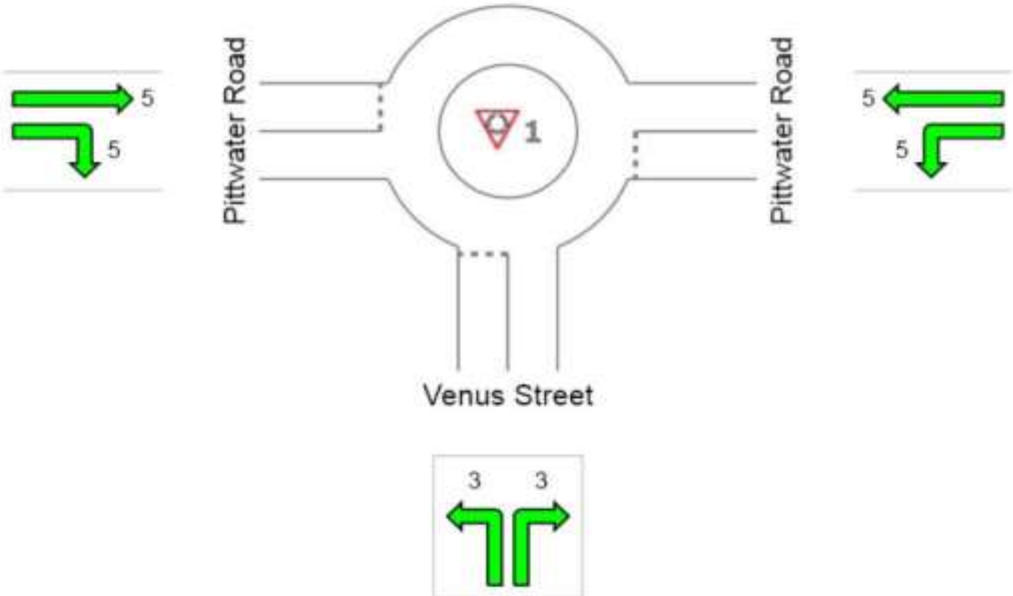
Average Back of Queue for any lane used by movement (metres)

Site: 2015 AM Pittwater Rd and Venus St

New Site
Roundabout

All Movement Classes

	South	East	West	Intersection
	3	5	5	5



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QUEUE DISTANCE (AVER)

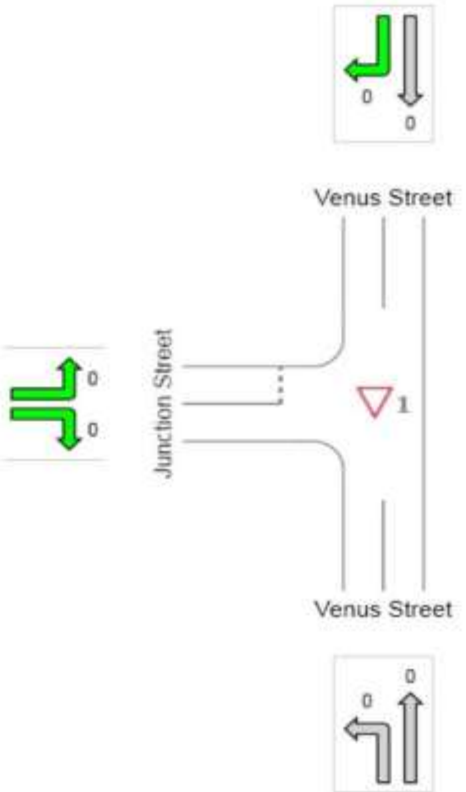
Average Back of Queue for any lane used by movement (metres)

Site: 2015 AM Venus St and Junction St

New Site
Giveway / Yield (Two-Way)

All Movement Classes

	South	North	West	Intersection
	0	0	0	0



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QUEUE DISTANCE (AVER)

Average Back of Queue for any lane used by movement (metres)

Site: 2015 AM Victoria Rd and Cowell St

Victoria Rd and Cowell St, Gladesville
Signals - Fixed Time Isolated   Cycle Time = 80 seconds (Practical Cycle Time)

All Movement Classes

	South	East	North	Intersection
	78	10	94	94

Colour code based on Queue Storage Ratio

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QUEUE DISTANCE (AVER)

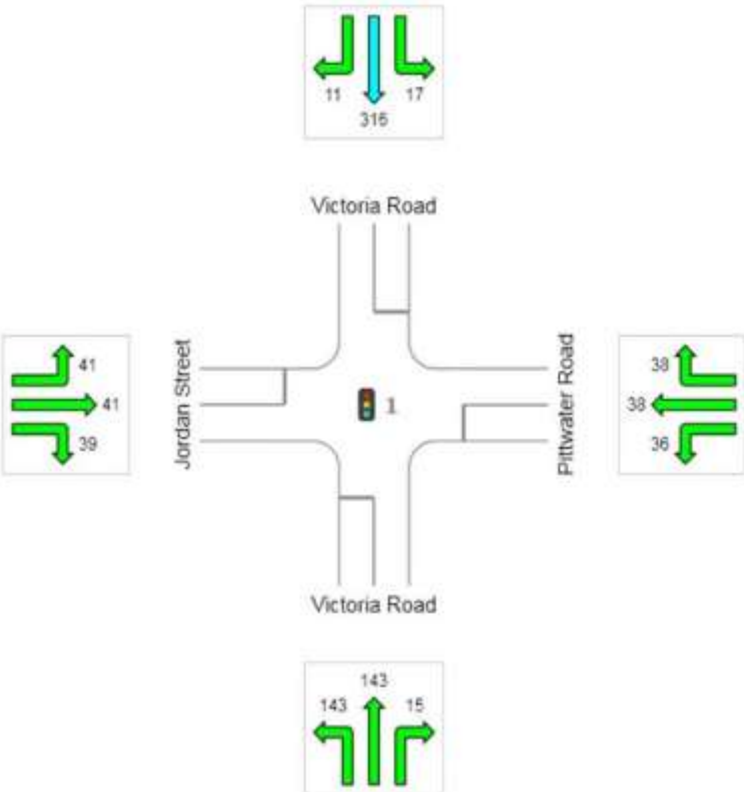
Average Back of Queue for any lane used by movement (metres)

Site: 2015 AM Victoria Road and Pittwater Road

Pittwater Road
Signals - Fixed Time Isolated Cycle Time = 150 seconds (Practical Cycle Time)

All Movement Classes

	South	East	North	West	Intersection
	143	38	316	41	316



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QUEUE DISTANCE (AVER)

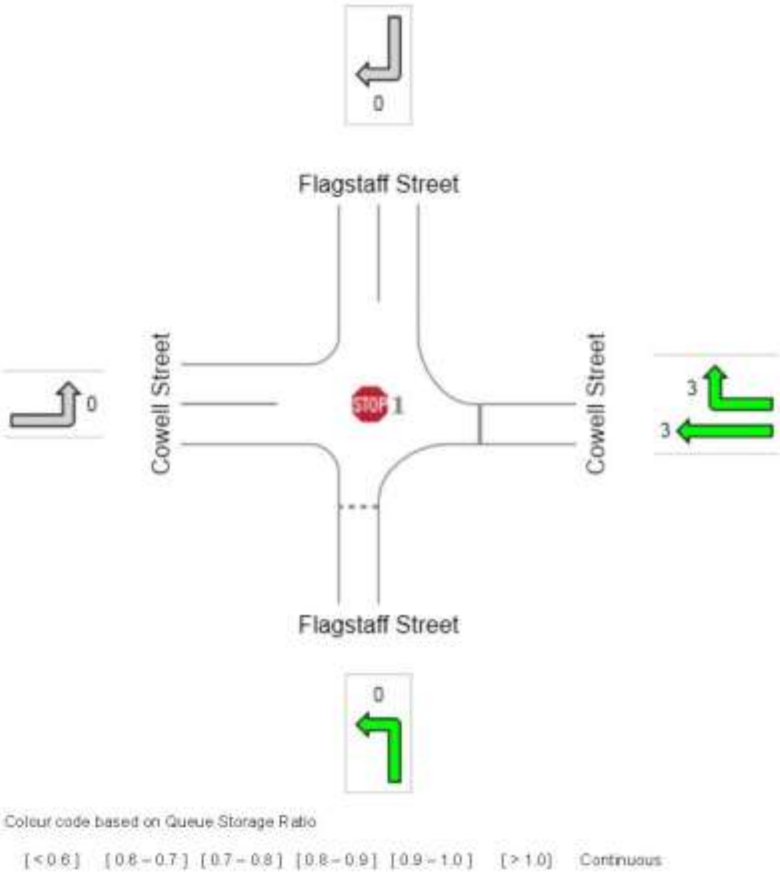
Average Back of Queue for any lane used by movement (metres)

Site: 2015 PM Cowell St and Flagstaff St

New Site
Stop (Two-Way)

All Movement Classes

	South	East	North	West	Intersection
	0	3	0	0	3



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QUEUE DISTANCE (AVER)

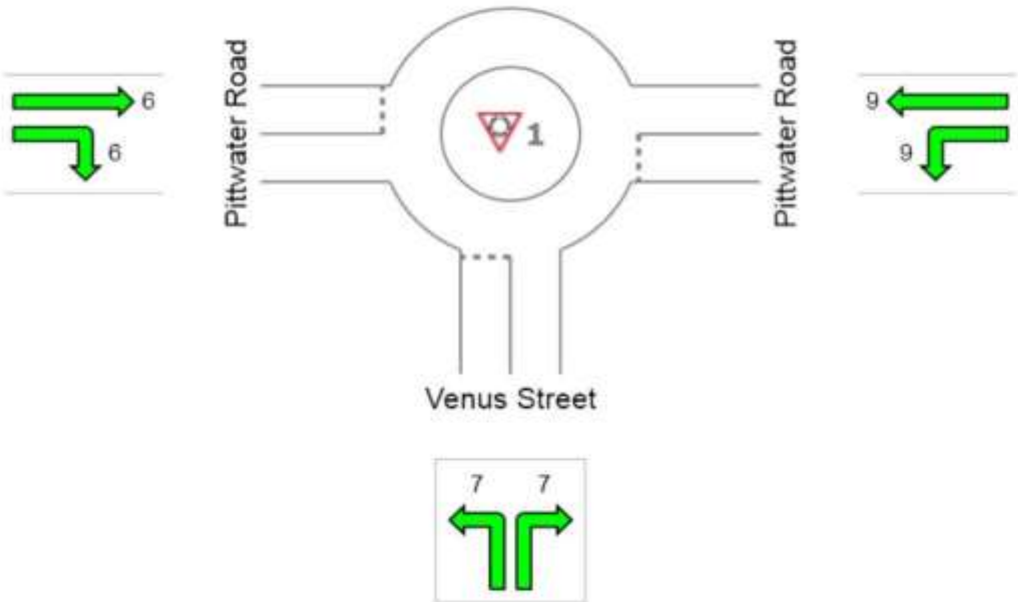
Average Back of Queue for any lane used by movement (metres)

Site: 2015 PM Pittwater Rd and Venus St

New Site
Roundabout

All Movement Classes

	South	East	West	Intersection
	7	9	6	9



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QUEUE DISTANCE (AVER)

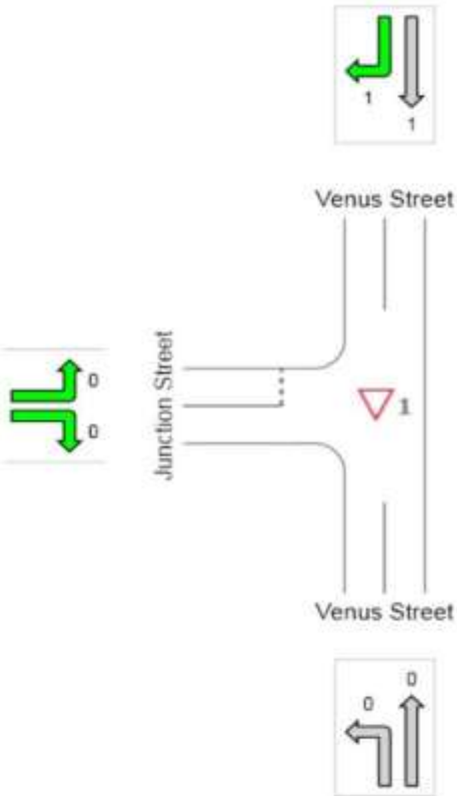
Average Back of Queue for any lane used by movement (metres)

Site: 2015 PM Venus St and Junction St

New Site
Giveway / Yield (Two-Way)

All Movement Classes

	South	North	West	Intersection
	0	1	0	1



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QUEUE DISTANCE (AVER)

Average Back of Queue for any lane used by movement (metres)

Site: 2015 PM Victoria Rd and Cowell St

Victoria Rd and Cowell St, Gladesville
Signals - Fixed Time Isolated Cycle Time = 80 seconds (Practical Cycle Time)

All Movement Classes

	South	East	North	Intersection
	104	16	105	105

Colour code based on Queue Storage Ratio

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QUEUE DISTANCE (AVER)

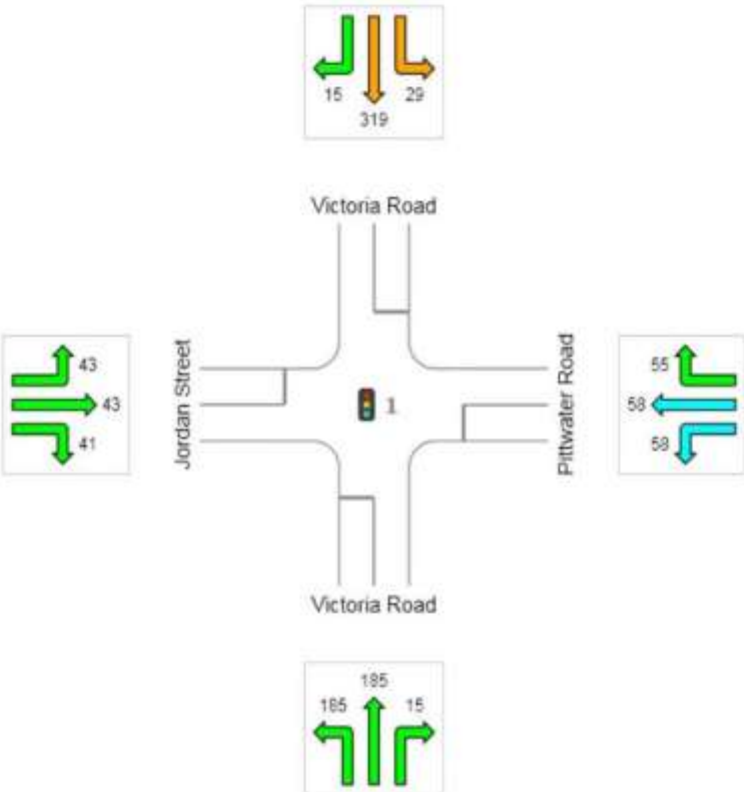
Average Back of Queue for any lane used by movement (metres)

Site: 2015 PM Victoria Road and Pittwater Road

Pittwater Road
Signals - Fixed Time Isolated   Cycle Time = 150 seconds (Practical Cycle Time)

All Movement Classes

	South	East	North	West	Intersection
	185	58	319	43	319



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QUEUE DISTANCE (AVER)

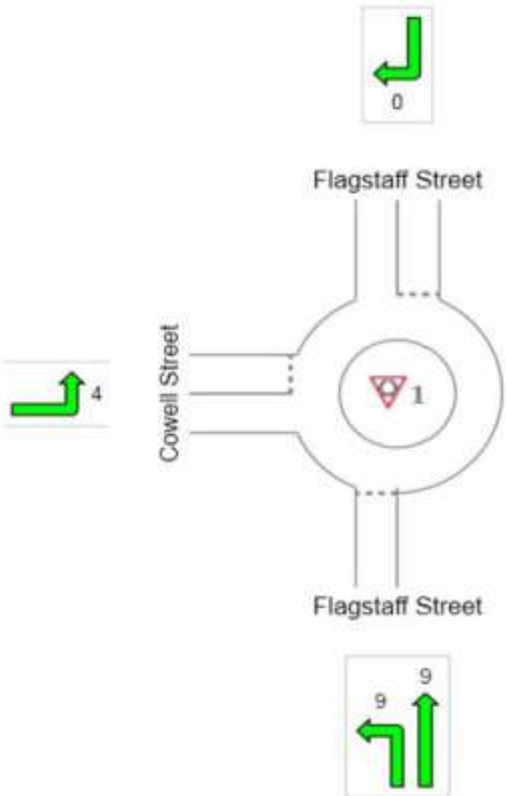
Average Back of Queue for any lane used by movement (metres)

Site: 2021 AM Cowell St and Flagstaff St

New Site
Roundabout

All Movement Classes

	South	North	West	Intersection
	9	0	4	9



Colour code based on Queue Storage Ratio

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QUEUE DISTANCE (AVER)

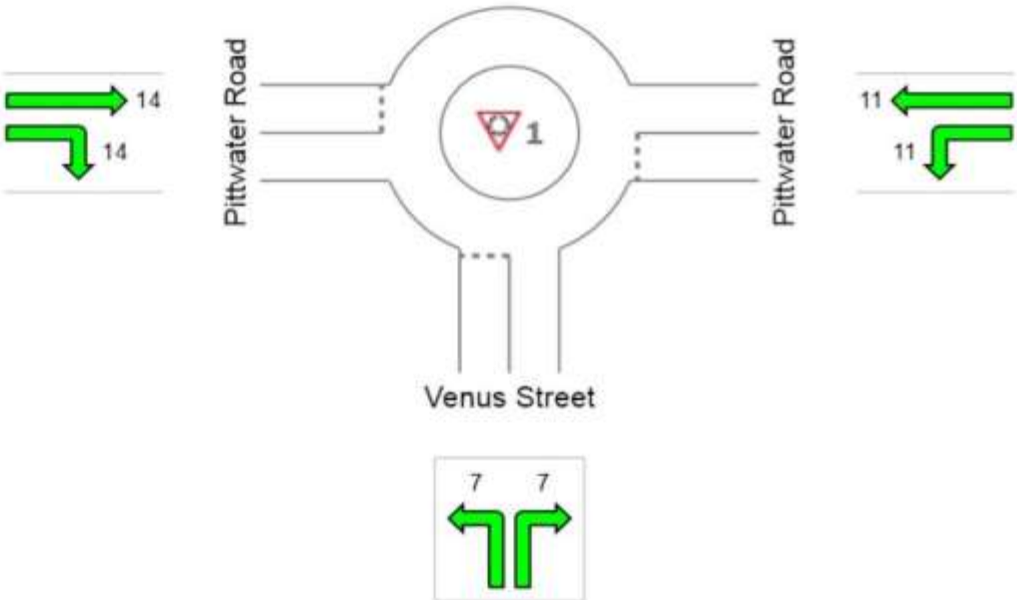
Average Back of Queue for any lane used by movement (metres)

Site: 2021 AM Pittwater Rd and Venus St

New Site
Roundabout

All Movement Classes

	South	East	West	Intersection
	7	11	14	14



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QUEUE DISTANCE (AVER)

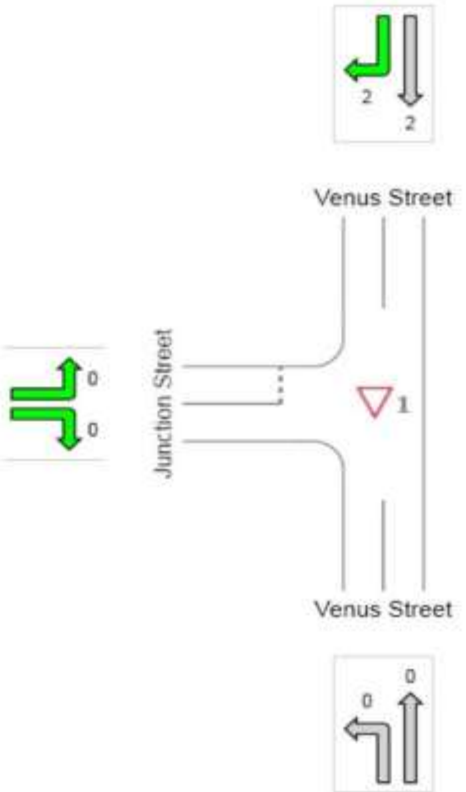
Average Back of Queue for any lane used by movement (metres)

Site: 2021 AM Venus St and Junction St

New Site
Giveway / Yield (Two-Way)

All Movement Classes

	South	North	West	Intersection
	0	2	0	2



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QUEUE DISTANCE (AVER)

Average Back of Queue for any lane used by movement (metres)

Site: 2021 AM Victoria Rd and Cowell St

Victoria Rd and Cowell St, Gladesville
Signals - Fixed Time Isolated   Cycle Time = 150 seconds (Practical Cycle Time)

All Movement Classes

	South	East	North	Intersection
	144	138	437	437

Colour code based on Queue Storage Ratio

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QUEUE DISTANCE (AVER)

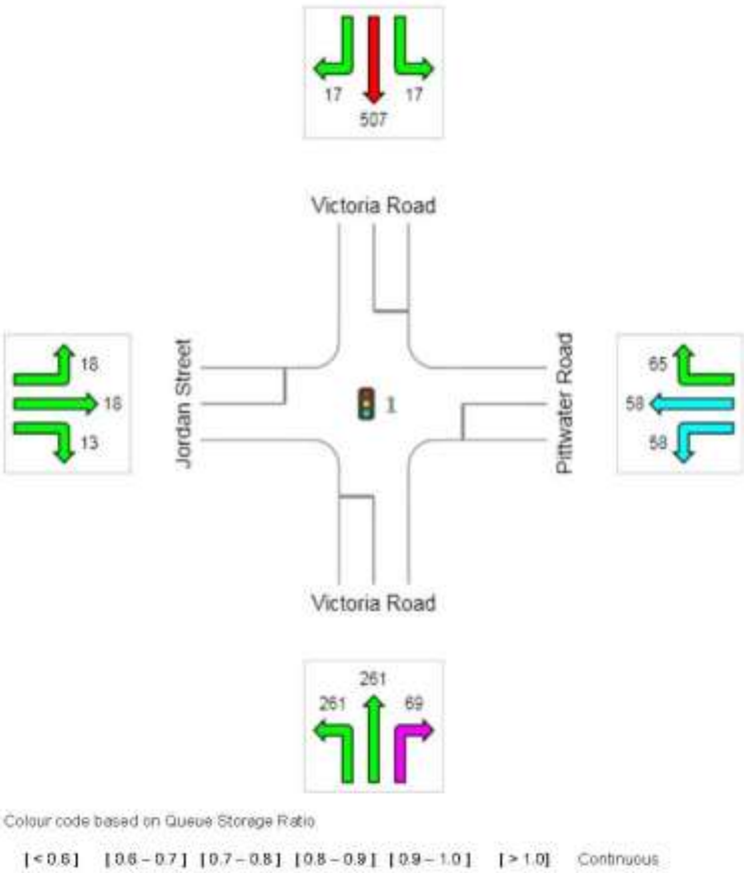
Average Back of Queue for any lane used by movement (metres)

Site: 2021 AM Victoria Road and Pittwater Road

Pittwater Road
Signals - Fixed Time Isolated   Cycle Time = 180 seconds (Optimum Cycle Time - Minimum Delay)

All Movement Classes

	South	East	North	West	Intersection
	261	65	507	18	507



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QUEUE DISTANCE (AVER)

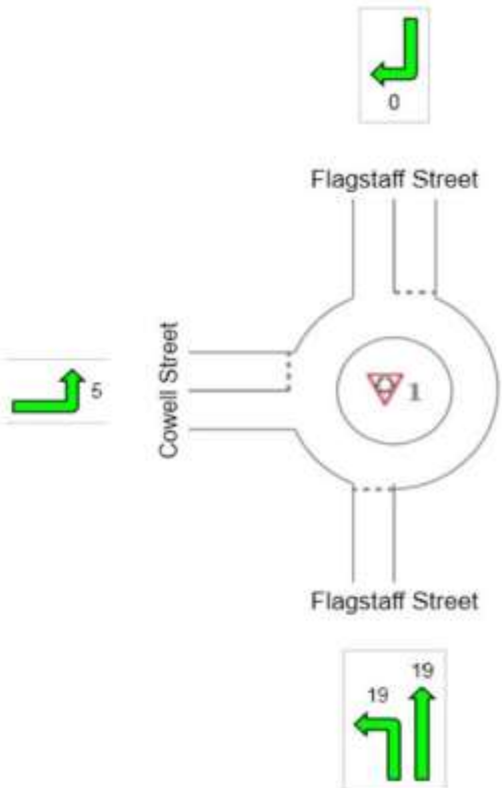
Average Back of Queue for any lane used by movement (metres)

Site: 2021 PM Cowell St and Flagstaff St

New Site
Roundabout

All Movement Classes

	South	North	West	Intersection
	19	0	5	19



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QUEUE DISTANCE (AVER)

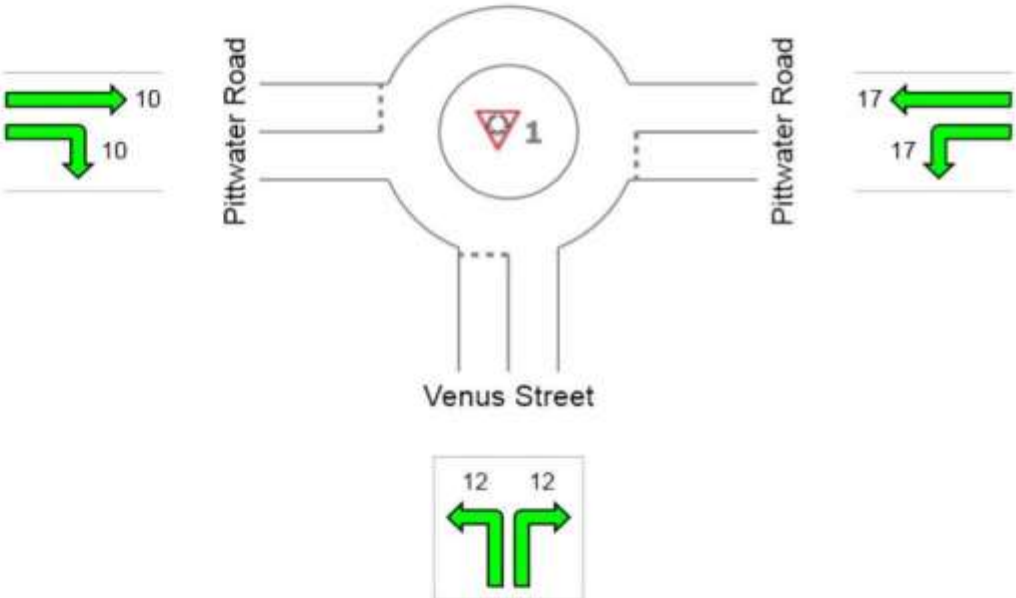
Average Back of Queue for any lane used by movement (metres)

Site: 2021 PM Pittwater Rd and Venus St

New Site
Roundabout

All Movement Classes

	South	East	West	Intersection
	12	17	10	17



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QUEUE DISTANCE (AVER)

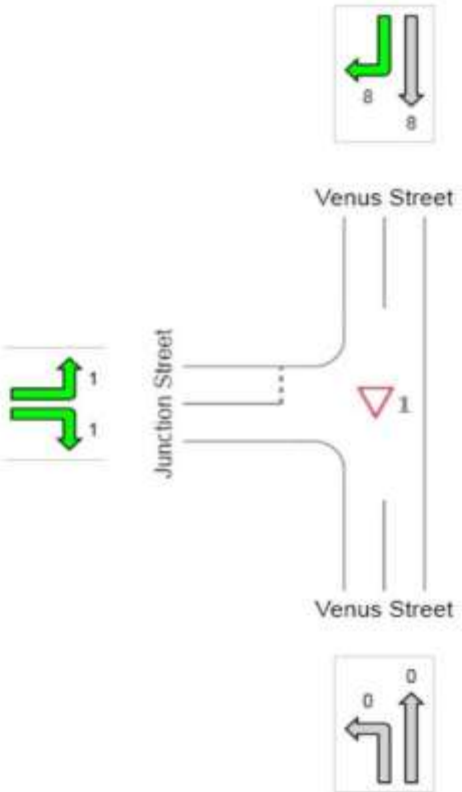
Average Back of Queue for any lane used by movement (metres)

Site: 2021 PM Venus St and Junction St

New Site
Giveway / Yield (Two-Way)

All Movement Classes

	South	North	West	Intersection
	0	8	1	8



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QUEUE DISTANCE (AVER)

Average Back of Queue for any lane used by movement (metres)

Site: 2021 PM Victoria Rd and Cowell St

Victoria Rd and Cowell St, Gladesville
Signals - Fixed Time Isolated Cycle Time = 150 seconds (Practical Cycle Time)

All Movement Classes

	South	East	North	Intersection
	194	162	344	344

Colour code based on Queue Storage Ratio

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QUEUE DISTANCE (AVER)

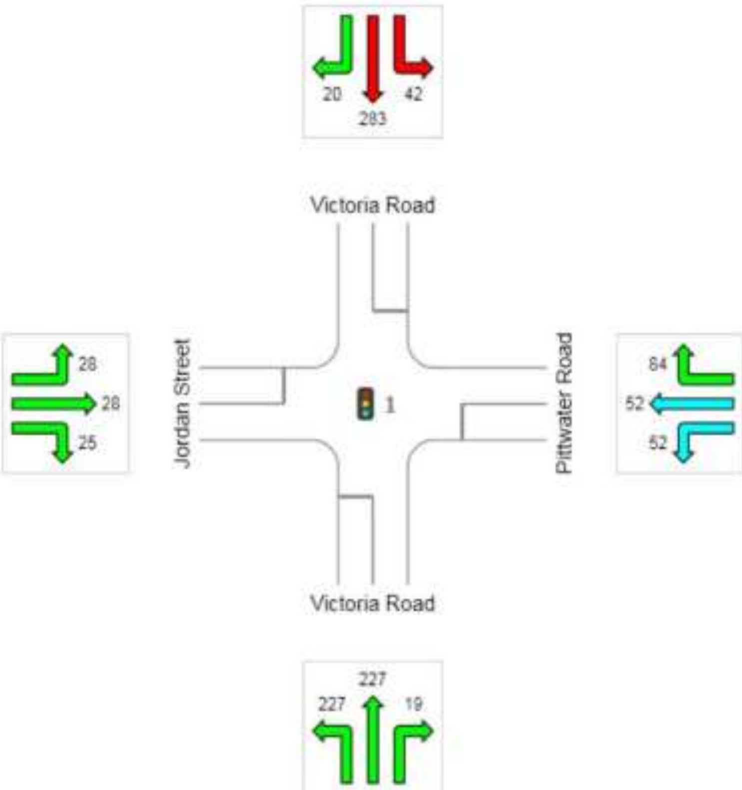
Average Back of Queue for any lane used by movement (metres)

Site: 2021 PM Victoria Road and Pittwater Road

Pittwater Road
Signals - Fixed Time Isolated   Cycle Time = 170 seconds (Optimum Cycle Time - Minimum Delay)

All Movement Classes

	South	East	North	West	Intersection
	227	84	283	28	283



Colour code based on Queue Storage Ratio

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APPENDIX D – PERFORMANCE INDICATORS

GENERAL

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.

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]

Figure 44 Performance Indicators by Control Mode

AVERAGE VEHICLE DELAY (AVD)

The AVD is a measure of the operational performance of a road network or an intersection.

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

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

DEGREE OF SATURATION (DS)

The DS of an intersection is usually taken as the highest ratio of traffic volume on an approach to the intersection 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.

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. 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.

Figure 45 Qualified Level of Service by Control Method

APPENDIX E – 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.

ROUTE SELECTION

Route selection between zonal pairs is determined on the basis of the shortest travel cost ('time is money'), considering the inherent route delays, and associated parameters, incurred along possible link(s), 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 and distance are coded into the model, by the user, from which the program determines the relative vehicular delays on each route, selecting, after undertaking a prescribed number of iterations, the route with the shortest travel time. 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 cost.

In the most general form, this 'cost' represents a combination of factors that drivers take 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.

The process which Netanal employs to determine the 'cost' of travel on competing paths, equates heavily on travel time. Time penalties for turning manoeuvres, vehicle delays, and tolls increase the cost of travel on competing routes. Toll value, on a specific link, is included indirectly by converting the monetary toll value to time (in minutes) based on the driver's perceived value of time and socio economic proclivity to pay the toll. This 'time value of the toll' is applied as a 'penalty' to the link and is known as the Toll Diversion Penalty (TDP).

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

INCREMENTAL ASSIGNMENT

In order to reflect the impact of 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 the routes with the shortest travel times, for each origin-destination 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 0ne hour, 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 link. During the increment, routes yielding the lowest travel time between zonal pairs are chosen. Again the resultant delays on each link, inclusive of intersection, are recorded by the program.*
- *Each subsequent increment performs ongoing route selection based on recorded delay and the resultant link 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 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. 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.

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 calculations 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.***

- ***Speed limits.***

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

- → ***Pedestrian crossings.***

- → ***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.

  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 is run to dynamically emulate the SCATS operation at all intersections so designated within the model. A 'cost' penalty is added to the travel time to represent the delay that is associated with pedestrian conflict at a marked crossing and/or any left turns and/or opposing traffic for right turns.

  Netanal specifically calculates both road mid-block and intersection performance. The model is therefore able to calculate queues when traffic demand exceeds capacity and incorporate the queuing delay in the calculation of travel time for each route.

INTERSECTION TURNING MOVEMENT VOLUMES

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 GTC, to enable the operational micro analysis, utilising the Sidra program, at key intersections.

Inherently, the predictive nature of mesoscopic modelling and the location of the 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, representing up to 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 the vehicle generation. A zone may be located so as to avoid the unwanted diversion or 'rat run' of vehicles 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. Zone disaggregation or 'splitting' allows a finer distribution of traffic but requires an iterative adjustment process which inadvertently increases the project duration, resources and costs, quite often is beyond the scope of a project.

The zone locations selected within the Camellia precinct have been allocated in accordance with the access and car parking provisions identified from preliminary architectural drawings of the proposed development.

INTERSECTION TURNING MOVEMENT VOLUMES

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 Meadowbank precinct, 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 the vehicle generation. A zone may be located so as to avoid the unwanted diversion or 'rat run' of vehicles 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. Zone disaggregation or 'splitting' allows a finer distribution of traffic but requires an iterative adjustment process which inadvertently increases the project duration, resources and costs, quite often is beyond the scope of a project.

The zone locations selected within the Meadowbank precinct have been allocated in accordance with the access and car parking provisions identified from preliminary architectural drawings of the proposed development. Manual correction may be required to some turn movement outputs from the mesoscopic model when assessing the operational performance of an intersection, in close proximity to a zone.

CURRENT YEAR TRIP MATRIX

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 972 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. The trip table specifies the number of car trips travelling from each zone to every other zone in the modelled area.

The boundaries of these zones for the Sydney Metropolitan Area were defined in 1996, by the NSW Department of Transport's TPDC, and have been generic across all traffic and transport modelling activities undertaken in Sydney. New boundaries were defined by TPDC in 2006, and an equivalency table, prepared by the DoP, is employed to rationalise the current projected land use and trip distribution patterns.

The assignment process, described above, essentially determines the anticipated route selection made by motorists between the 'origin' and 'destination' zone 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 models the road network assignment over a 1hr period.

The base year 2015 trip matrix was originally developed by BTS in October 2012. Disagregation of the generation and distribution of trip demand between zonal pairs has been undertaken by *Road Delay Solutions* to the one (1) hour morning and evening peak travel trip tables to accurately reflect and assimilate the operation of the Sydney Metropolitan road network.