ROAD DELAY SOLUTIONS

Concept Plan

Shepherds Bay Urban Renewal Meadowbank

Strategic Netanal Model 2026

Traffic Impact Assessment

for...

Holdmark PROPERTY GROUP PL

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ROAD DELAY SOLUTIONS

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EXECUTIVE SUMMARY

This report will clearly demonstrate that the recommended infrastructure improvements in Year 2026, are triggered by the growth in intrusive background traffic, with the theoretical contributions, attributed to the Shepherds Bay Urban Renewal project, considered minor in comparison.

The Purpose of this Assessment…….

Road Delay Solutions has been engaged by Robertson + Marks Architects and Holdmark NSW Pty Ltd to undertake the preparation of a Strategic Transport Model in support of the Concept Plan for the Shepherds Bay Urban Renewal Development and subsequent TMAP prepared by Varga Traffic Planning.

The purpose of this report is to determine the cumulative traffic impacts of the Shepherds Bay development, juxtaposed to the existing traffic and background growth on the Meadowbank road network in the horizon year 2026. The report reviews any identified road network deficiencies or capacity constraints surrounding the proposed development and recommends the appropriate transport measures and strategies to improve the transport outcomes for residents and employees of the Shepherds Bay Precinct.

The report has been prepared in accordance with the DGR's dated 20 May 2010, with reference to the *Metropolita Transport Plan – Connecting the City of Cities*, the *NSW State Plan*, the *Integrated Land Use and Transport Policy Package*, the *NSW Bike Plan*, the Roads and Maritime Services (RMS) *Guide to Traffic Generating Developments and* the *Meadowbank Employment Area – Concept Plan Transport Assessment*.

The Shepherds Bay Development….

The Shepherds Bay urban renewal project is located within the Meadowbank employment area (BTS zone 2522)and incorporates the staged tranformation of the current industrial activity for the purpose of introducing modern, architecturally designed, residential living and 10,000m² of commercial floor space.

2,005 high density residential lots are proposed generally bounded by Bowden Street to the west, Constitution Road to the north and Belmore Street to the east.

10,000m² of commercial floor space is proposed in the area bounded by Church Street to the east, Loop Road to the south, Porter Street to the west and Well Street to the north.

It is anticipated the development will be staged over some 10 years, commencing in 2013.

The Shepherds Bay Precinct is dominated by approximately 40 industrial premises with a floor space of 72,200m² to the south of Constitution Road, of which, only 42,700m² or 59.2% is currently occupied.

The Existing Transport Conditions…..

Junction Street, Belmore Street and Constitution Road form part of a *collector route*, generally following an east-west alignment from Victoria Road in the north and Church Street to the east. Subject to a 50km/h speed limit, the corridor provides a primary access to the Meadowbank Railway Station and Parramatta River ferry service while providing significant bypass between Church Street and Victoria Road. The two way traffic flow on Constitution Road carries some 1,100 vph during the commuter peaks.

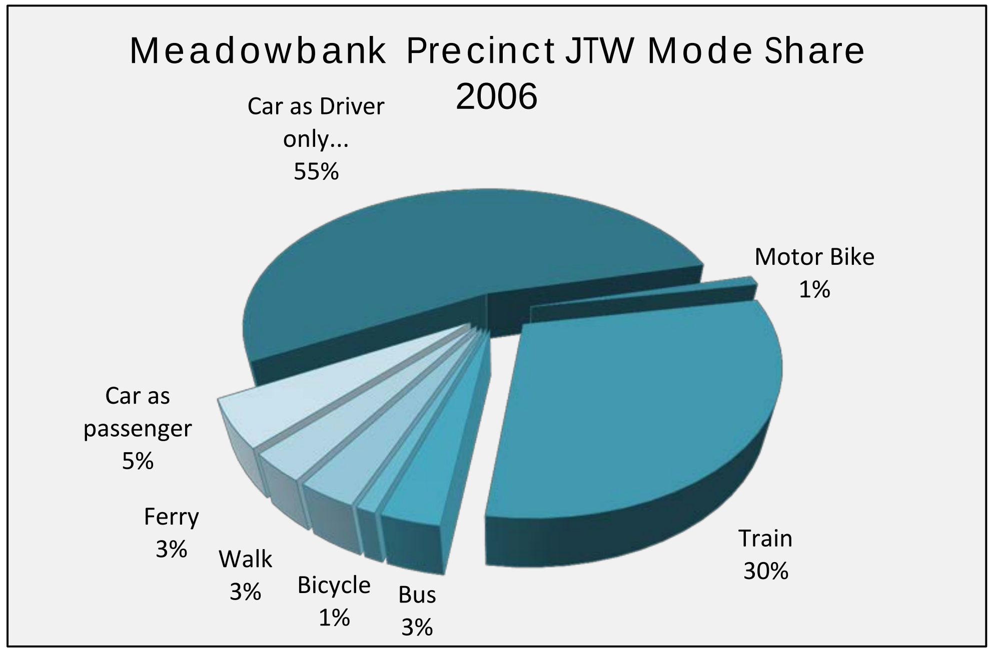
Sidra analysis suggests that the operational performance of the current 2010 road network, surrounding the proposed development, is satisfactory.

2010 Existing Operational Performance

Intersection	2010 AM Peak			2010 PM Peak		
	DS	AVD	LOS	DS	AVD	LOS
Belmore Street and Junction Street	0.332	33.3	C	0.356	32.7	C
Porter Street and Loop Street and Parsonage Street	0.386	11.8	A	0.407	10.2	A
Belmore Street and Constitution Road	0.94	23.2	C	1	33.1	C
Constitution Road and Hamilton Crescent	0.371	8.6	A	0.355	6.7	A
Constitution Road and Bowden Street	0.667	11.1	A	0.658	9.7	A
Railway Road and Bank Street	0.576	7.6	A	0.604	9.2	A

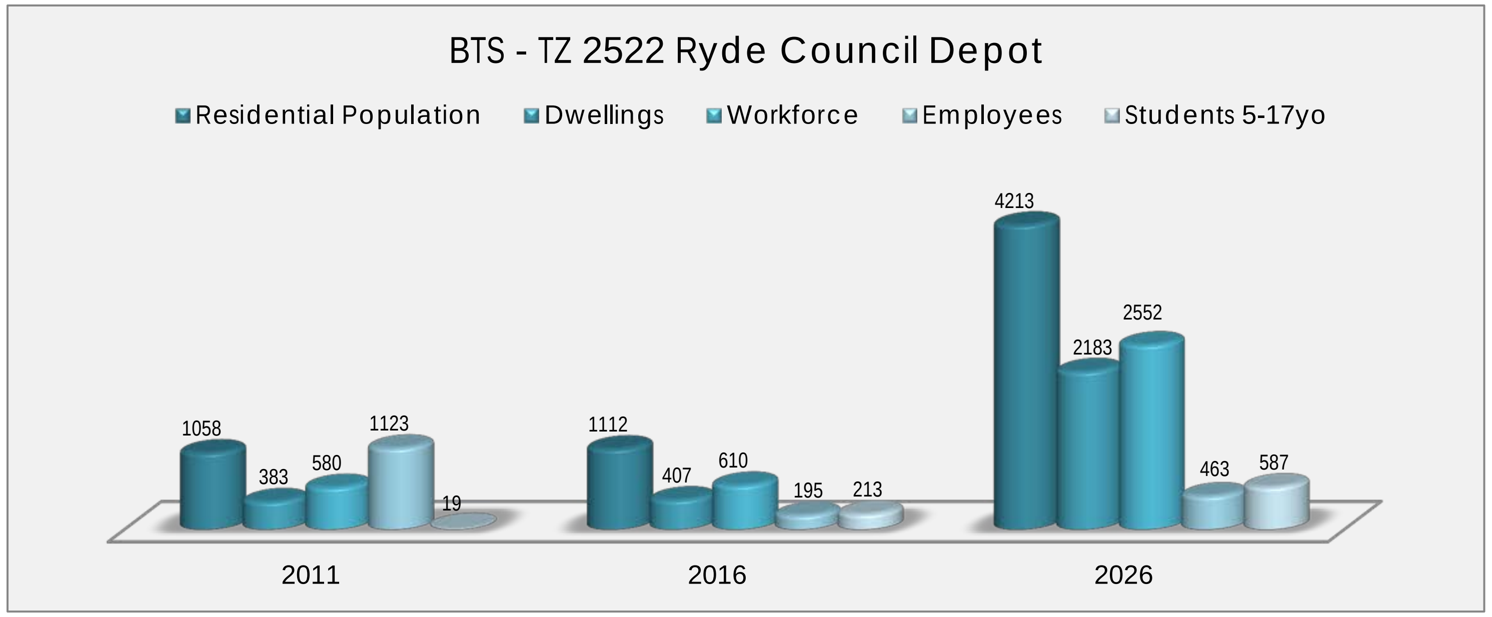
Significant mode choice is available within the precinct. Meadowbank Railway Station, the Parramatta River Ferry service and frequent bus operations afford the work force significant opportunity to leave the car at home.

The 2006 Meadowbank Precinct Mode Share

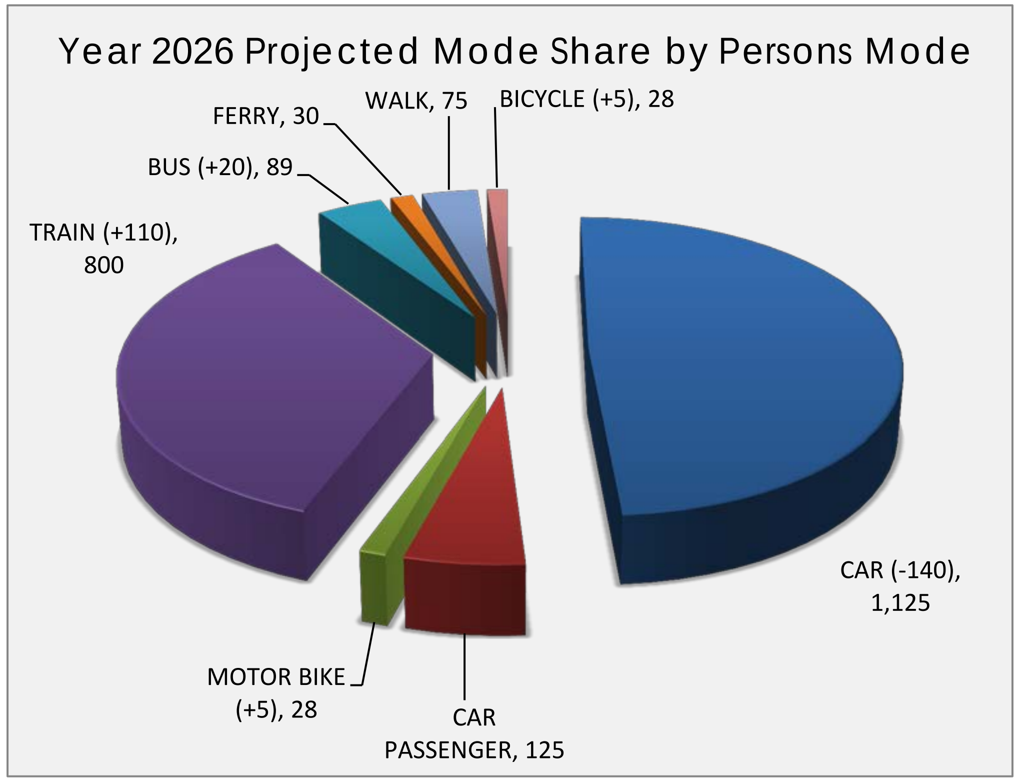


Future Transport Requirements…….. In addition to the following infrastructure upgrades, improvements and increases to current public transport services are required to sustain the anticipated growth within the Meadowbank Precinct.

Projected Growth Levels within the Meadowbank Employment Area



Projected Mode Share by Persons in 2026 with 10% Mode Shift to Public Transport



A future 10% mode shift to public transport from private vehicle usage has been applied to the future JTW projections and has been based on a potential increase in train service(s) on the Northern Line through Meadowbank and modest increases in bus patronage, motor bike and bicycle usage.

Adopting the projected mode share, juxtaposed with the background growth in traffic, generally intruding on the precinct from Church Street and Victoria Road, the following infrastructure upgrades are required to sustain satisfactory operation on the road network, surrounding the Shepherds Bay Urban Renewal Project by year 2026.

Recommended Infrstructure Upgrades Under Resrticted Precinct Access by 2026

No.	*Interim Development Stage	Recommended Infrastucture Upgrade
1	Stage 2	The widening of Constitution Road to 4 trafficable lanes during the commuter peaks
2	Stage 2/3	The construction of traffic signals at the intersection of Constitution Road and Bowden Street
3	Stage3	The installation of left in/left out only at the intersection of Belmore Street and Nancarrow Avenue
4	Stage 4	The installation of left in/left out only (banning of the right turn movement from Constitution Road) at the intersection of Constitution Road and Hamilton Crescent
5	Stage 5	The transformation of Hamilton Crescent to One Way movement southbound

*Note: *Interim Development Staging is subject to Council's works program*

2026 Projected Operational Performance

Intersection	2026 AM Peak			2026 PM Peak		
	DS	AVD	LOS	DS	AVD	LOS
Belmore Street and Junction Street	0.605	24.4	C	0.747	21.9	C
Porter Street and Loop Road and Parsonage Street	1.075	109.8	F	0.929	20.8	C
Belmore Street and Constitution Road	0.640	31.8	C	0.668	33.9	C
Constitution Road and Bowden Street	0.865	36.8	D	0.883	39.6	D
Railway Road and Bank Street	1424	100.2	F	2.202	>200	F
Belmore Street and Nancarrow Avenue	0.299	5	A	0.284	5	A
Bowden Street and Nancarrow Avenue	0.516	7.6	A	0.126	4.8	A
Bowden Street and Nancarrow Avenue	0.170	5.1	A	0.258	5.3	A

The transport planning assessment for the Meadowbank Employment Area has considered the implications of future traffic demand under full urban renewal.

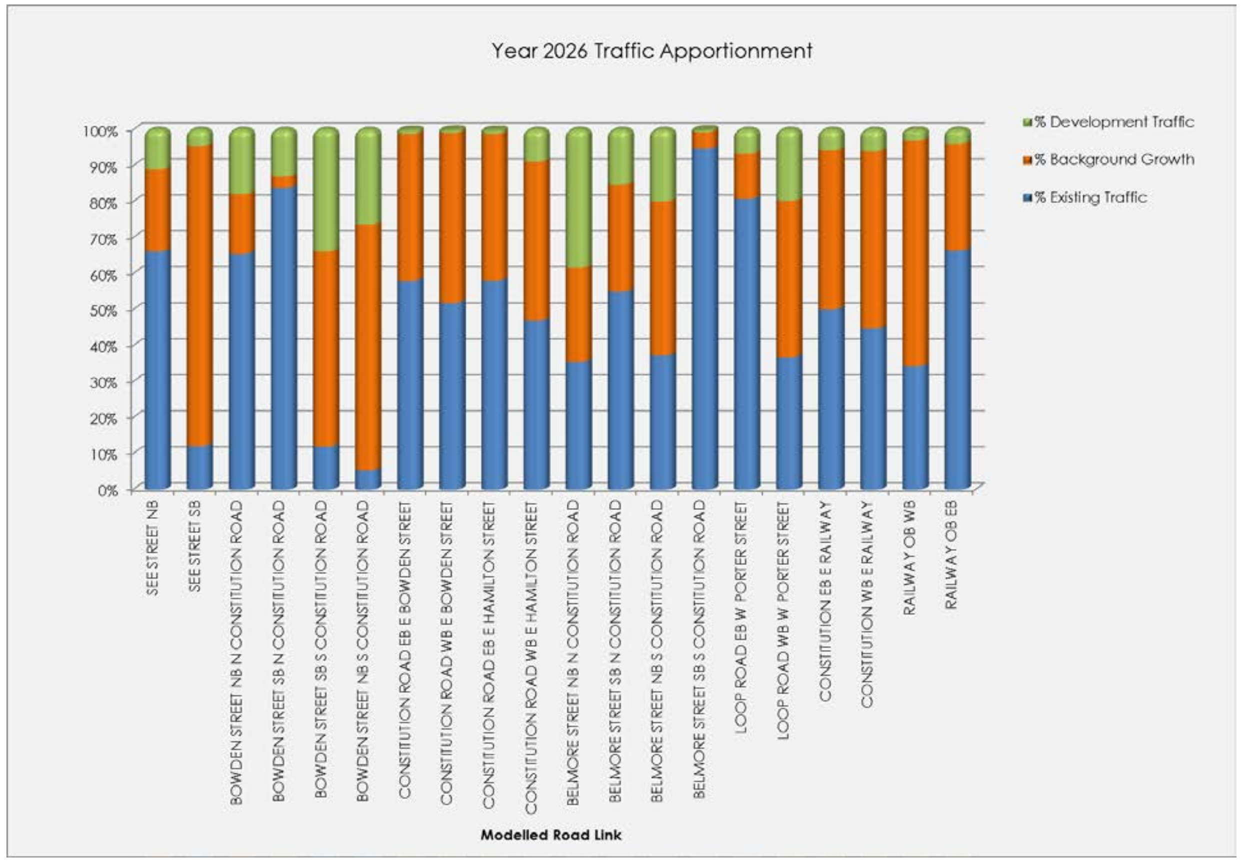
Each road link and intersection has been diligently assessed under differing control methods to achieve a safe and efficient outcome under the burden of future traffic demands in year 2026.

Not restricting traffic entering the precinct would undoubtedly make the Constitution Road corridor prone to the further intrusion by through traffic, originating outside the local precinct. It is for this reason that the road overbridge between Railway Road and Banks Street and also the single lane roundabout at the intersection of Porter Street, Parsonage Street and Loop Road are recommended for retention, until such time as background traffic growth triggers concerns, warranting further consideration at each site.

The recommended road network improvements are intended to reduce motor vehicle and pedestrian delays on the local road network, while endeavouring to create an acceptable level of amenity for the residential community.

The mid block formation guidelines, as outlined in Ryde Council's Draft DCP, 2011, have been considered and, with the transformation of the current industrial operations, should adequately manage the corresponding vehicle generations associated with the local urban release.

Funding………………………………. The proposed mechanism of funding remains the proportional contribution based on usage. The measure of usage is the proportion of traffic or passengers using the infrastructure link.



The calculation of funding is based on the proportion of proposed development traffic contributing to the recommended improvement.

Conclusion…………………………..

The range of public transport opportunities within the Meadowbank precinct are capable of greater utilisation and should reduce the dependence on private motor vehicle usage for the surrounding developments, including the Shepherds Bay Urban Renewal Project. The greatest potential for mode shift lies with State Rail and services. In combination with STA buses and the Parramatta River ferry services, the availability of public transport should adequately realise a modest 10% mode shift to public transport.

The theoretical level of contributions to infrastructure upgrades, as presented, is based on the full development of the Meadowbank Employment Area by year 2026 and is intended as a base line for negotiation between the Developer and the appropriate authoritiy(s).

It is envisaged that the final design requirements, associated with the recommended traffic works, will necessitate refinement by Council and the RMS, during the course of urban renewal. Monitoring of traffic patterns and the determination of the allowable growth in cross regional traffic flow, over the coming 14 years, will be paramount in ensuring a safe and efficient local road network.

1 INTRODUCTION

Road Delay Solutions has been engaged by Robertson + Marks Architects and Holdmark NSW Pty Ltd to undertake the preparation of a Strategic Transport Model in support of the Concept Plan for the Shepherds Bay Urban Renewal Development and subsequent TMAP prepared by Varga Traffic Planning.

A significant proportion of the current land use within the southern Meadowbank Precinct, BTS Zone 2522, has been identified as commercial/light industrial, with an occupancy rate of only 59.2%.

The purpose of this document is to catalogue and assess the impacts envisaged from the future projected vehicle movements within the Meadowbank precinct for the Énd State' year 2026.

This assessment incorporates the predominant available transport mode choices for journey to work trips (JTW) as determined by the Department of Planning and Infrastructure. These mode choices are considered manually, external to the Netanal model, from the available modes within, or adjacent to, the Meadowbank precinct, as defined by BTS Zone 2522. The location of BTS Transport Zone 2522 is shown in *Figure 2*.

2 EXISTING CONDITIONS

THE DEVELOPMENT SITE

The development site is generally bounded by Bowden Street to the west, Constitution Road to the north and Belmore Street to the east, and forms part of the Meadowbank employment area, as shown in *Figure 1*.

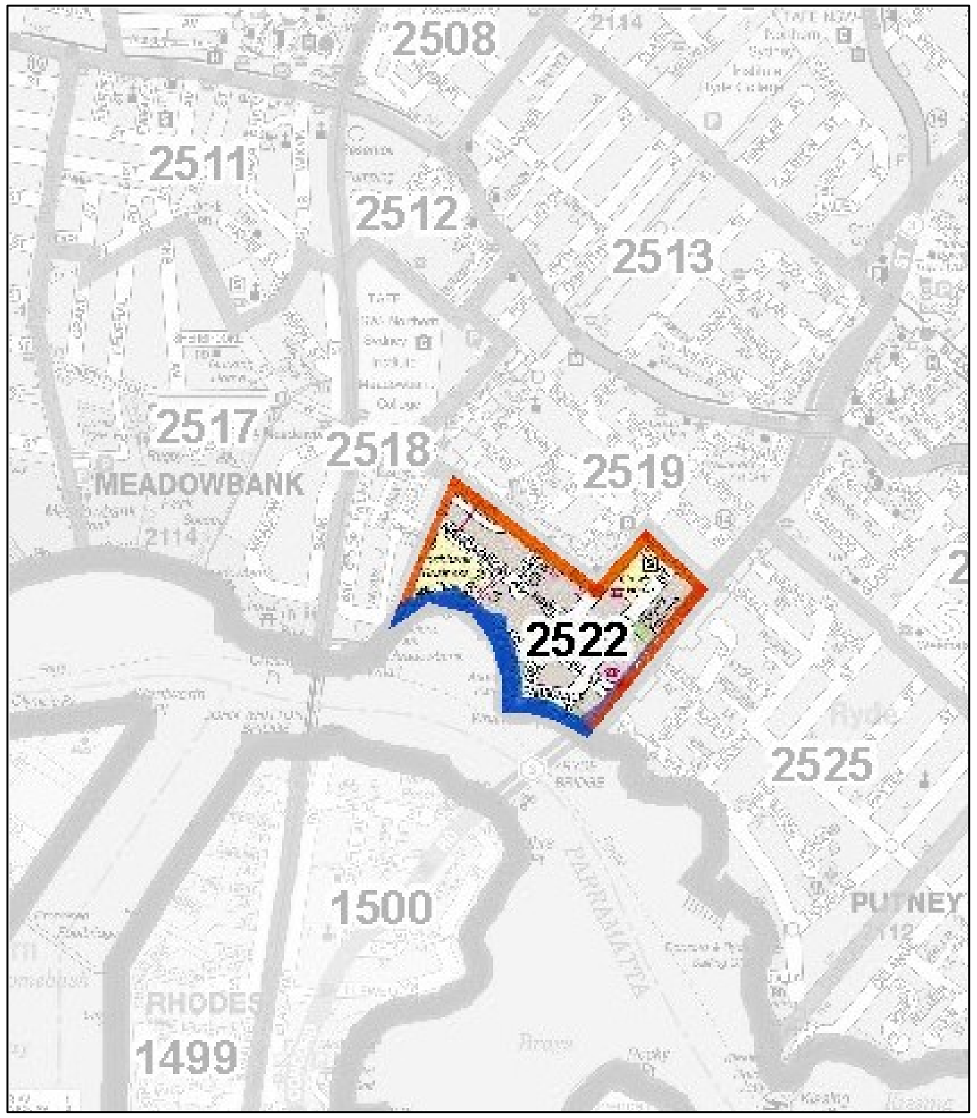
The Shepherds Bay precinct is currently occupied by a large number of industrial buildings and associated landuses such as carparking and service vehicle areas.

A survey of properties located within the Shepherds Bay precinct has identified approximately 40 industrial buildings or premises, with a cumulative floor area of some 72,200m2. At the time of the survey, approximately 42,700m2, or 59.2%, of the total floor area was occupied.

Figure 1: Meadowbank Employment Area and Development Footprint

Source: ROBERTSON + MARKS Architects, Revision L - 2012

Figure 2: BTS Zone 2522 (Ryde Council Depot)



Source: Extract from BTS 2006 Transport Zone Map, 2011

3 THE STRATEGIC NETANAL 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 an assignment model not a gravity nor equilibrium model but rather utilises delay in the route selection choice.

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 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 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 can be included as part of the network. Netanal can report on travel time changes on these routes.

- **On-street parking**.
- **Speed limits**.
- **LATM devices** (eg 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.

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

INTERSECTION TURNING MOVEMENT VOLUMES

Netanal is capable of projecting the hourly intersection turn movement demands at each node *(intersection)* within the strategic 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 strategic 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 strategic 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 960 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 2010 trip matrix was originally developed by BTS in October 2009. 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.

The land use assumptions adopted, and transposed into the year 2010 trip matrices, are presented in *Table 3*.

3 MODEL CALIBRATION

This section provides a concise framework for the verification, validation and calibration of the base year 2010 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, as presented in *Figure 4*.

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, and
- → Toll collection locations on motorways.

All major infrastructure projects, to the future model date, have been employed in the future year modelled road networks.

Figure 3: Principle Road Infrastructure Projects to Year 2036

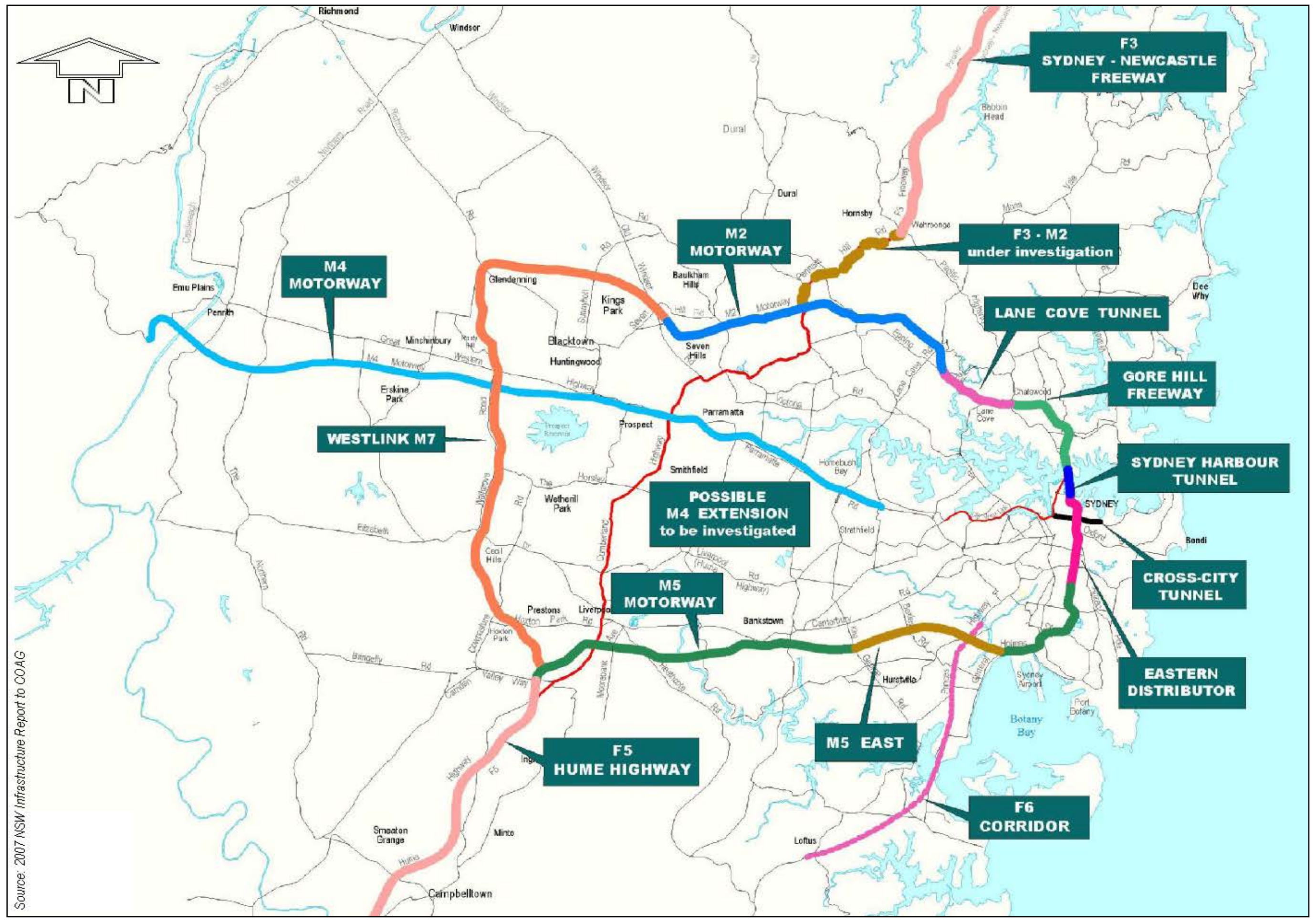
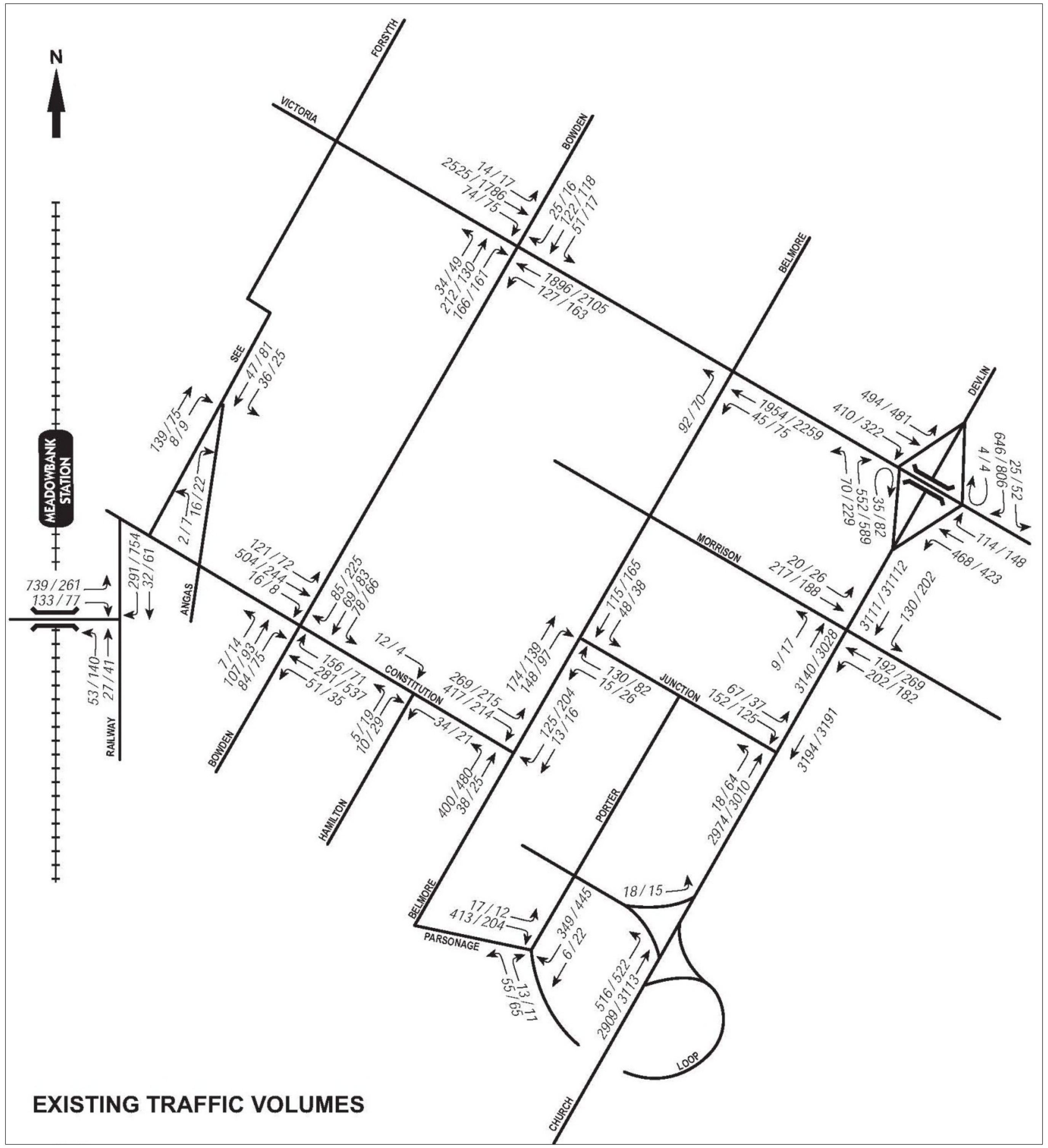


Figure 4: Existing Traffic Volumes



Source: Varga Traffic Planning, 2010

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.

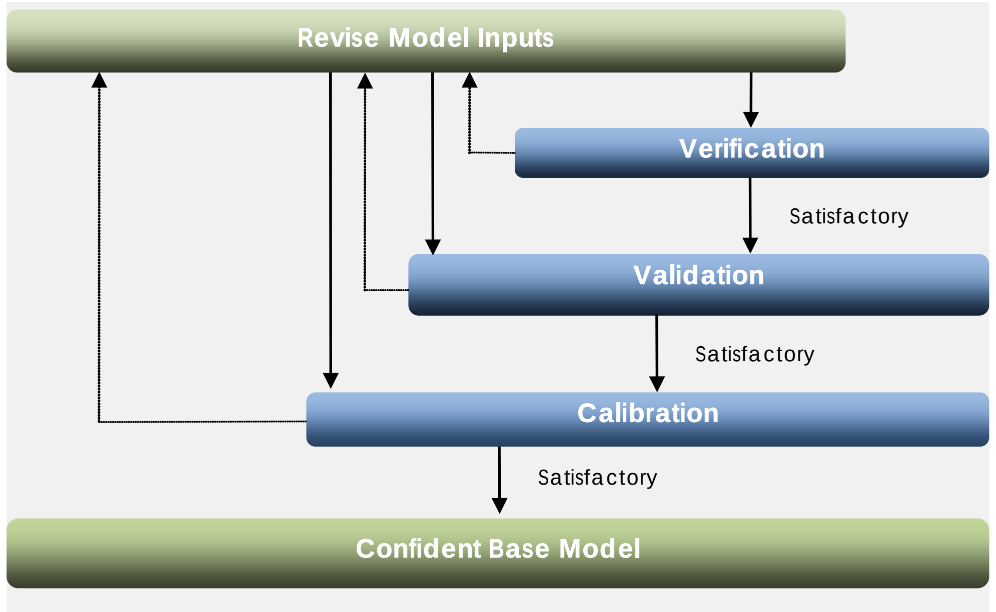
The Netanal software package produces traffic forecasts generally based upon travel time rather than distance or gravity principles. Netanal determines the invoked link and intersection delays, during a model assignment run, to effectively produce travel times between origin and destination.

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 5: The Correctness Procedure



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.

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*.

Figure 6: The GEH Statistic

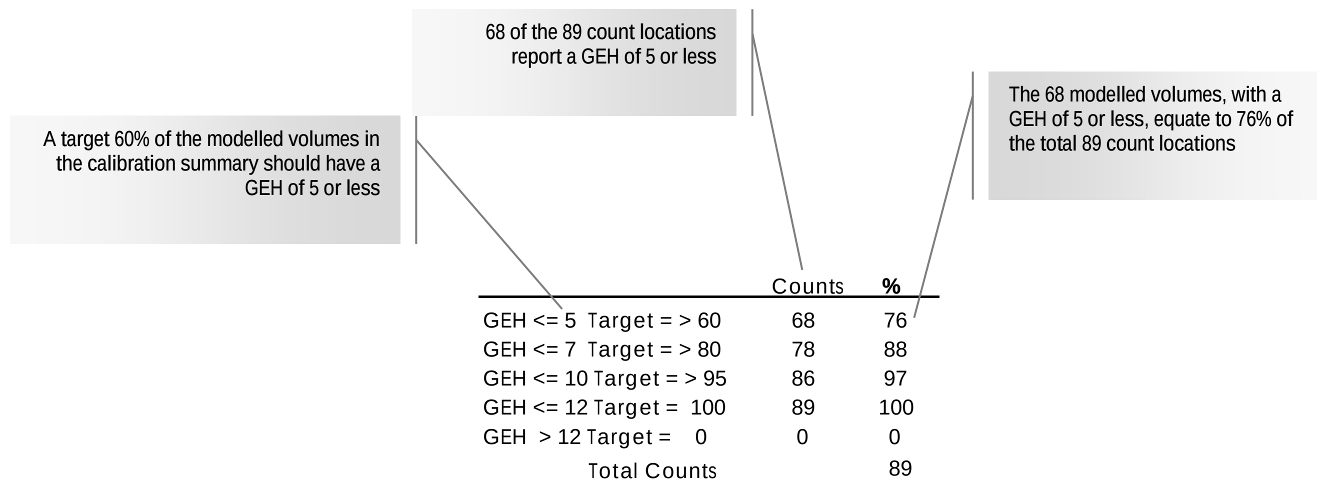
$$GEH = \sqrt{\frac{(E-V)^2}{(E+V)/2}}$$

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

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 degree of difference between modelled volumes and the collected field data.

Figure 7, below, describes the components of the GEH Statistic and the targets employed in the calibration of the base year models.

Figure 7: Typical GEH Targets



[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.

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 2010.

The trip matrices, currently employed in the base Netanal models, were originally developed by TPDC, based upon the Year 2006 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 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. 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, significant vehicle queues exist at a site.

The count data utilised during this project was supplied by Varga Traffic Planning and can be found in *Figure 4*.

Discrepancies between adjacent intersection counts are to be expected and an error of some 3% is recorded in a number of locations.

CALIBRATION SYNOPSIS

Table 1: Morning Peak Calibration Report

Calibration Summary for Model 10AM56
Network = 2010 Trip Table = 10AM56
2010 AM Peak BASE SYDNEY MODEL
Observed Counts versus Modelled Volumes
Date = 05-21-2012. Time = 11:40:03

Note.... If a record contains a '*' it is possible that the count flow data used is low due to being a SCATS count or oversaturated queueing is present. SCATS counts will be up to 10% low under normal flow conditions & up to 40% low where oversaturation occurs. All counts for a 1 hour peak period will be low where queues occur due to oversaturation. The count flow data at these locations represents the actual capacity and not the demand whereas the modelled flows are the demand.
Note.... If a record contains a '?' the calibration is suspect.
Note.... If a record contains a '!' the calibration is unacceptable.

Location..........	Flag	Node	Node	Count	Model	Diff	Diff%	GEH
VICTORIA EB E FORSYTH		1034	4118	2613	2309	-304	-12	6
VICTORIA WB E FORSYTH		4118	1034	1955	1797	-158	-8	4
BOWDEN NB N VICTORIA		4118	3684	226	197	-29	-13	2
BOWDEN SB N VICTORIA	?	3684	4118	198	162	-36	-18	3
VICTORIA EB E BOWDEN		4118	7779	2742	2425	-317	-12	6
VICTORIA WB E BOWDEN		7779	4118	2023	1860	-163	-8	4
VICTORIA WB E BELMORE	*	4131	4132	1999	2056	57	3	1
DEVLIN NB ONLOAD		4131	4164	608	564	-44	-7	2
DEVLIN SB OFFLOAD	*	4164	4130	675	726	51	8	2
MORRISON EB W CHURCH		1026	4128	237	219	-18	-8	1
MORRISON EB E CHURCH		4128	4139	347	355	8	2	0
CHURCH SB N MORRISON		4129	4128	3241	3053	-188	-6	3
MORRISON WBE CHURCH	?	4139	4128	394	475	81	21	4
JUNCTION EB E BELMORE	?	4120	1027	196	137	-59	-30	5
JUNCTION WB E BELMORE		1027	4120	145	131	-14	-10	1
EB W CHURCH	?	1027	4127	219	137	-82	-37	6
JUNCTION WB W CHURCH	?	4127	1027	18	0	-18	-100	6
CHURCH NB S JUNCTION		4122	4127	2992	2886	-106	-4	2
CHURCH SB S JUNCTION		4127	4122	3346	3314	-32	-1	1
LOOP LT ONTO CHURCH		4125	4124	419	446	27	6	1
BELMORE NB S CONSTITUT	?	1028	4121	438	372	-66	-15	3
BELMORE SB S CONSTITUT		4121	1028	430	446	16	4	1
BELMORE NB N CONSTITUT	?	4119	4120	322	237	-85	-26	5
BELMORE SB N CONSTITUT		4120	4119	138	138	0	0	0
BELMORE NB S MORRISON	?	4120	1026	304	368	64	21	3
BELMORE SB S MORRISON	?	1026	4120	163	275	112	69	8
MORRISON WB W CHURCH		4128	1026	201	194	-7	-3	0
SEE SB N ANGAS	?	1032	1036	83	51	-32	-39	4
SEE NB S ANGAS		4116	1036	147	158	11	7	1
RAIL O'BRIDGE EB	!	4112	4113	872	731	-141	-16	5
RAIL O'BRIDGE WB		4113	4112	344	368	24	7	1
CONSTITUTION EB E SEE	*	4116	4117	641	703	62	10	2
CONSTITUTION WB E SEE	?	4117	4116	373	448	75	20	4
BOWDEN NB S CONSTITUTI	?	1038	4117	198	165	-33	-17	2
BOWDEN SB S CONSTITUTI	?	4117	1038	136	95	-41	-30	4
BOWDEN NB S VICTORIA	?	1037	4118	412	594	182	44	8
BOWDEN SB S VICTORIA		1037	4117	323	364	41	13	2
CONSTITUTION EB E BOWD		4117	1031	666	689	23	3	1
CONSTITUTION WB E BOWD		1031	4117	488	494	6	1	0
HAMILTON NB S CONSTITU		1030	1031	15	16	1	7	0
HAMILTON SB S CONSTITU	?	1031	1030	46	37	-9	-20	1
CONSTITUTION EB E HAMI		1031	4119	686	683	-3	-0	0
CONSTITUTION WB E HAMI		4119	1031	559	510	-49	-9	2

Summary of GEH Calibration Validation

	Counts	%
GEH <= 5 Target = > 60%	37	86
GEH <= 7 Target = > 80%	41	95
GEH <= 10 Target = > 95%	43	100
GEH <= 12 Target = 100%	43	100
GEH > 12 Target = 0%	0	0
Total Counts	43	

Mean, Mean Absolute Difference (MAD) & +/- 10% MAD Analysis - Model 10AM56
Date = 05-21-2012. Time = 11:40:03

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

Observed Count Range	Mean %	MAD ABS %	MAD +-10% %	Counts
0001 to 0500	-1.71	16.91	6.91	28
0501 to 1000	2.15	7.92	0.00	7
1001 to 1500	0.00	0.00	0.00	0
1501 to 2000	4.00	5.44	0.00	2
2001 to 2500	8.06	8.06	0.00	1
2501 to 3000	8.71	8.71	0.00	3
3001 to 3500	3.34	3.34	0.00	2
3501 to 4000	0.00	0.00	0.00	0
4001 to 5000	0.00	0.00	0.00	0
5001 to Maximum	0.00	0.00	0.00	0
Total of Counts 0001 to Maximum Range	3.66	8.82	0.00	43
Total of Counts 0501 to Maximum Range	5.12	6.63	0.00	15

Table 2: Evening Peak Calibration Report

Calibration Summary for Model 10PM54
Network = 2010 Trip Table = 10PM54
2010 PM Peak BASE SYDNEY MODEL
Observed Counts versus Modelled Volumes
Date = 06-02-2012. Time = 10:37:23

Note.... If a record contains a '*' it is possible that the count flow data used is low due to being a SCATS count or oversaturated queueing is present. SCATS counts will be up to 10% low under normal flow conditions & up to 40% low where oversaturation occurs. All counts for a 1 hour peak period will be low where queues occur due to oversaturation. The count flow data at these locations represents the actual capacity and not the demand whereas the modelled flows are the demand.
Note.... If a record contains a '?' the calibration is suspect.
Note.... If a record contains a '!' the calibration is unacceptable.

Location..........		Node	Node	Count	Model	Diff	Diff%	GEH
VICTORIA EB E FORSYTH		1034	4118	1878	1675	-203	-11	5
VICTORIA WB E FORSYTH		4118	1034	2170	1936	-234	-11	5
BOWDEN NB N VICTORIA		4118	3684	147	137	-10	-7	1
BOWDEN SB N VICTORIA		3684	4118	151	130	-21	-14	2
VICTORIA EB E BOWDEN		4118	7779	1964	1750	-214	-11	5
VICTORIA WB E BOWDEN		7779	4118	2268	2039	-229	-10	5
VICTORIA WB E BELMORE		4131	4132	2334	2061	-273	-12	6
DEVLIN NB ONLOAD		4131	4164	629	597	-32	-5	1
DEVLIN SB OFFLOAD		4164	4130	862	770	-92	-11	3
CHURCH SB ONLOAD	!	4130	4129	745	620	-125	-17	5
CHURCH NB OFFLOAD	!	4129	4131	900	763	-137	-15	5
MORRISON EB W CHURCH	?	1026	4128	214	165	-49	-23	4
MORRISON EB E CHURCH		4128	4139	214	182	-32	-15	2
CHURCH SB N MORRISON		4129	4128	3314	2858	-456	-14	8
MORRISON WB E CHURCH		4139	4128	451	386	-65	-14	3
JUNCTION EB E BELMORE	?	4120	1027	135	109	-26	-19	2
JUNCTION WB E BELMORE		1027	4120	108	95	-13	-12	1
JUNCTION EB W CHURCH	?	1027	4127	162	210	48	30	4
JUNCTION WB W CHURCH		4127	1027	64	64	0	0	0
CHURCH NB S JUNCTION		4122	4127	3074	2980	-94	-3	2
CHURCH SB S JUNCTION		4127	4122	3316	2947	-369	-11	7
LOOP LT ONTO CHURCH	?	4125	4124	226	174	-52	-23	4
LOOP LT FROM CHURCH	?	4124	4125	76	47	-29	-38	4
BELMORE NB S CONSTITUT		1028	4121	505	450	-55	-11	3
BELMORE SB S CONSTITUT		4121	1028	230	197	-33	-14	2
BELMORE NB N CONSTITUT		4119	4120	236	202	-34	-14	2
BELMORE SB N CONSTITUT	?	4120	4119	220	183	-37	-17	3
BELMORE NB S MORRISON		4120	1026	221	215	-6	-3	0
BELMORE SB S MORRISON		1026	4120	203	210	7	3	0
MORRISON WB W CHURCH	?	4128	1026	286	241	-45	-16	3
SEE SB N ANGAS		1032	1036	106	96	-10	-9	1
SEE NB S ANGAS		4116	1036	84	75	-9	-11	1
RAIL O'BRIDGE EB		4112	4113	338	340	2	1	0
RAIL O'BRIDGE WB	!	4113	4112	894	721	-173	-19	6
CONSTITUTION EB E SEE		4116	4117	324	368	44	14	2
CONSTITUTION WB E SEE		4117	4116	776	727	-49	-6	2
BOWDEN NB S CONSTITUTI	?	1038	4117	182	212	30	16	2
BOWDEN SB S CONSTITUTI	?	4117	1038	126	209	83	66	6
BOWDEN NB S VICTORIA		1037	4118	340	343	3	1	0
BOWDEN SB S VICTORIA		4118	1037	356	365	9	3	0
CONSTITUTION EB E BOWD		4117	1031	385	360	-25	-6	1
CONSTITUTION WB E BOWD		1031	4117	643	603	-40	-6	2
HAMILTON NB S CONSTITU		1030	1031	48	46	-2	-4	0
HAMILTON SB S CONSTITU	?	1031	1030	25	37	12	48	2
CONSTITUTION EB E HAMI		1031	4119	429	391	-38	-9	2
CONSTITUTION WB E HAMI		4119	1031	705	624	-81	-11	3

Summary of GEH Calibration Validation

	Counts	%
GEH <= 5 Target = > 60%	41	89
GEH <= 7 Target = > 80%	45	98
GEH <= 10 Target = > 95%	46	100
GEH <= 12 Target = 100%	46	100
GEH > 12 Target = 0%	0	0
Total Counts	46	

Mean, Mean Absolute Difference (MAD) & +/- 10% MAD Analysis - Model 10PM54
Date = 06-02-2012. Time = 10:37:23

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

Observed Count Range	Mean %	MAD ABS %	MAD +-10% %	Counts
0001 to 0500	4.90	12.72	2.72	29
0501 to 1000	11.77	11.77	1.77	9
1001 to 1500	0.00	0.00	0.00	0
1501 to 2000	16.42	10.85	0.85	2
2001 to 2500	10.87	10.87	0.87	3
2501 to 3000	0.00	0.00	0.00	0
3001 to 3500	9.47	9.47	0.00	3
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	9.54	10.98	0.98	46
Total of Counts 0501 to Maximum Range	10.59	10.59	0.59	17

4 FUTURE CONDITIONS

PLANNING POLICIES AND GUIDELINES

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

The focus here will be on the policies, strategic directions and development provisions that have direct implications for the development and will influence land use, transport services and facilities in the future. This information will be used as the basis for the development of the precinct plan and successful integration of land use and transport planning.

PLANNING PROVISIONS - SEPP NO. 59

CENTRAL WESTERN SYDNEY ECONOMIC AND EMPLOYMENT AREAS

State Environmental Planning Policy No.59 (SEPP 59) presents guiding principles for sustaining efficient transport with future developments and the requirements to be met in the preparation of a long-term transport plan. The aims of the policy include...

- *"promote economic development and the creation of employment in Western Sydney by providing for the development of major warehousing, industrial, high technology, research or ancillary facilities with good access to the existing and proposed road freight network, including the M4 motorway and the Westlink M7".*
- *"provide for the optimal environmental and planning outcomes for the land to which the policy applies by helping to achieve the goals set out in Action for Air, to contain the per capita growth in VKT (vehicle kilometres travelled) by achieving higher than normal public transport usage."*

The policy states that in developing Precinct plans, attention must be given to the following relevant issues that expand on the foregoing general provisions...

"A transport plan should be prepared that addresses the following...

i) roads, transit ways, and provision for walking and cycling, both within the Precinct and off site linkages,

ii) freight transport provisions, including initiatives for integrating freight handling within the precinct, and maximising opportunities for synergies between industries with regard to materials handling,

iii) the relationship between the staging of development and the provision of transport infrastructure,

iv) ways, including the design and layout of the proposal, in which the mode split to public transport, cycling and walking is to be increased above levels typical of areas surrounding the development. It is expected as a minimum that the proposal demonstrates that...

iv) the mode split of "cars as driver" for the journey to work can be reduced by at least 10% (eg from 75% down to 65%) compared to existing surrounding areas, and

- *the total VKT (vehicle kilometres travelled) to be generated by the proposed development should be reduced by at least 5% below that which would be generated by a 'conventional' approach to development, and*

v) funding proposals for the development of transport infrastructure."

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.

METROPOLITAN PLANNING STRATEGIES

EMPLOYMENT LANDS FOR SYDNEY ACTION PLAN, 2007

The strategic framework in *'City of Cities Metropolitan Strategy, a Plan for Sydney's Future'*, dictates transport systems and urban structures with equitable access to jobs, services and leisure.

It also identifies the priority outcomes and presents the key policies and actions to achieve them. The regional strategy bridges the gap between local area needs and opportunities and the broader goals of the City of Cities strategy.

The purpose of the Employment Lands Action Plan is to create more job oportunities and stimulate economic growth, providing a cleaner environment, an improved transport network, safe community neighbourhoods and affordable housing. Further, it aims to reduce the growth of private vehicle use and curb urban sprawl.

THE DEVELOPMENT FOOTPRINT

The proposed development comprises 2,005 residential units and 10,000m² of commercial floor space which are intended to replace 72,207m2 of industrial floor area, of which 42,751m2, or 59.2%, is currently occupied.

The planned Shepherds Bay Development, Meadowbank, is defined by the the Bureau of Transport Statistics (BTS) as Zone 2522, within the Ryde LGA, as shown in *Figure 2*.

While the theoretical vehicle generation rate will not be significantly higher with the tranformation of the commercial/industrial lands to residential, trip distribution and flow patterns will be impacted.

Currently traffic generally accesses the Shepherds Bay precinct in the morning and departs in the evening. With the planned development, this condition will reverse with traffic generally leaving the precinct in the morning and returning in the evening. This is reflected in the strategic modelling with the majority of morning peak vehicle trips from the precinct travelling to Sydney and the Eastern Suburbs, Macquarie Park, Homebush Bay and select key regional centres.

POPULATION FORECASTS

The future Year trip matrices, produced by BTS in October 2009, have been developed from a 4 step travel model and are based on forecast population and employment projections assigned to a computer based transport network.

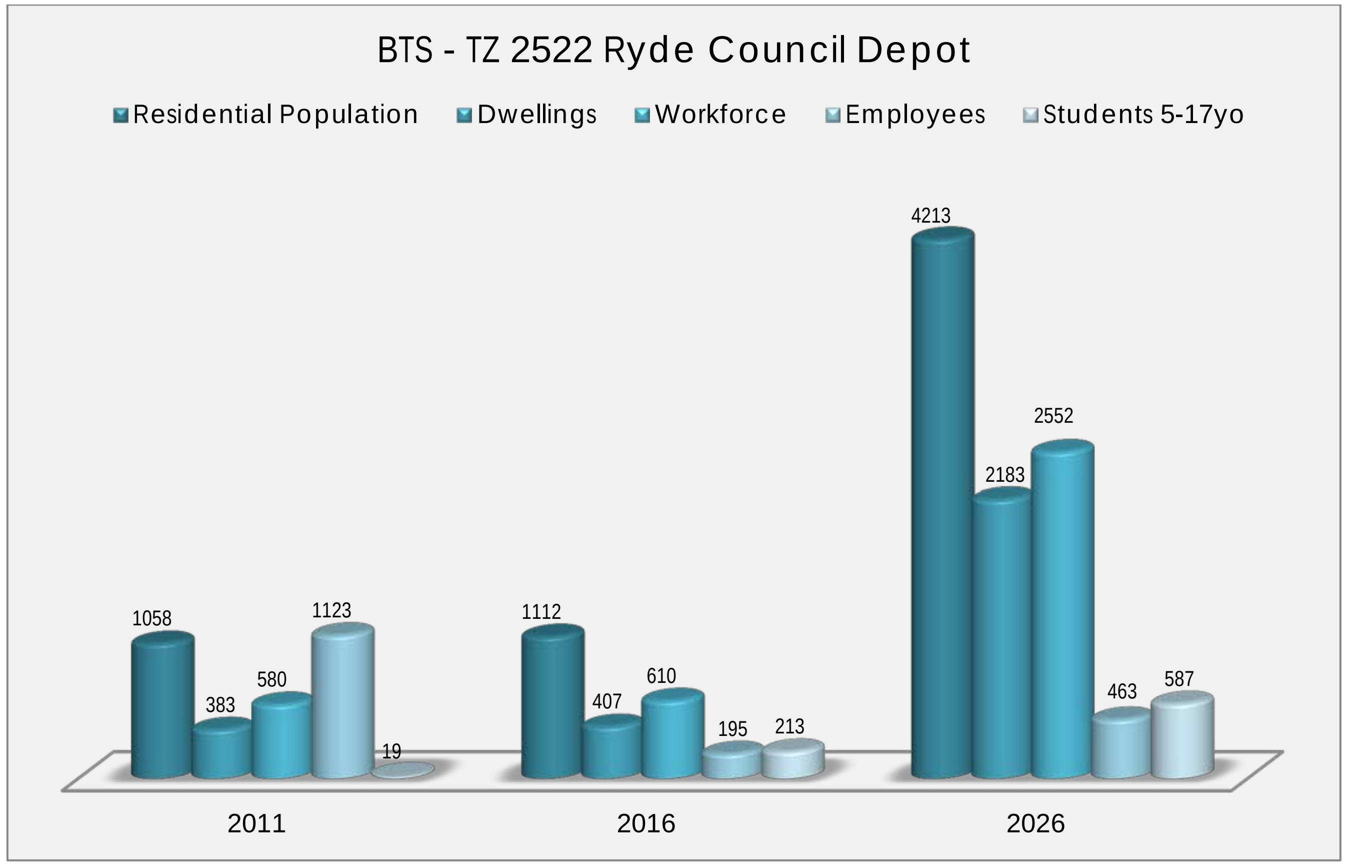
These trip tables form the basis for the Netanal future year trip demands and have been applied to the 2001 travel zone (TZ) system, through the employment of an equivalency table, prepared by the BTS.

Generally, the Netanal vehicle trip distribution for the future year trip tables of the Sydney Statistical Division has been retained from the BTS trip matrices. However, irregularities between the land use assumptions within the BTS matrices and available growth data, in particular BTS 2006 TZ 2522, make it necessary to disaggregate the zone structure to better reflect the furture year demand generations associated with the Shepherds Bay Development.

Figure 8 presents the interpreted population data employed in the trip matrices for Zone 2522.

A residential population of 1,058 persons in year 2011 is anticipated to escalate to 4,213 by year 2026 while the current workforce of 580 is expected to reach 2,552 by year 2026. With the growth in dwellings to reach 2,183 by year 2026 a high density residential occupancy rate of 1.93 persons is anticipated.

Figure 8: Projected Growth Levels within the Meadowbank Employment Area



Source: Bureau of Transport Statistics, 2012 adjusted in 2026 to reflect the Urban Renewal Projects

PUBLIC TRANSPORT CHOICE

This assessment reviews 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, from the available modes within, or adjacent to, the Meadowbank precinct (MEA), as defined within the BTS Transport Zone number 2522.

The seven (7) dominant mode choices available to the Meadowbank community are…

- Private motor vehicle,
- Motor bike,
- Bus,
- Train,
- Ferry,
- Walking, and
- cycling.

Walking is considered a valid transport mode, in consideration of multi modal JTW trips. and particularly in close proximity to public transport provisions juxtaposed with medium to high density residential land use. The primary impact on road based transport movements from such pedestrian activity is generally concentrated at crossing points.

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

In line with NSW 2021 targets, growth in public transport trips was higher than growth in passenger vehicle trips. Vehicle driver trips increased by 1.5%, while train and bus trips increased by 2.6% and 2.3%, respectively. These inherent increases can be attributed to increased frequency and improve intermodal provisions.

Results from the Sydney Cycling Survey, undertaken in November 2011, show that the cycling mode share for trips, up to ten kilometres, is currently 2%. The BTS conducts this survey annually to track performance against the NSW target which aims for a doubling of the cycling share by 2016.

The BTS trip matrices provide travel demand estimates based on trips (i.e. from origin to destination) by selected modes (car driver, rail and bus, etc…) for all travel purposes during the morning and evening commuter peak 2 hour periods. These have been factored to reflect the one (1) hour peak period by adopting a factor determined by calculating the percentage of actual or counted patrons, during the peak period, from the 2 hour BTS trip matrix.

The content of the files is as follows…

- Car, Rail and Bus Trips by time period, and
- Road assignment statistics by time period
    - including passenger cars and trucks (light, rigid and articulated trucks) in passenger car units (PCU).
    - total vehicle travel time in hours.
    - total vehicle travel distance in kilometres.

Note: The "auto" demand vehicle matrix demand is factored (59.6%) down to achieve the 1-hour commuter period for the Netanal assignment.

The Strategic Netanal model focuses on the peak, one hour, morning and evening commuter periods.

With the advent of the Shepherds Bay Residential Development, including 10,000m² of commercial floor space, the proposed growth pattern within Zone 2522 will differ from the data published by BTS. The general direction of traffic flow emminating from Zone 2522 during the peak commuter periods will change.

With the transformation of the current industrial/commercial activities within Zone 2522 to the proposed predominantly residential land use, traffic attracted to the precinct during the morning peak will significantly reduce. Traffic will be directed outbound from the zone towards key employment, education and local retail attractors during the AM peak period, as indicated in *Figure 12*.

Some 200 vehicles per hour will be attracted by the proposed commercial activities and ancillary retail operations during the morning peak while the total of 2,183 residential lots, within the zone, will generate some 640 vehicle trips at the Roads and Maritime Services (RMS) rate of 0.29 trips per hour per high density residential lot.

In combination with the remaining residential lots, neighbouring developments and the Achieve Australia project, the total workforce, as shown in *Figure 8*, will be generate some 1,125 vehicle trips are proposed generated by the zone during the morning peak commuter period in Year 2026, under full development.

The Netanal model has adopted 3,005 residential lots and 10,000m² of commercial floor space associated with the Shepherds Bay Development realising the potential buy up of all current commercial activities along Constitution Road. As a result, the model has adopted 1,230 vehicle trips generated by the zone under full development, marginally higher than the calculated data derived from the BTS projections. Therefore, it is considered that the model adequately addresses the growth in traffic associated with the Urban Renewal Project and encompases all planned future development within the zone.

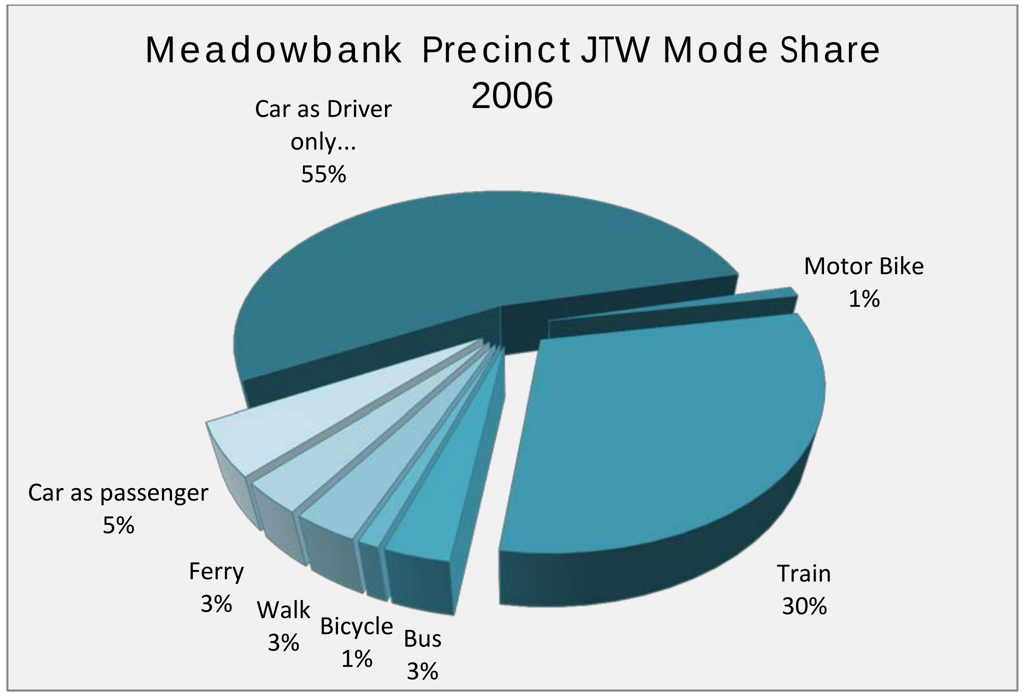
The Shepherds Bay Development model has adopted the mode share shown in *Figure 11*.

The current vehicle generation from the commercial activities within the zone is some 387 vehicle trips during the morning commuter peak one hour, as interpolated from the count data presented in *Figure 4* and the survey of some 40 current industrial premises. This generation rate is the direct result of the current industrial unit occupancy rate of only 59.2% within the zone. The potential generation of the industrial precinct could realise a further 40.8% or 267 vehicle trips with full occupation. This could potentially result in a total vehicle generation of 660vph from the industrial precinct. This theoretical number has been calculated to determine the growth.

Figure 9 depicts the JTW mode share exhibited within the Meadowbank Precinct, drawn from the Australian Bureau of Statistics (ABS) 2006 Community Profile of the Meadowbank Precinct.

The LGA mode share has been applied to commercial JTW entering the zone while the Meadowbank mode share has been applied to the residential workforce JTW leaving the zone.

Figure 9: Meadowbank JTW Mode Share – Journey by Single Mode



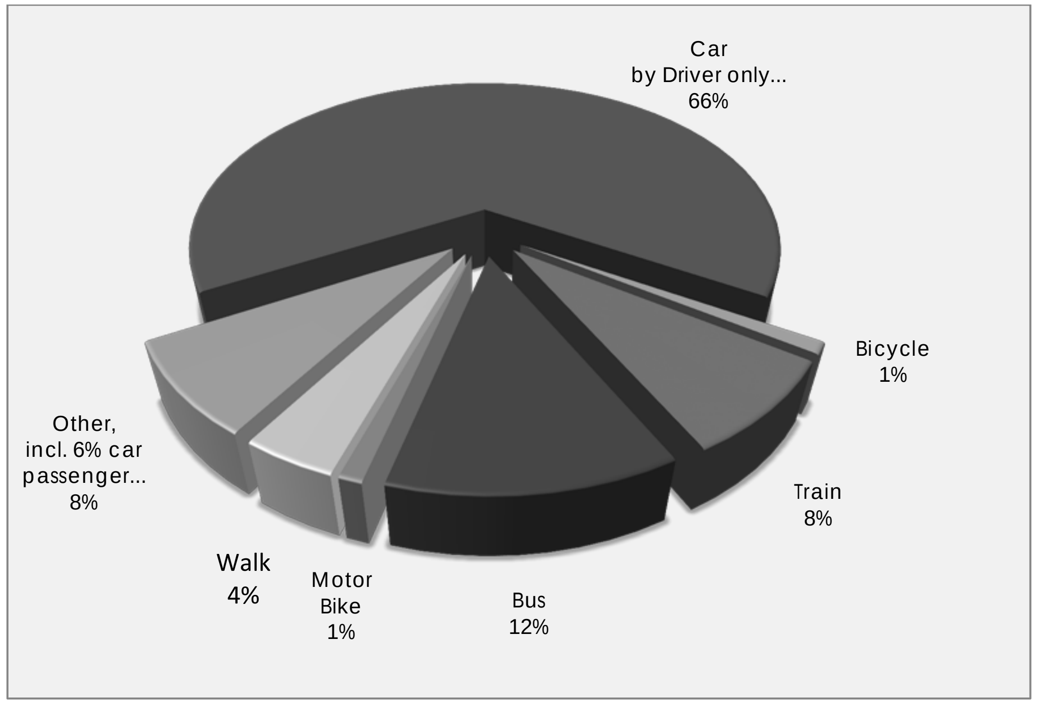
Source: 2006 ABS Census data – 'Suburban Community Profile- Meadowbank

It should be noted that the zone locations within Shepherd's Bay Precinct have been selected to coincide with areas of homogenous land use and planned residential parking provisions, broadly based on the intended residential, retail and commercial activities.

The 2006 census data indicates that the overall mode split for the Meadowbank Precinct is 55% car driver only, in the context of a single mode journey.

Figure 10 presents a comparison of transport modes for JTW trips within the Ryde LGA, as adopted in the trip matrices for JTW trips inbound to Zone 2522 while the Meadowbank profile has been adopted for JTW trips emanating from Zone 2522.

Figure 10: Ryde LGA JTW Mode Share – Journey by Single Mode



Source: 2006 ABS Census data – 'Community Profile- Ryde LGA

The high percentage of car drivers and passangers, is likely a result of one or a combination of any or all the following reasons...

- *Inability or perception that public transport fails to meet community needs,*
- *Lack of direct public transport services to employment centres,*
- *Inadequate frequency of public transport,*
- *Inadequate inter regional services,*
- *Congestion on major roads accommodating bus services,*
- *Poor modal interchange,*
- *The peception that private vehicle travel is more convenient,*
- *Access by motor vehicles to regional employment centres, is comparatively more convenient, and/or*
- *A significantly high proportion of self employed and/or tradesmen are car dependent for business.*

MODE SHIFT

The future traffic generation rates for Zone 2522, and more specifically, the Shepherds Bay Development, have been factored to reflect a 10% modal shift away from private motor vehicle usage, in juxtaposition with the close proximity to Meadowbank Railway Station, the significant bus corridors along Church Street and Victoria Road, Ferry provisions on Parramatta River, improved pedestrian amenity, revitalised urban cohesion between transport modes and increased focus on the differing community priorities.

The future 10% mode shift to public transport from private vehicle usage has been based on the potential increase in train service(s) on the Northern Line through Meadowbank and modest increases in bus patronage and bicycle usage.

The current occupancy rate on trains stopping at Meadowbank is some 48% which is considered an 'all stops' service rather than express. Currently, only one train service in 4 stops at Meadowbank Railway Station. Should one additional, 6 carriage express service stop at Meadowbank Station, potentially an additional 460 passengers could be support from the precinct.

In addition, the current ferry service in the morning, stopping at Meadowbank wharf, has spare capacity of some 20 -30 passengers.

It has been observed that bus services on Victoria Road and Church Street have capacity, in the vicinity of the Meadowbank Precinct, for a further 25 and 30 patrons during the morning one hour peak, respectively.

This potential capacity, without significant consideration to increases in frequency and rolling stock, can see public transport modes accommodate some additional 545 JTW trips.

With a projected workforce of 2,552 persons in year 2026, excluding the current percentage of dual mode JTW, work from home, non working, etc…, the adopted mode share for the resultant 2,300 workers is shown in *Figure 11*.

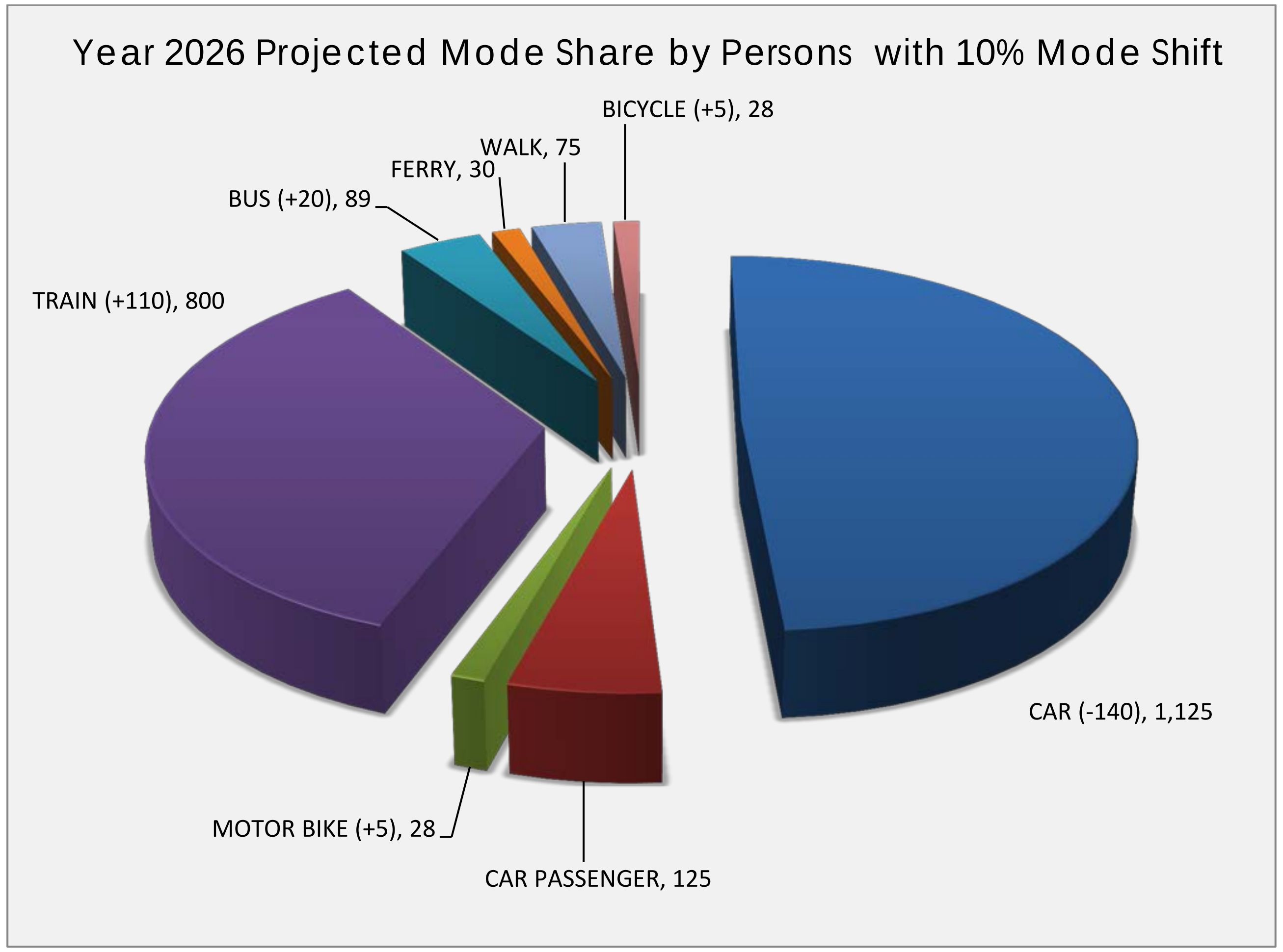
In line with NSW 2021 targets, growth in public transport trips was higher than growth in passenger vehicle trips. Vehicle driver trips increased by 1.5%, while train and bus trips increased by 2.6% and 2.3%, respectively. These inherent increases can be attributed to increased frequency and improve intermodal provisions. This trend has been employed in the future model projections.

Bus services were considered and given the transformation of the precinct within BTS zone from commercial/industrial to residential it will fall on the bus operators to provide bus services to within 400m of the new development.

The mode shift of 10% was considered modest given the public transport provisions within the precinct. Realistically, a mode shift of some 14-15% is possible but no firm commitment can be given by State Rail or STA that an increase in rolling stock or services will eventuate as a result of the proposed development.

With the development growth along the Parramatta River, it is anticipated ferry services may increase by year 2026 and the potential mode share shown is considered achievable.

Figure 11: Adopted Mode Share Year 2026 – With 10% Mode Shift to Public Transport



The mode share has been determined from the total projected workforce of 2,552 less the current number published by the Australian Bureau of Statistics (ABS) for multi mode JTW trips, work at home, who did not work, were unemployed and/or were in between jobs at the time of the census.

Table 3: Modelled Land Use Projections and Vehicle Generation Table

		2010			2026		HOUSEHOLDS				EMPLOYEES				2026 AM		2026 PM	
Zone	Zone Identity	LGA	HHD	EMP	HHD	EMP	*Peak Vehicle Trips/HHD	10% Mode Shift Due to Transport Initiatives	Trips from Zone Morning Peak	Trips from Zone Evening Peak	Vehicle Trips per Employee	10% Mode Shift Due to Transport Initiatives	Trips from Zone Morning Peak	Trips from Zone Evening Peak	Trips from Zone Morning Peak	Trips to Zone Morning Peak	Trips from Zone Evening Peak	Trips to Zone Evening Peak
476	Marsfield	Ryde	4,868	1,895	5,061	1,557	0.65	0.000	0.80	0.20	0.66	0.000	0.15	0.85	2,786	1,532	1,532	2,786
477	East Ryde	Ryde	2,084	6,848	2,250	7,991	0.65	0.000	0.80	0.20	0.66	0.000	0.15	0.85	1,961	4,775	4,775	1,961
478	South Ryde	Ryde	2,276	678	2,429	565	0.65	0.000	0.80	0.20	0.66	0.000	0.15	0.85	1,319	633	633	1,319
479	North Ryde	Ryde	3,388	1,253	3,530	1,078	0.65	0.000	0.80	0.20	0.66	0.000	0.15	0.85	1,942	1,063	1,063	1,942
480	Eastwood	Ryde	3,509	2,118	3,609	1,902	0.65	0.000	0.80	0.20	0.66	0.000	0.15	0.85	2,065	1,536	1,536	2,065
481	Denistone	Ryde	2,878	1,941	2,942	1,626	0.65	0.000	0.80	0.20	0.66	0.000	0.15	0.85	1,691	1,295	1,295	1,691
482	Eastwood West	Ryde	1,540	1,948	1,806	1,667	0.65	0.000	0.80	0.20	0.66	0.000	0.15	0.85	1,104	1,170	1,170	1,104
483	Denistone West	Ryde	2,185	1,161	2,334	992	0.65	0.000	0.80	0.20	0.66	0.000	0.15	0.85	1,312	860	860	1,312
484	Meadowbank	Ryde	3,201	764	3,748	633	0.65	0.066	0.80	0.20	0.66	0.066	0.15	0.85	1,879	787	787	1,879
#2522 638	Shepherds Bay	Ryde		171	1,000		0.32	0.066	0.80	0.20	0.66	0.066	0.15	0.85	239	60	60	239
#2522 639	Shepherds Bay	Ryde		38	1,000		0.32	0.066	0.80	0.20	0.66	0.066	0.15	0.85	239	60	60	239
#2522 652	Shepherds Bay	Ryde	342		350		0.32	0.066	0.80	0.20	0.66	0.066	0.15	0.85	84	21	21	84
#2522 657	Shepherds Bay	Ryde			350		0.32	0.066	0.80	0.20	0.66	0.066	0.15	0.85	84	21	21	84
#2522 658	Shepherds Bay	Ryde			305		0.32	0.066	0.80	0.20	0.66	0.066	0.15	0.85	73	18	18	73
#2522 640	Shepherds Bay Commercial	Ryde				310	0.30	0.066	0.80	0.20	0.66	0.066	0.15	0.85	31	174	31	174
641	Morrison Rd south Residual	Ryde		110	426	110	0.29	0.066	0.80	0.20	0.66	0.066	0.15	0.85	92	23	23	103
485	Ryde	Ryde	5,231	6,921	3,622	6,210	0.65	0.000	0.80	0.20	0.66	0.000	0.15	0.85	2,498	3,955	3,955	2,498
486	Tennyson	Ryde	4,010	3,504	4,179	2,967	0.65	0.000	0.80	0.20	0.66	0.000	0.15	0.85	2,467	2,208	2,208	2,467
487	Gladesville	Ryde	1,853	2,791	1,954	2,245	0.65	0.000	0.80	0.20	0.66	0.000	0.15	0.85	1,239	1,514	1,514	1,239
784	Macquarie Park North	Ryde	2,523	28,110	2,641	33,161	0.65	0.000	0.80	0.20	0.66	0.000	0.15	0.85	4,656	18,946	18,946	4,656
785	Macquarie Park	Ryde	77	5,234	228	5,841	0.65	0.000	0.80	0.20	0.66	0.000	0.15	0.85	697	3,306	3,306	697
853	Macquarie University	Ryde	445	2,747	532	9,059	0.65	0.000	0.80	0.20	0.66	0.000	0.15	0.85	1,174	5,151	5,151	1,174

\# *Denotes Proposed Shepherds Bay Development Zone*

* *0.65 Trips per HHD is non density specific*

0.3 Trips per high density dwelling inclusive of residual single lot dwellings within the zone

Figure 12: Zone 2522 AM Peak JTW Vehicle Trip Distribution

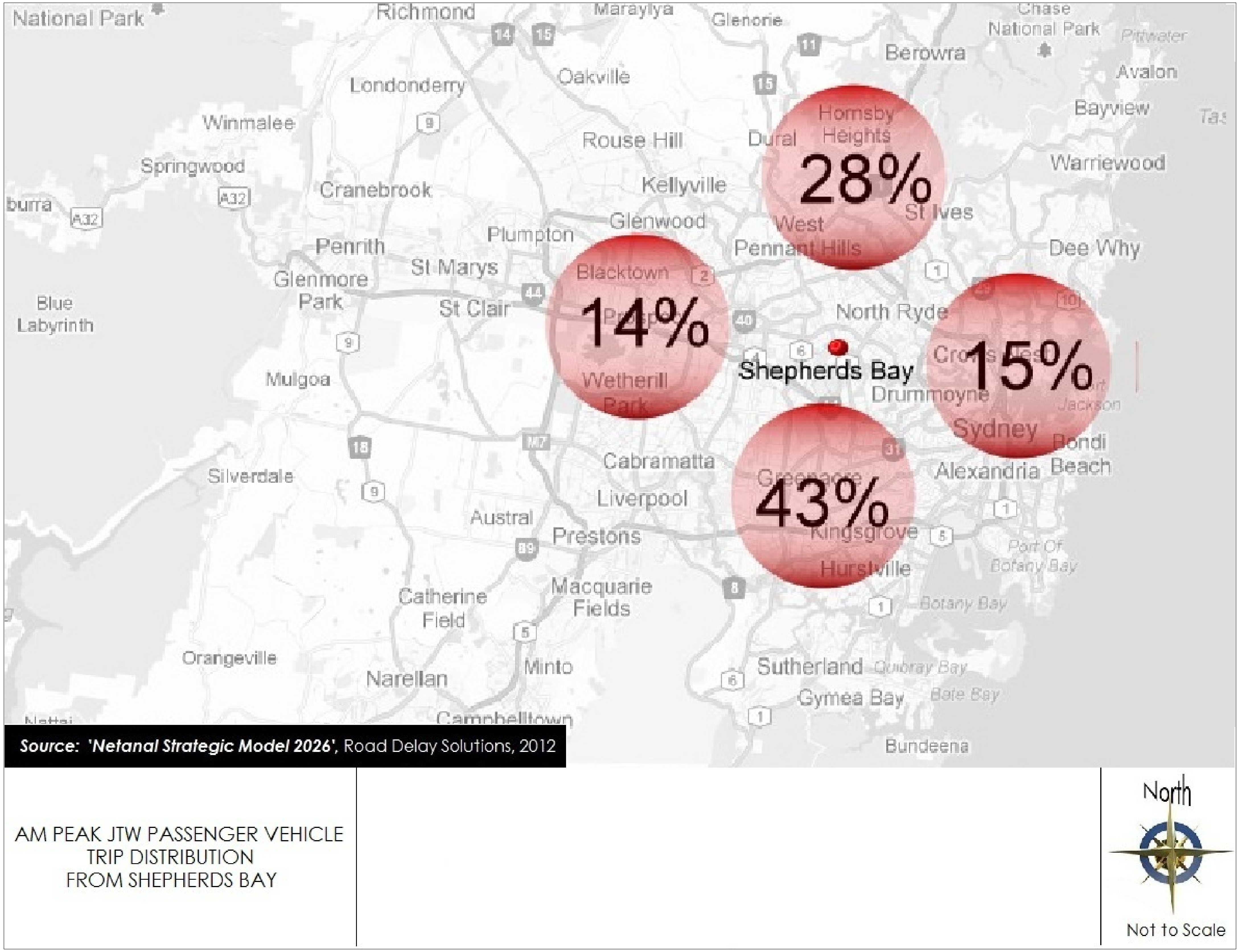


Figure 13: AM Peak Residential Distribution by Road Link from the Proposed Development

AM PEAK RESIDENTIAL
OUTBOUND TRIP DISTRIBUTION
SHEPHERDS BAY

The projected vehicles leaving the development during the morning commuter peak...

Constitution Road	14vph
Bank Street	59vph
See Street	76vph
Bowden Street	118vph
Belmore Street	372vph
Parsonage Street	60vph
Loop Road	91vph (generally outgoing commercial)

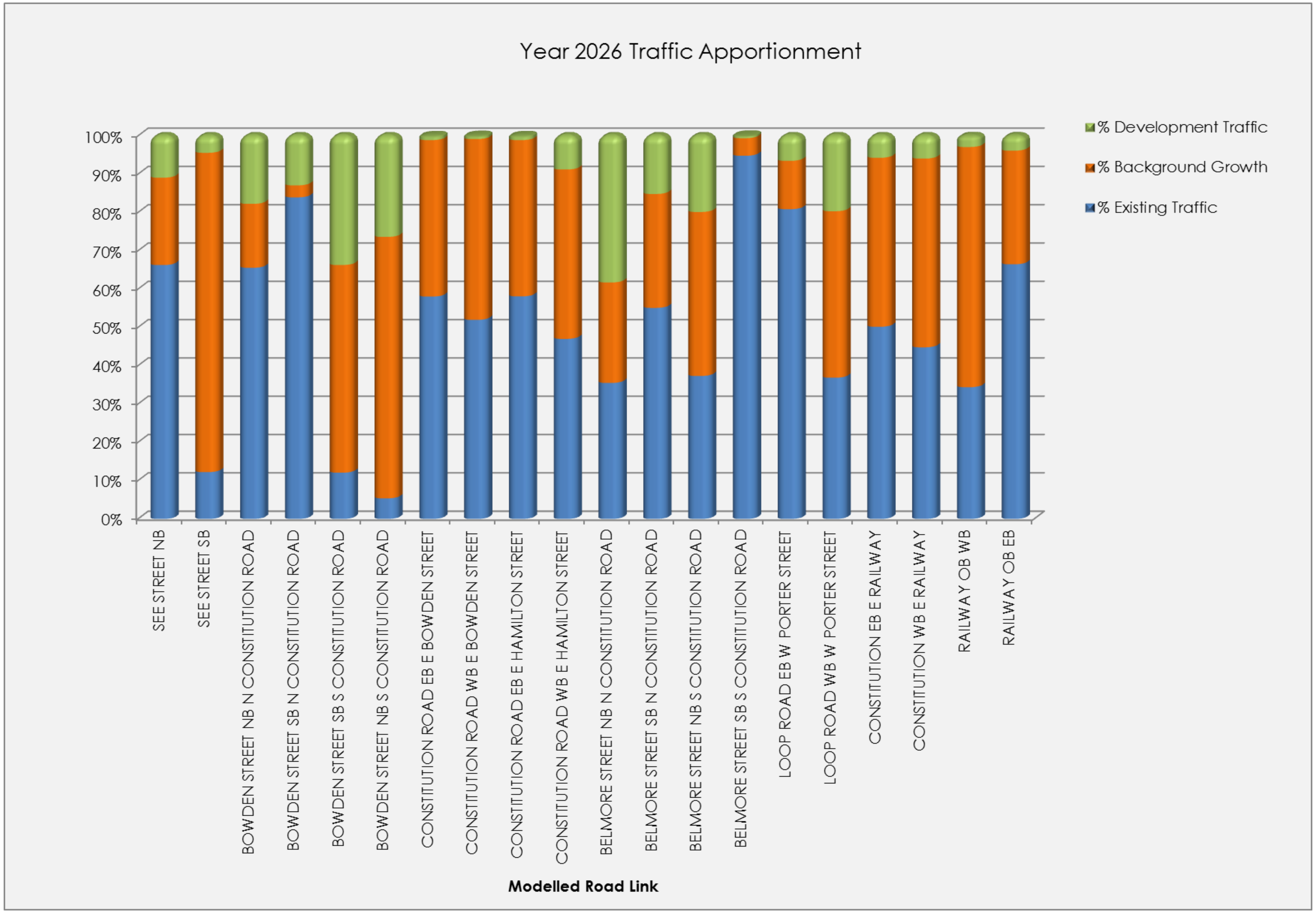
North

Not to Scale

Table 4: Year 2026 Traffic Apportionment

	Link	Total Existing Traffic (*excluding current industrial traffic*)	Projected 2026 Development Traffic	Total Traffic on Link	Background Traffic	% Existing Traffic	% Background Growth	% Development Traffic
1	SEE STREET NB	491	81	741	169	66%	23%	11%
2	SEE STREET SB	113	41	925	771	12%	83%	4%
3	BOWDEN STREET NB N CONSTITUTION ROAD	491	133	749	125	66%	17%	18%
4	BOWDEN STREET SB N CONSTITUTION ROAD	643	99	766	24	84%	3%	13%
5	BOWDEN STREET SB S CONSTITUTION ROAD	73	204	605	328	12%	54%	34%
6	BOWDEN STREET NB S CONSTITUTION ROAD	60	295	1118	763	5%	68%	26%
7	CONSTITUTION ROAD EB E BOWDEN STREET	1040	20	1792	732	58%	41%	1%
8	CONSTITUTION ROAD WB E BOWDEN STREET	1101	18	2119	1000	52%	47%	1%
9	CONSTITUTION ROAD EB E HAMILTON STREET	1041	20	1792	731	58%	41%	1%
10	CONSTITUTION ROAD WB E HAMILTON STREET	1101	206	2343	1036	47%	44%	9%
11	BELMORE STREET NB N CONSTITUTION ROAD	459	495	1293	339	35%	26%	38%
12	BELMORE STREET SB N CONSTITUTION ROAD	639	176	1160	345	55%	30%	15%
13	BELMORE STREET NB S CONSTITUTION ROAD	809	431	2168	928	37%	43%	20%
14	BELMORE STREET SB S CONSTITUTION ROAD	929	6	980	45	95%	5%	1%
15	LOOP ROAD EB W PORTER STREET	929	75	1149	145	81%	13%	7%
16	LOOP ROAD WB W PORTER STREET	809	432	2195	954	37%	43%	20%
17	CONSTITUTION EB E RAILWAY	971	111	1936	854	50%	44%	6%
18	CONSTITUTION WB E RAILWAY	1251	166	2793	1376	45%	49%	6%
19	RAILWAY OB WB	1025	87	2981	1869	34%	63%	3%
20	RAILWAY OB EB	1217	71	1831	543	66%	30%	4%

Figure 14: Year 2026 Traffic Apportionment at a Glance



5 RECOMMENDED INFRASTRUCTURE IMPROVEMENTS

The transport planning assessment for the Meadowbank Employment Area has considered the implications of future traffic demand under full urban renewal.

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 2026.

The encumbrance of this action would undoubtedly make the Constitution Road corridor prone to intrusion by through traffic originating outside the local precinct. It is for this reason that the road overbride between Railway Road and Banks Street and also the single lane roundabout at the intersection of Porter Street, Parsonage Street and Loop Road are recommended for retention, until such time as traffic growth triggers safety concerns, warranting further consideration at each site.

The recommended road network improvements are intended to reduce motor vehicle and pedestrian delays on the local road network, while endeavouring to create an acceptable level of amenity for the residential community.

The mid block formation guidelines, as outlined in Ryde Council's Draft DCP, 2011, have been considered and, with the transformation of the current industrial operations, should adequately manage the corresponding vehicle generations associated with the local urban release.

The modelling undertaken clearly indicates that by year 2026 the growth in cross regional traffic, within the precinct, will place considerable strain on local infrastructure and trigger the improvements recommended in *Table 5*.

Revised intersection modelling has been undertaken for the future year 2026 under full development of the Shepherds Bay Precinct. The models are based on the Urban Renewal Project yielding 3,005 residential lots, including the demands of 10,000m² of commercial floor space.

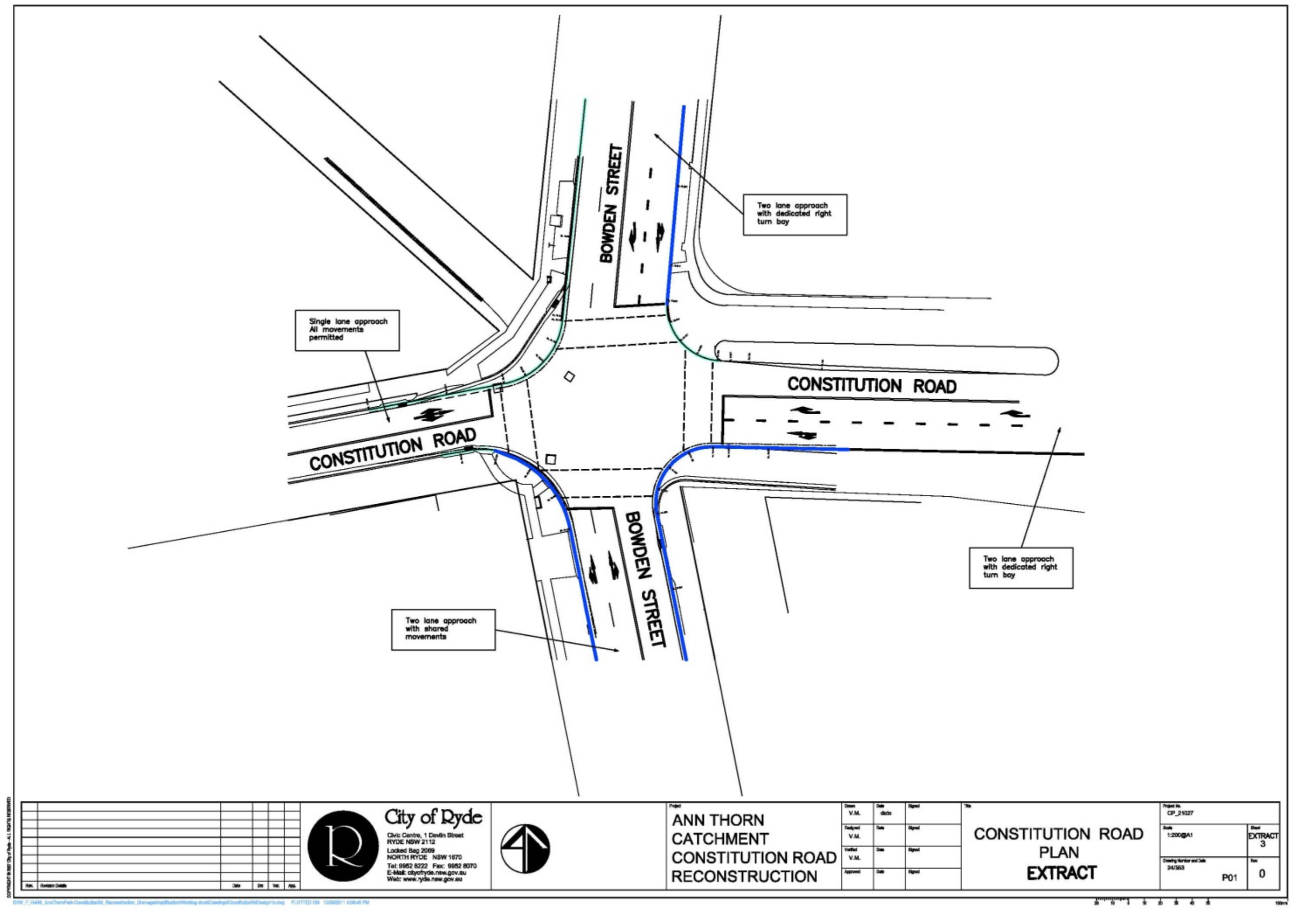
CONSTITUTION ROAD AND BOWDEN STREET

It is understood that the intersection has been identified by Council, under the 2005 works program as defined by Urban Horizon in July of 2010, to be reconstructed and operate under the control of traffic signals.

The road reserve in Constitution Road, west of Bowden Street, is some 15 metres wide, allowing for only single lane approach and departure within the confines of the current carriageway, as detailed in Council's DCP and as depicted in *Figure 15*.

It is considered that the formation width should be retained until such time as the background growth in cross regional traffic, pressures Council to consider road widening of the western leg. It is envisaged that the growth in intrusive traffic on Constitution Road will be dependent on the performance of the surrounding arterial road network.

Figure 15: Council Concept – Interim Traffic Signals (Extract)



Source: Ryde Council Concept – Extract from Constitution Road Plan

Widening of Constitution Road, west of Bowden Street, is considered necessary by year 2026 to ensure the efficient movement of vehicles to and from the western leg of the intersection with the projected growth in background traffic. A single lane is not seen as optimal to the operation of the traffic signals when the left turn and right turn from the eastbound approach are held up by pedestrian movements along Constitution Road. Refer also to the comments on the Bank Street overbridge, following.

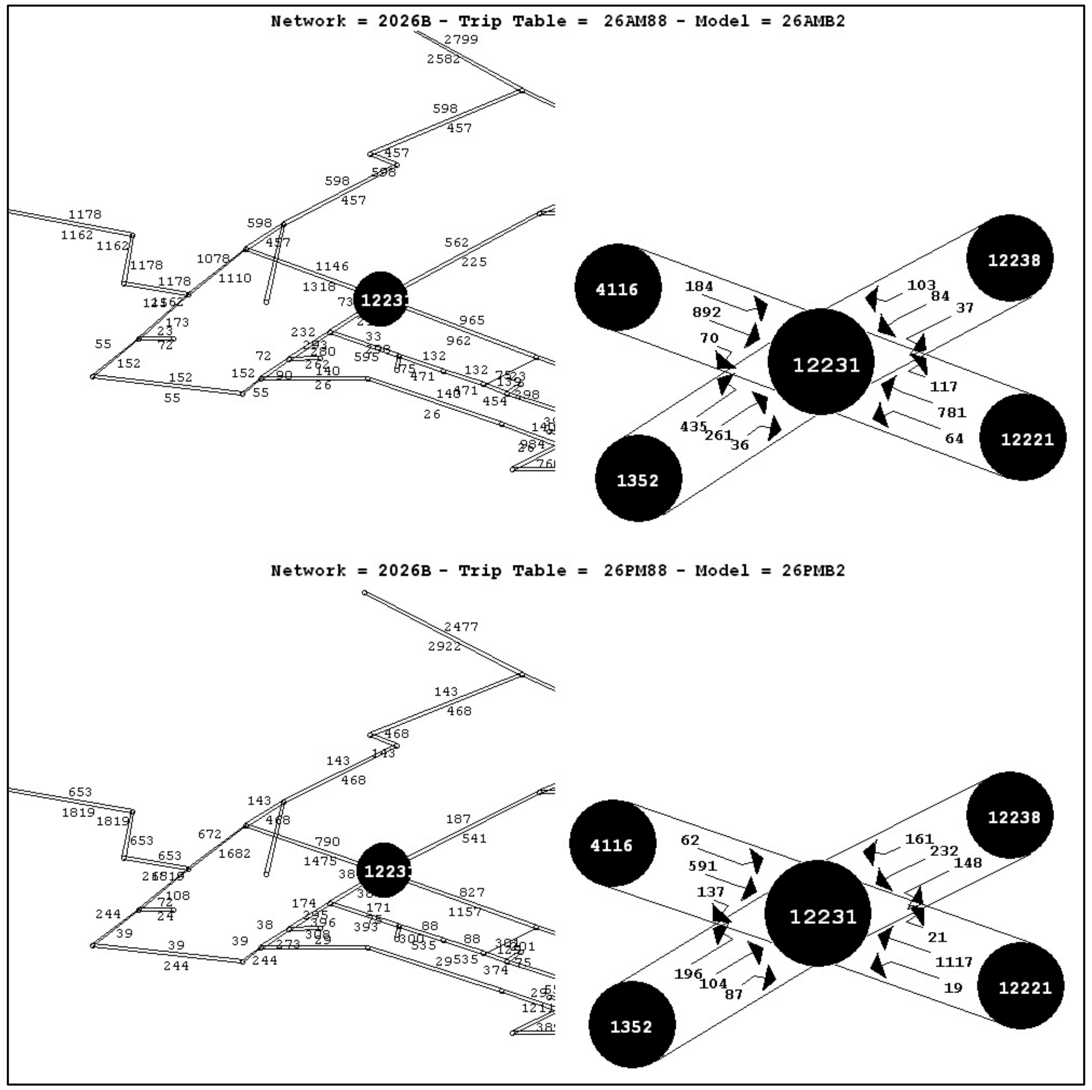
The DCP concept configuration, detailed by Council, will adequately function as an interim stage, prior to the year 2026 projected traffic volumes. However, consideration should be given to the potential to introduce turn bays in Constitution Road to allow the unimpeded through movement of vehicles.

The recommended layout is considered the 'final state', and will require acquisition by Council, should the RMS and Council accept the recommended lane configuration.

A minimum road reserve of 20m, for a distance of some 60m, is necessary in Constitution Road, west of Bowden Street, to accommodate the recommended layout and achieve a satisfactory LOS in 2026. The road reserve for this section is currently 15m, as detailed in Council's DCP.

The implementation of acquisition would be the responsibility of Council, through the gazettal of an accepted road boundary, with purchase costs apportioned to local development and the various proponents contributing to the composition of traffic along the corridor.

Figure 16: 2026 Projected Turn Volumes



HAMILTON CRESCENT

It is understood that the recommended transformation of Hamilton Crescent to one way, southbound, will be at Council's discretion. The current two way flow should be retaned until such time as the right turn movement from Constitution Road becomes excessive and filtering through the on-coming traffic poses an increased potential for vehicular conflict.

Numerous control method iterations were considered for the intersection of Constitution Road and Hamilton Crescent retaining the current two way movement and the future projected traffic volumes. Roundabout, sign priority and traffic signal control were all modelled resulting in differing satisfactory levels of service and vehicle queue lengths.

A projected right turn volume from Constitution Road into Hamilton Crescent in the evening peak of some 300vph is sufficiently high to eliminate the possibility of allowing the filtered right turn movement. In combination with a right turn movement from Hamilton Crescent into Constitution Road of some 200vph during the morning peak, sign control was eliminated from further consideration.

A roundabout was modelled, catering for all movements at the intersection, while retaining the two way movement in Hamilton Crescent, and resulted in a satisfactory level of service 'B' during each peak period. However, the Constitution Road, westbound approach, was found to generate a queue length of some 190m which posed safety concerns and might impact the traffic signal operation at the Belmore Street intersection. Acquisition and extensive utility adjustment would be required to introduce a two lane circulating roundabout at the site. Given the roundabout would be 'sandwiched' between two sets of traffic signals it was considered that roundabout control would be inappropriate for the site.

Traffic signals were also considered, retaining all movements at the intersection but a resultant queue length of some 260m in the westbound approach of Constitution Road was considered detrimental to the operation of the Belmore Street intersection and the control method was dismissed.

Access to the industrial operations on Nancarrow Avenue is currently available from both Hamilton Crescent and Nancarrow Avenue. Access to these properties, under the proposed one way operation, is to be retained. Access to the Hamilton Crescent driveway will be possible by left turn from Constitution Road while the current right turn will be relayed to the proposed Bowden Street signals and then left turn into Nancarrow Avenue.

Current industrial owners will undoubtedly appreciate that changes to the road network and its operation are inevitable with the urban renewal process and the transformation of Hamilton Crescent to one way southbound is not considered detrimental to access conditions associated with the existing properties.

ON-STREET PARKING

As the roads within the precinct are under the auspices of Ryde Council, it is intended to seek clarification of any recommended changes to on-street parking provisions.

On-street parking is a privilege, not a right and should conditions dictate, it is common practice to reduce the degree of on-street parking to afford improved operation of a local road network.

The recommended parking restrictions are intended during the peak, directional flow, periods only. Off peak parking may be retained.

It is considered that some 18 spaces will be lost in Belmore Street by year 2026. This will be a gradual loss, as the operation of traffic signals at the intersection of Constitution Road with Belmore Street demands additional capacity to facilitate queuing.

The removal of on-street parking will be at Council's discretion during the urban renewal process, should any identifiable delays cause a reduction in capacity or impact the traffic signal operation. Until such time, no reduction in on-street parking is envisaged.

BELMORE STREET AND NANCARROW AVENUE

One of two primary access points for the Shepherds Bay Development, the intersection has been modelled under the three primary methods of control, sign priority, roundabout and traffic signals.

It is identified that a queue back from Constitution Road at the intersection with the Belmore Street will exceed the distance between the two intersections. Rroundabout control returned a satisfactory level of service 'B' in both peaks but given the inherent costs associated with the necessary acquisition and utility adjustments, in juxtaposition to the queue back from Constitution Road, it was considered inappropriate.

Traffic signal operation would need to be linked with the Constitution Road traffic signals to alleviate the impacts of queuing in the northbound approach. It is considered that consultation with the RMS is necessary to pursue or eliminate a recommendation for traffic signals control at the intersection.

Finally, left in/left out operation would be seen as the optimum method of control with the right turns from Nancarrow Avenue and Belmore Street banned. This option was considered but was initially dismissed, given the inherent limitations on access for the Shepherds Bay residential community. The LILO option does however reduce the impacts of northbound queuing in Belmore Street and provide a satisfactory level of service.

PARSONAGE STREET, LOOP ROAD AND PORTER STREET

The current single lane roundabout at the site provides a potential constraint to the intrusion by cross regional traffic flow and is recommended for retention until such time as the volume of traffic in Porter Street and Well Street results in traffic queuing back to Church Street.

By 2026 under traffic signal control or a two lane circulating roundabout, volumes queuing in Porter Street qre reported as being some 140m. The models further report the existing single lane roundabout will produce queues in Porter Street exceeding 200m. Currently, 160m is available before the back of queue reaches onto Church Street. Therefore, when vehicle queues in Well Street become untenable, an alternative method of intersection control at the site will be required.

Access to the commercial operation on Well Street and Porter Street is proposed as left in/left out only.

NANCARROW AVENUE AND ROTHESAY AVENUE

Strict traffic calming and limitation measures should be considered during detailed design to minimise the intrusion by through traffic in both Nancarrow Avenue and Rothesay Avenue. Slow points will be critical along both corridors to deter traffic and maintain the local amenity once the road links are joined.

BANK STREET OVERBRIDGE

Modelling further suggests the single lane bridge over the railway line, between Railway Road and Bank Street, will be incapable of managing the projected background traffic in 2026. The bridge, as with the Porter Steet, Parsonage Street and Loop Road roundabout, are seen as the primary constraints to limiting the growth in cross regional traffic, with the roundabout on Railway Road reporting unsatisfactory LOS 'F' during the commuter peaks.

Table 5: Recommended Infrastructure Improvements under Restricted Precinct Access by 2026

No.	*Interim Development Stage	Recommended Infrastucture Upgrade
1	Stage 2	The widening of Constitution Road to 4 trafficable lanes during the commuter peaks
2	Stage 2/3	The construction of traffic signals at the intersection of Constitution Road and Bowden Street
3	Stage3	The installation of left in/left out only at the intersection of Belmore Street and Nancarrow Avenue
4	Stage 4	The installation of left in/left out only (banning of the right turn movement from Constitution Road) at the intersection of Constitution Road and Hamilton Crescent
5	Stage 5	The transformation of Hamilton Crescent to One Way movement southbound

*Note: *Interim Development Staging is subject to Council's works program.*

Table 6: Sidra Intersection Performance Chart

Results of Revised SIDRA Modelling				
	2010 Existing		2026 Full Development	
	AM	PM	AM	PM
1. Belmore Street and Junction Street				
DS	0.332	0.356	0.605	0.747
AVD *(sec)*	33.3	32.7	24.4	21.9
LOS	C	C	C	C
2. Porter Street and Loop Road and Parsonage Street				
DS	0.386	0.407	1.075	0.939
AVD *(sec)*	11.8	10.2	109.8	20.8
LOS	A	A	F	C
3. Belmore Street and Constitution Road				
DS	0.94	1	0.640	0.668
AVD *(sec)*	23.2	33.1	31.8	33.9
LOS	C	C	C	C
4. Constitution Road and Hamilton Crescent				
DS	0.371	0.355	-	-
AVD *(sec)*	8.6	6.7	-	-
LOS	A	A	-	-
5. Constitution Road and Bowden Street				
DS	0.667	0,658	0.865	0.883
AVD *(sec)*	11.1	9.7	36.8	39.6
LOS	A	A	D	D
6. Railway Road and Bank Street				
DS	0.576	0.604	1.424	2.202
AVD *(sec)*	7.6	9.2	100.2	>200
LOS	A	A	F	F
7. Belmore Street and Nancarrow Avenue				
DS	-	-	0.299	0.284
AVD *(sec)*	-	-	5	5
LOS	-	-	A	A
8. Bowden Street and Nancarrow Avenue				
DS	-	-	0.516	0.126
AVD *(sec)*	-	-	7.6	4.8
LOS	-	-	A	A
9. Bowden Street and Rothesay Avenue				
DS	-	-	0.170	0.258
AVD *(sec)*	-	-	5.1	5.3
LOS	-	-	A	A

FUNDING

By 2026 a significant proportion of the current, available, spare capacity on the Meadowbank road network will be consumed by background growth and intrusive through traffic. Even with the recommended and planned infrastructure upgrades the roads will quickly fill with non locally generated traffic.

With the exception of Belmore Street and Bowden Street, the proposed Shepherds Bay Urban Renewal project will have only a minor impact on the 'triggers' for infrastructure improvement.

The modelling clearly indicates, that were the current industrial operations to continue without the future urban renewal within the precinct, the growth in vehicular traffic on the major local corridors would remain high given...

- The anticipated growth and inherent congestion occurring on the arterial road system,
- The convenience and accessibility the precinct affords Meadowbank Railway Station and the Parramatta River Ferry wharf, and
- The significant bypass achievable between Victoria Road and Church Street.

The modelling of the road network was utilised to determine the necessary infrastructure requirements as they pertained to the Shepherds Bay Urban Renewal Development. The composition of future traffic, projected on the road network, was catagorised into three components...

1. Existing traffic, less the current industrial generation,
2. The background growth in traffic, excluding the Shepherds Bay Development generation, and
3. The proposed development traffic.

The proposed mechanism of funding remains the proportional contribution based on usage. The measure of usage is the proportion of traffic or passengers using the infrastructure link.

The calculation of funding should be based on the proportion of proposed development traffic (refer to *Table 4*) contributing to the recommended improvement. However, the development proportion, as presented, includes the burden of current industrial traffic.

Further modelling, in the form of a base Year 2026 model, is recommended to determine and quantify the necessary contributions to be made by the developer above the level of the current industrial traffic. Clarification is necessary to determine the composition of traffic on the road network should the proposed development not proceed.

The calculations undertaken in this report are intended as a theoretical starting point for further negotiation between the development proponent(s) and the relevant authorities.

APPENDIX A – 2010 CALIBRATED BASE PLOTS

Figure 17: 2010 Calibrated AM Peak Traffic Model Projections

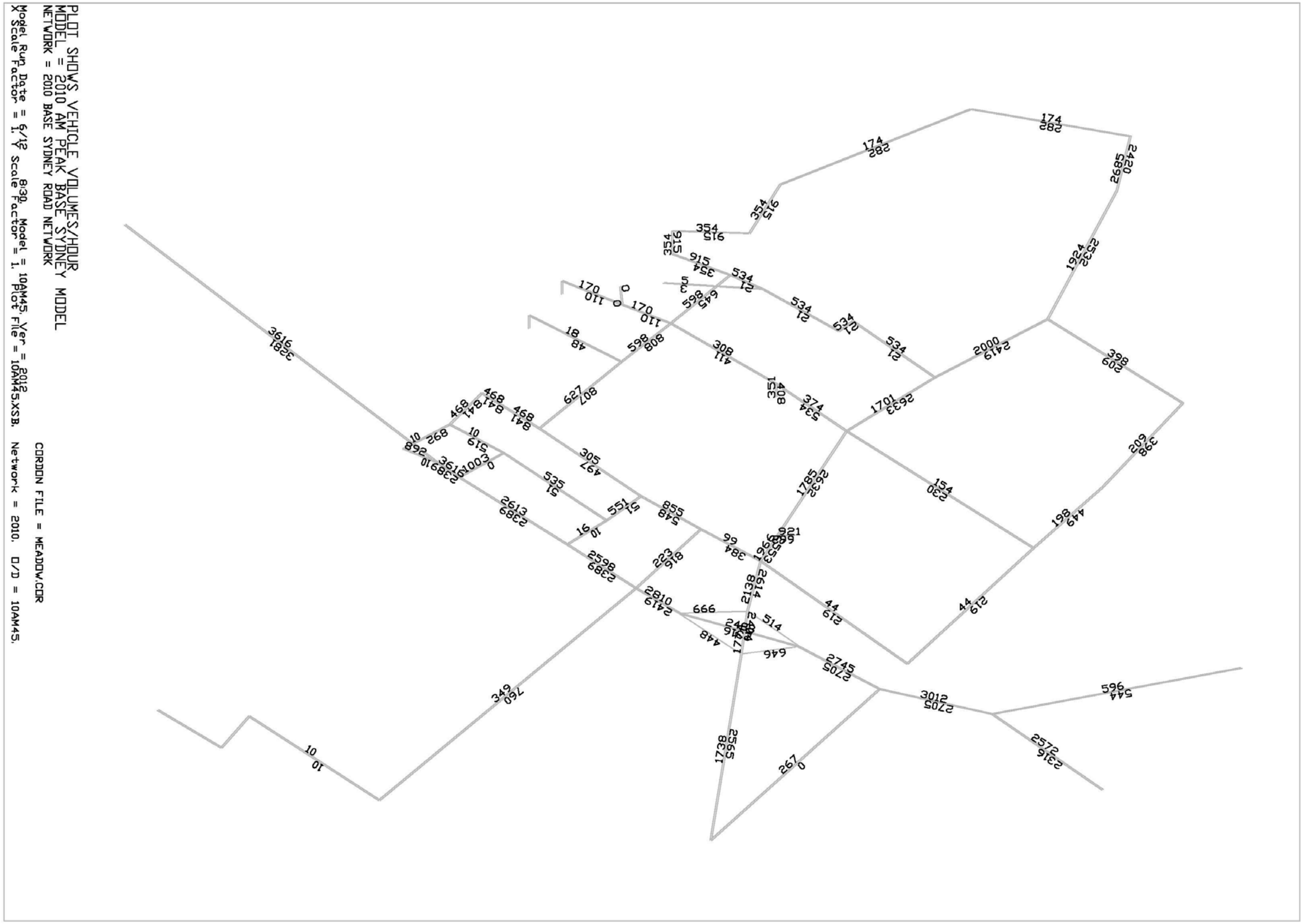


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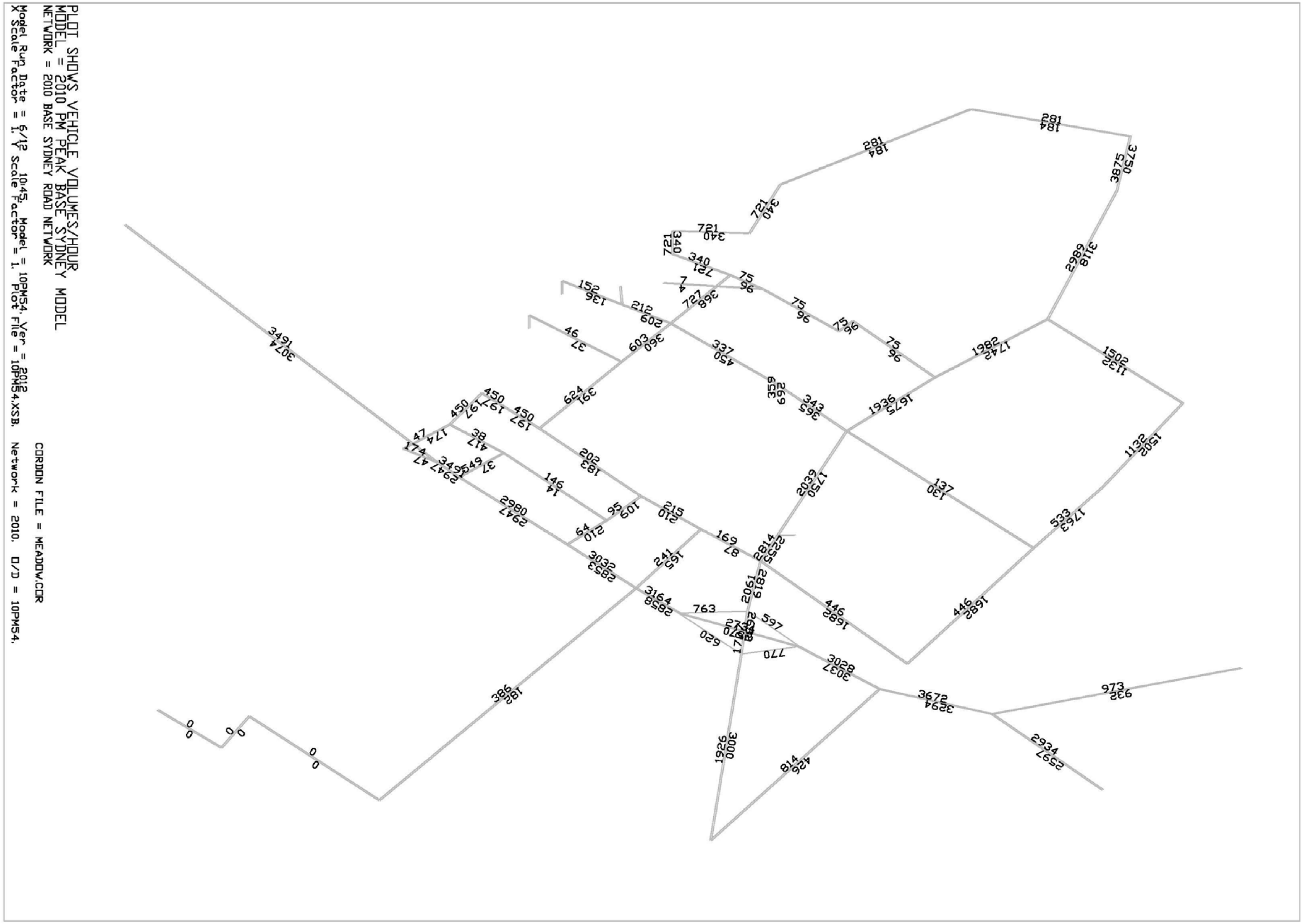
Figure 18: 2010 Calibrated PM Peak Traffic Model Projections



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APPENDIX B – 2026 PROJECTED TRAFFIC PLOTS

Figure 19: 2026 Projected AM Peak Traffic Model Projections

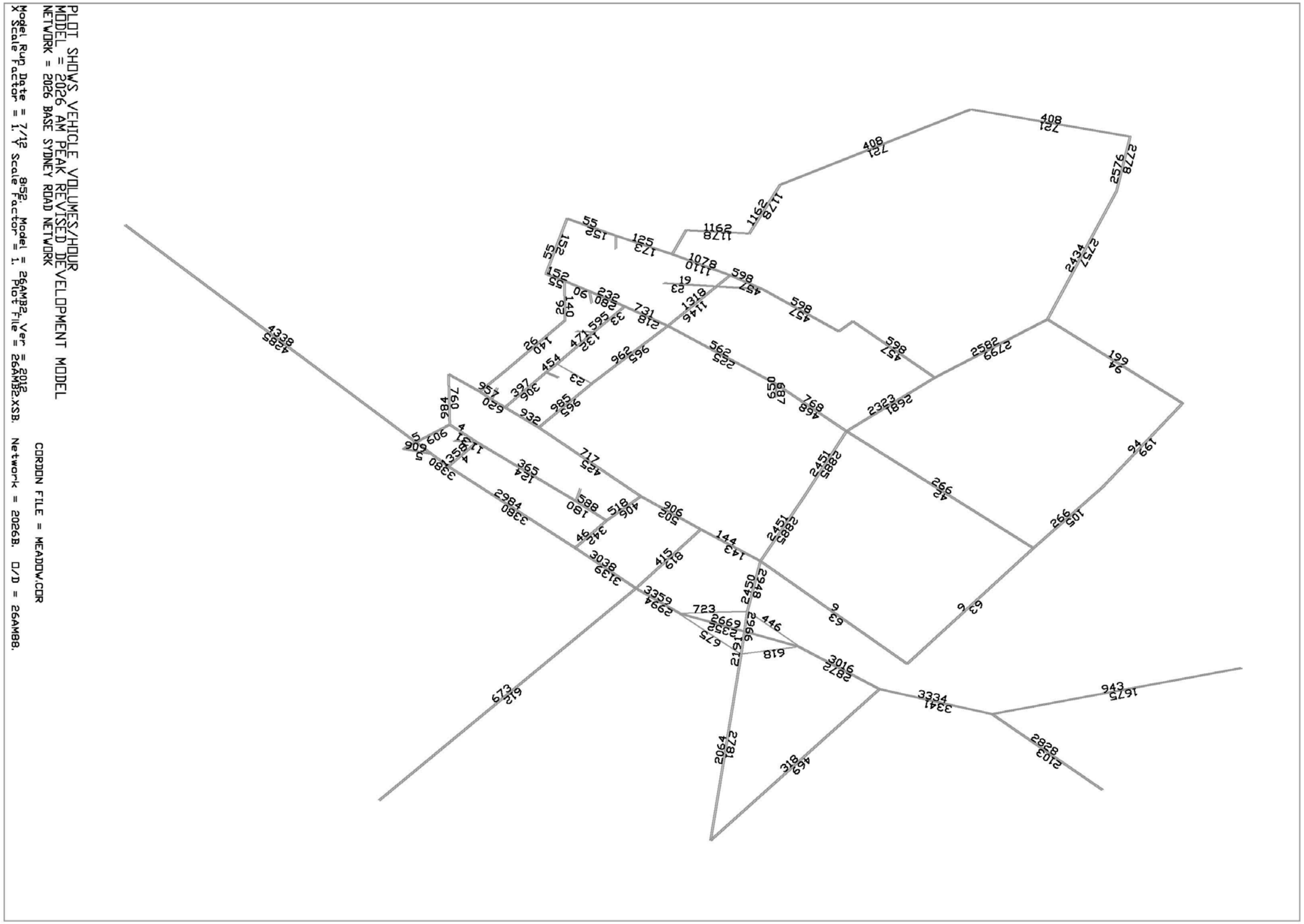

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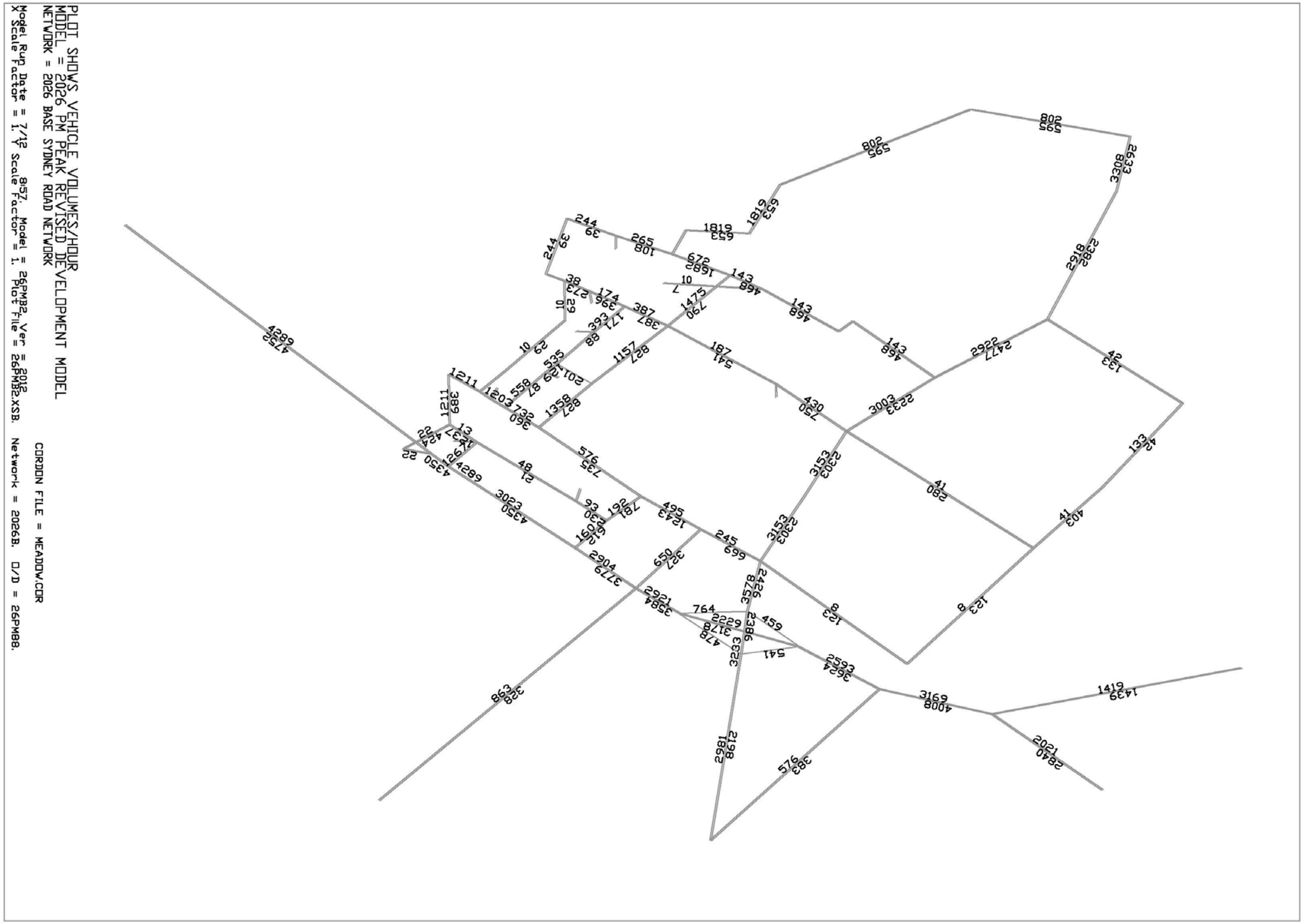
Figure 20: 2026 Projected PM Peak Traffic Model Projections



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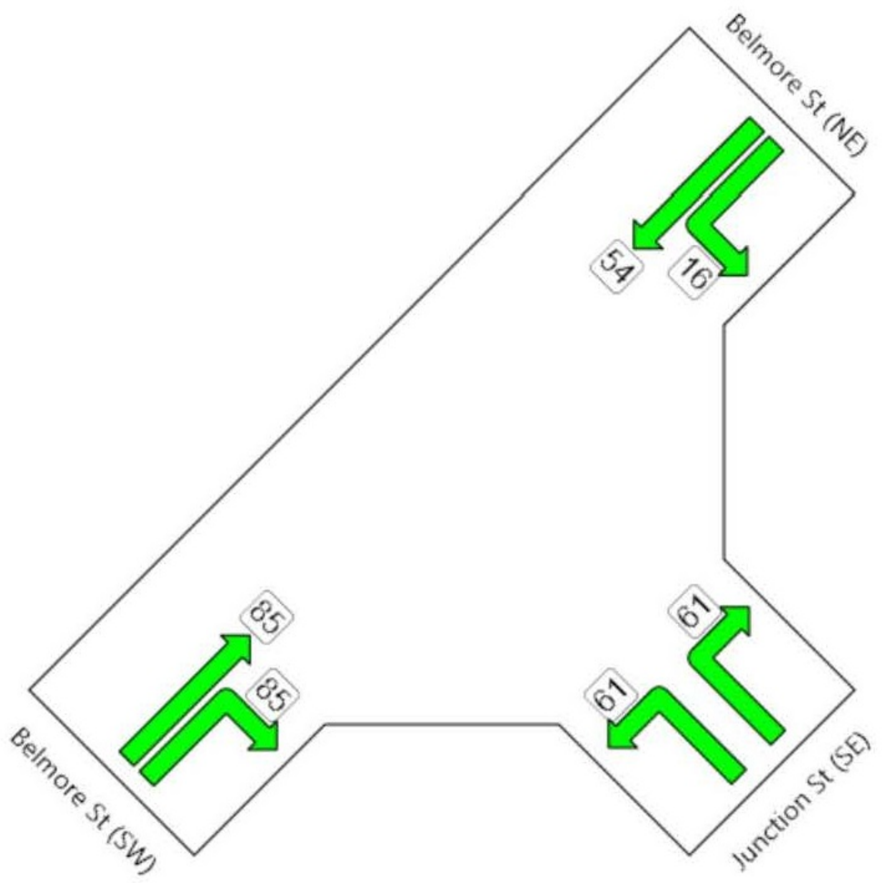
APPENDIX C – SIDRA INTERSECTION MODEL OUTPUTS

YEAR 2010 INTERSECTION QUEUE LENGTHS

Figure 21: Queues - Belmore Street and Junction Street 2010 AM Peak

QUEUE DISTANCE Site: Existing AM 2010
Largest 95% Back of Queue for any lane used by movement (metres)

Belmore St & Junction St
Signals - Fixed Time Cycle Time = 120 seconds (Optimum Cycle Time - Minimum Delay)



	Southeast	Northeast	Southwest	Intersection
Queue Distance	61	54	85	85

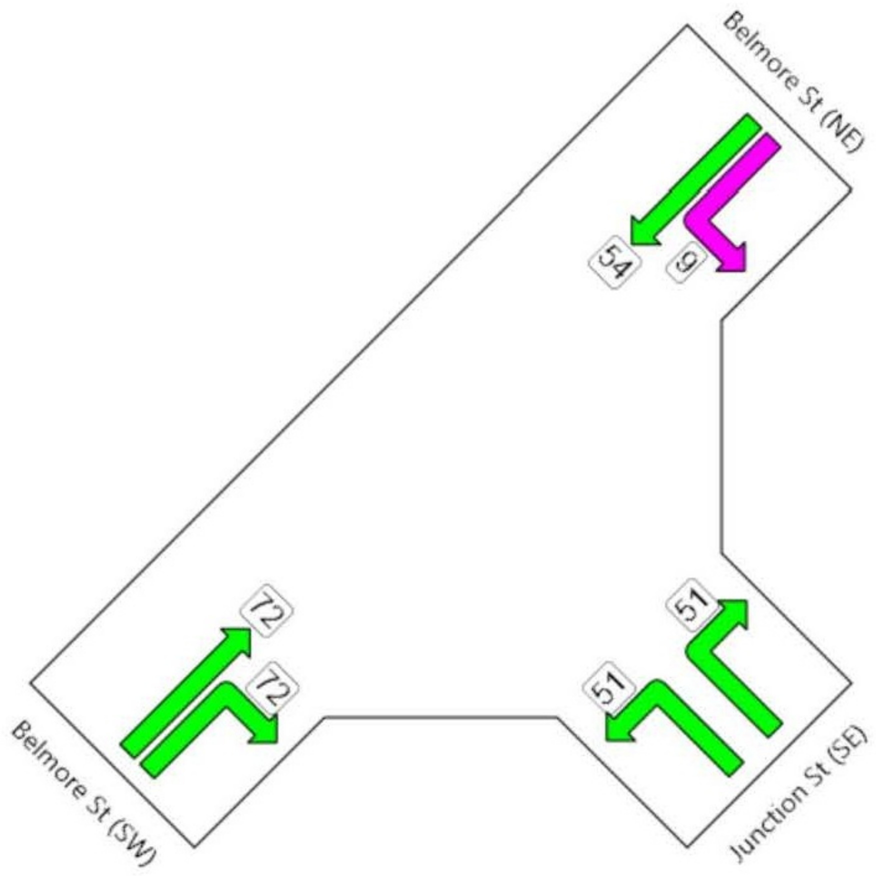
Colour code based on Queue Storage Ratio

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

Figure 22:Queues - Belmore Street and Junction Street 2010 PM Peak

QUEUE DISTANCE Site: Existing PM 2010
Largest 95% Back of Queue for any lane used by movement (metres)

Belmore St & Junction St
Signals - Fixed Time Cycle Time = 120 seconds (Optimum Cycle Time - Minimum Delay)



	Southeast	Northeast	Southwest	Intersection
Queue Distance	51	54	72	72

Colour code based on Queue Storage Ratio

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

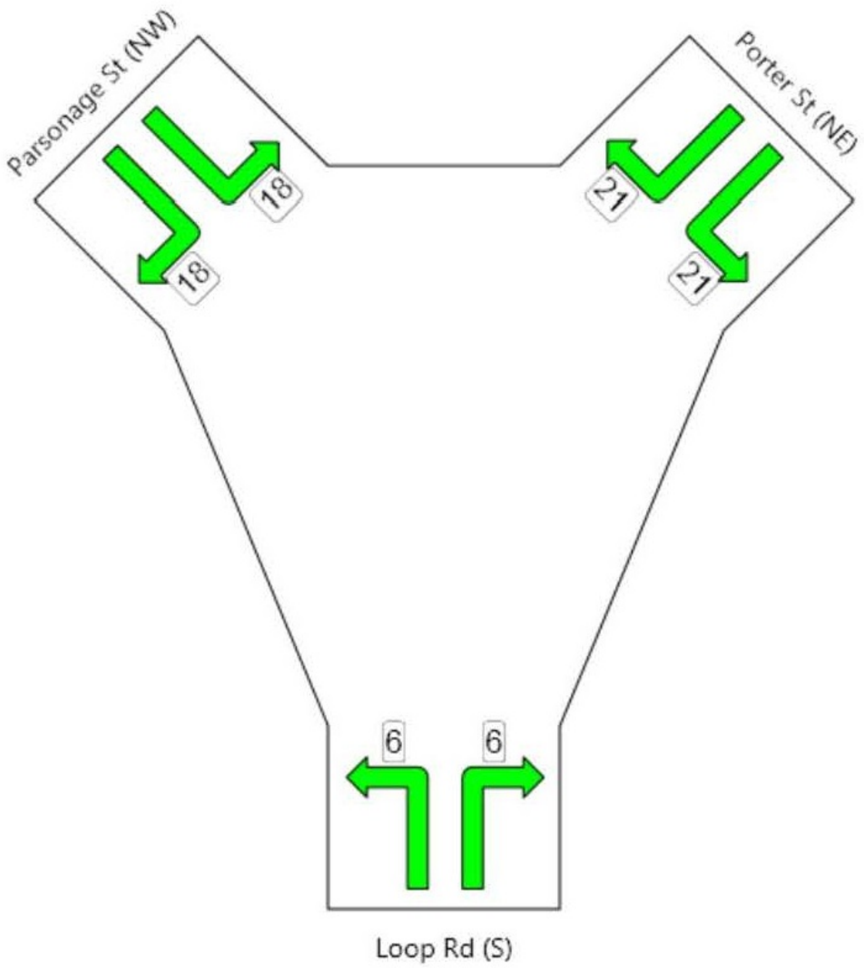
Figure 23: Queues - Porter Street and Loop Street and Parsonage Street 2010 AM Peak

QUEUE DISTANCE

Site: Existing AM 2010

Largest 95% Back of Queue for any lane used by movement (metres)

Porter St & Parsonage St
Roundabout



	South	Northeast	Northwest	Intersection
Queue Distance	6	21	18	21

Colour code based on Queue Storage Ratio

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

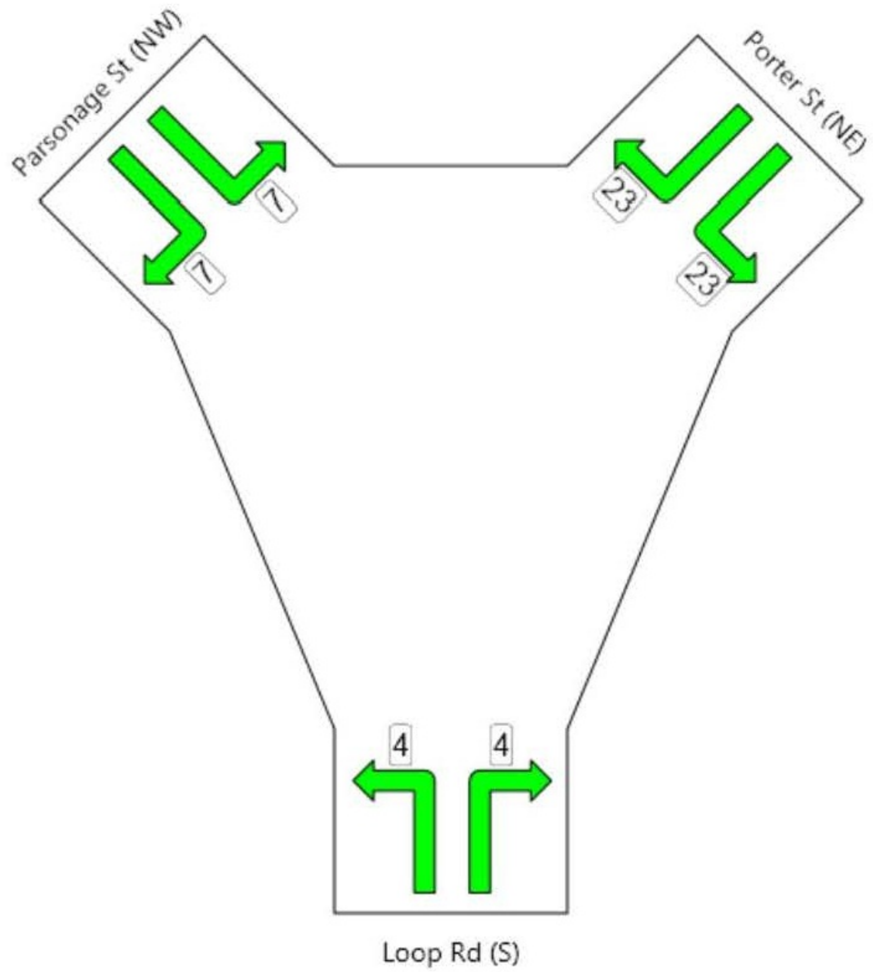
Figure 24: Queues - Porter Street and Loop Street and Parsonage Street 2010 PM Peak

QUEUE DISTANCE

Site: Existing PM 2010

Largest 95% Back of Queue for any lane used by movement (metres)

Porter St & Parsonage St
Roundabout



	South	Northeast	Northwest	Intersection
Queue Distance	4	23	7	23

Colour code based on Queue Storage Ratio

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

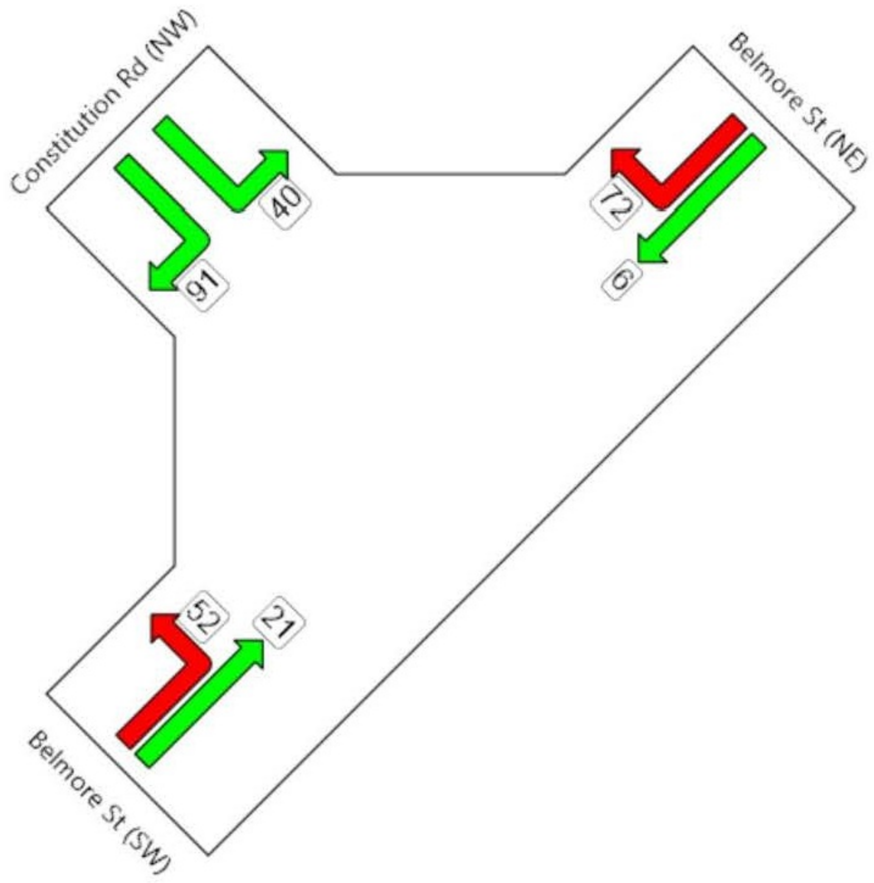
Figure 25: Queues - Belmore Street and Constitution Road 2010 AM Peak

QUEUE DISTANCE

Site: Existing AM 2010

Largest 95% Back of Queue for any lane used by movement (metres)

Belmore St & Constitution Rd
Signals - Fixed Time Cycle Time = 125 seconds (Optimum Cycle Time - Minimum Delay)



	Northeast	Northwest	Southwest	Intersection
Queue Distance	72	91	52	91

Colour code based on Queue Storage Ratio

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

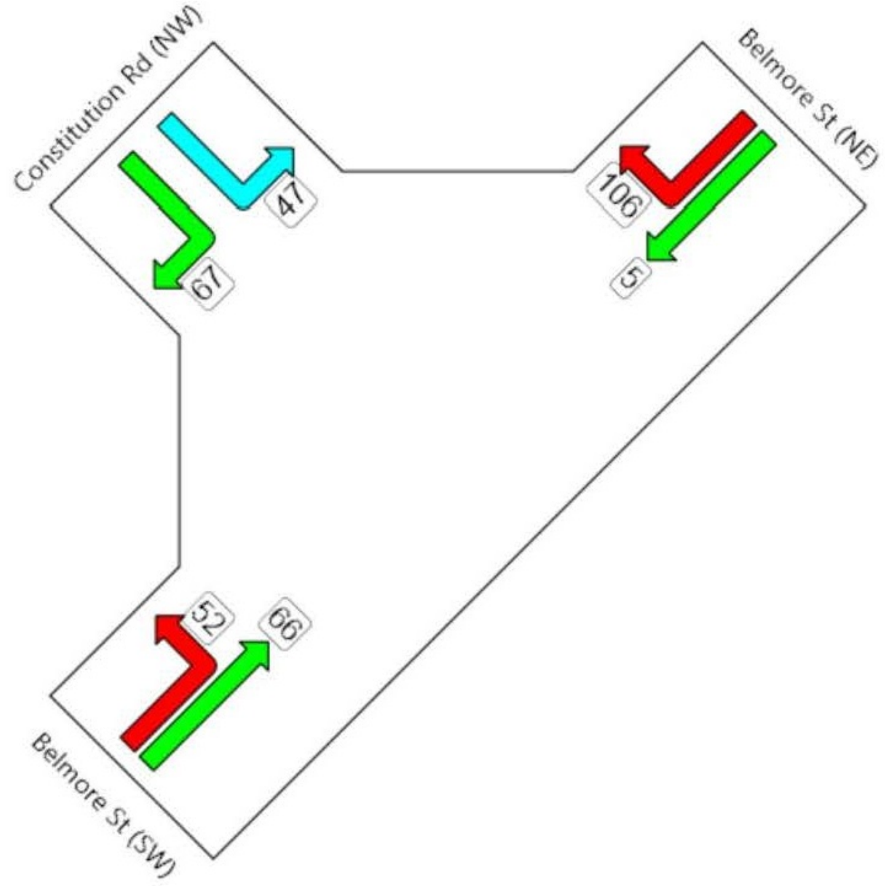
Figure 26: Queues - Belmore Street and Constitution Road 2010 PM Peak

QUEUE DISTANCE

Site: Existing PM 2010

Largest 95% Back of Queue for any lane used by movement (metres)

Belmore St & Constitution Rd
Signals - Fixed Time Cycle Time = 120 seconds (Optimum Cycle Time - Minimum Delay)



	Northeast	Northwest	Southwest	Intersection
Queue Distance	106	67	66	106

Colour code based on Queue Storage Ratio

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

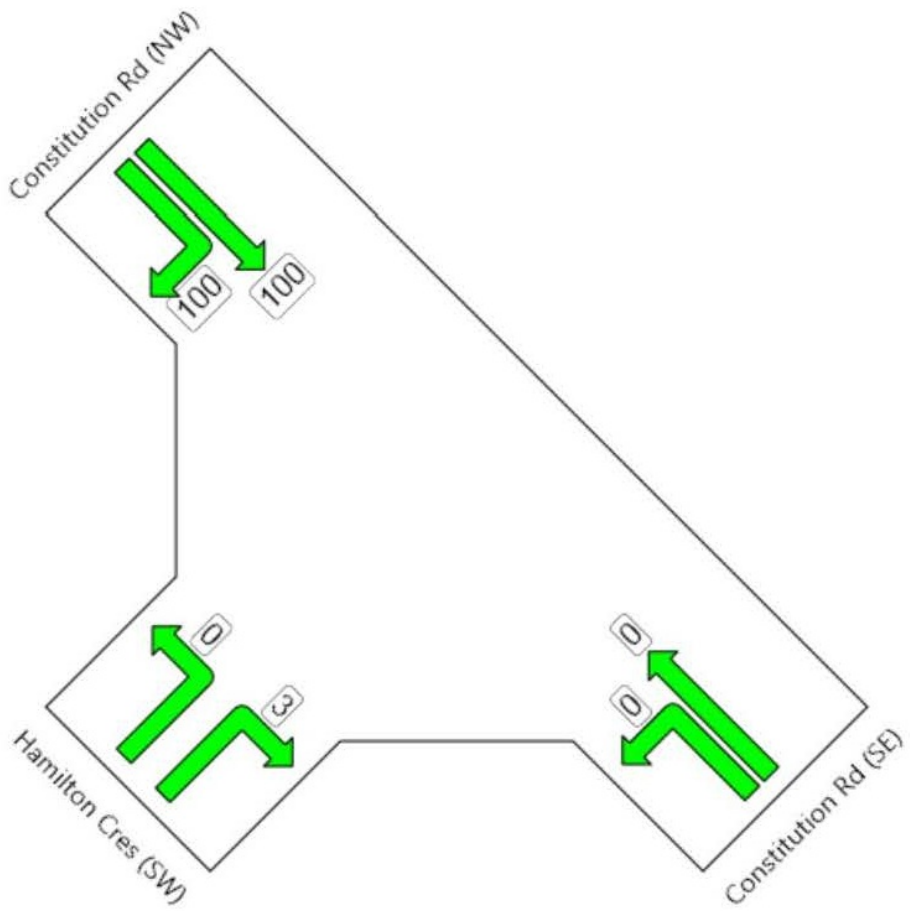
Figure 27: Queues - Constitution Road and Hamilton Crescent 2010 AM Peak

QUEUE DISTANCE

Largest 95% Back of Queue for any lane used by movement (metres)

Site: Existing AM 2010

Constitution Rd & Hamilton Cres
Giveway / Yield (Two-Way)



	Southeast	Northwest	Southwest	Intersection
Queue Distance	0	100	3	100

Colour code based on Queue Storage Ratio

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

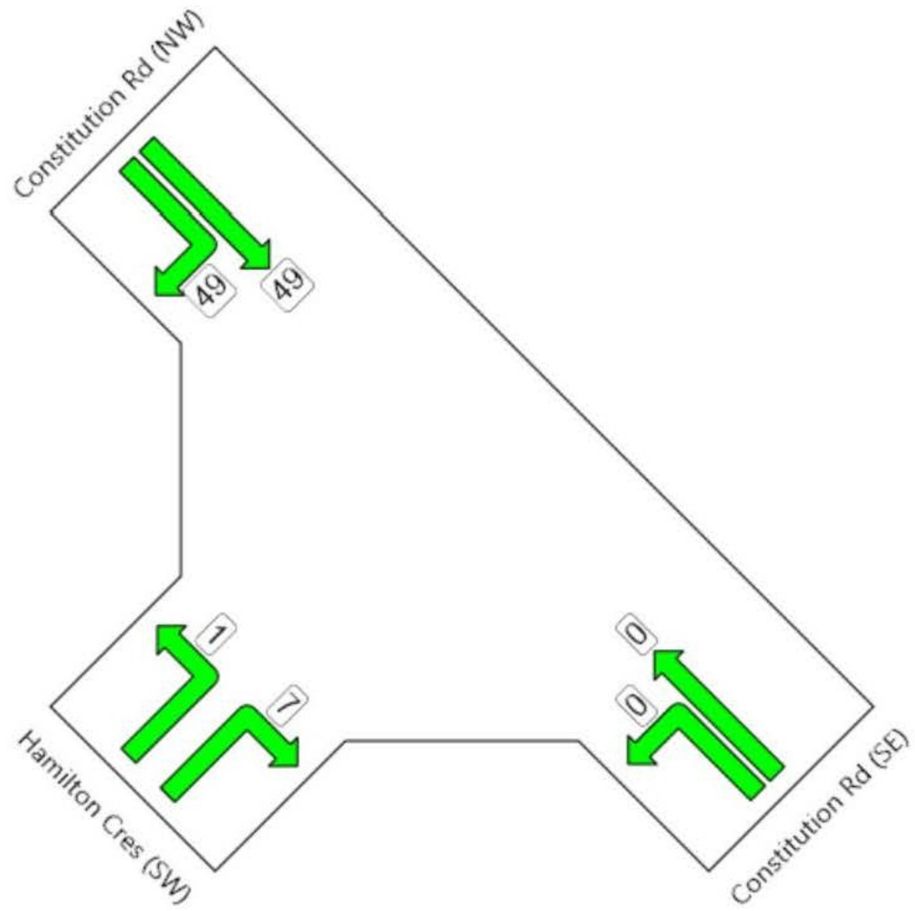
Figure 28: Queues - Constitution Road and Hamilton Crescent 2010 AM Peak

QUEUE DISTANCE

Largest 95% Back of Queue for any lane used by movement (metres)

Site: Existing PM 2010

Constitution Rd & Hamilton Cres
Giveway / Yield (Two-Way)



	Southeast	Northwest	Southwest	Intersection
Queue Distance	0	49	7	49

Colour code based on Queue Storage Ratio

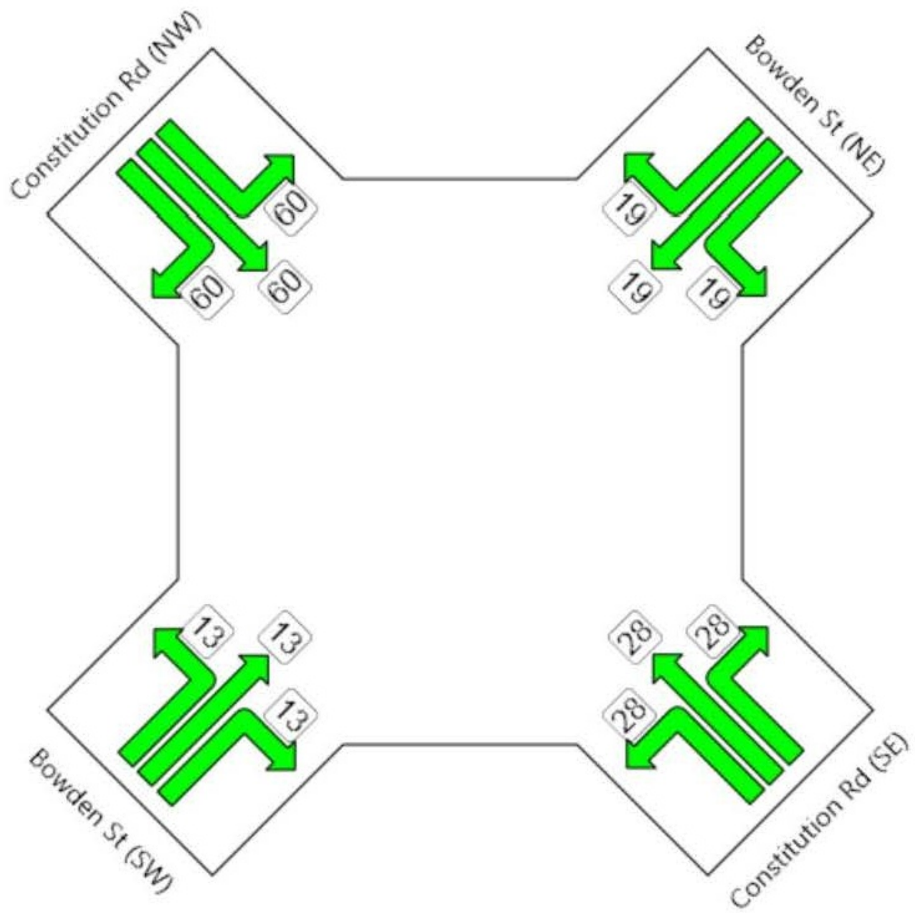
[< 0.6] [0.6 – 0.7] [0.7 – 0.8] [0.8 – 0.9] [0.9 – 1.0] [> 1.0] Continuous

Figure 29: Queues - Constitution Road and Bowden Street 2010 AM Peak

QUEUE DISTANCE Site: Existing AM 2010

Largest 95% Back of Queue for any lane used by movement (metres)

Constitution Rd & Bowden St
Roundabout



	Southeast	Northeast	Northwest	Southwest	Intersection
Queue Distance	28	19	60	13	60

Colour code based on Queue Storage Ratio

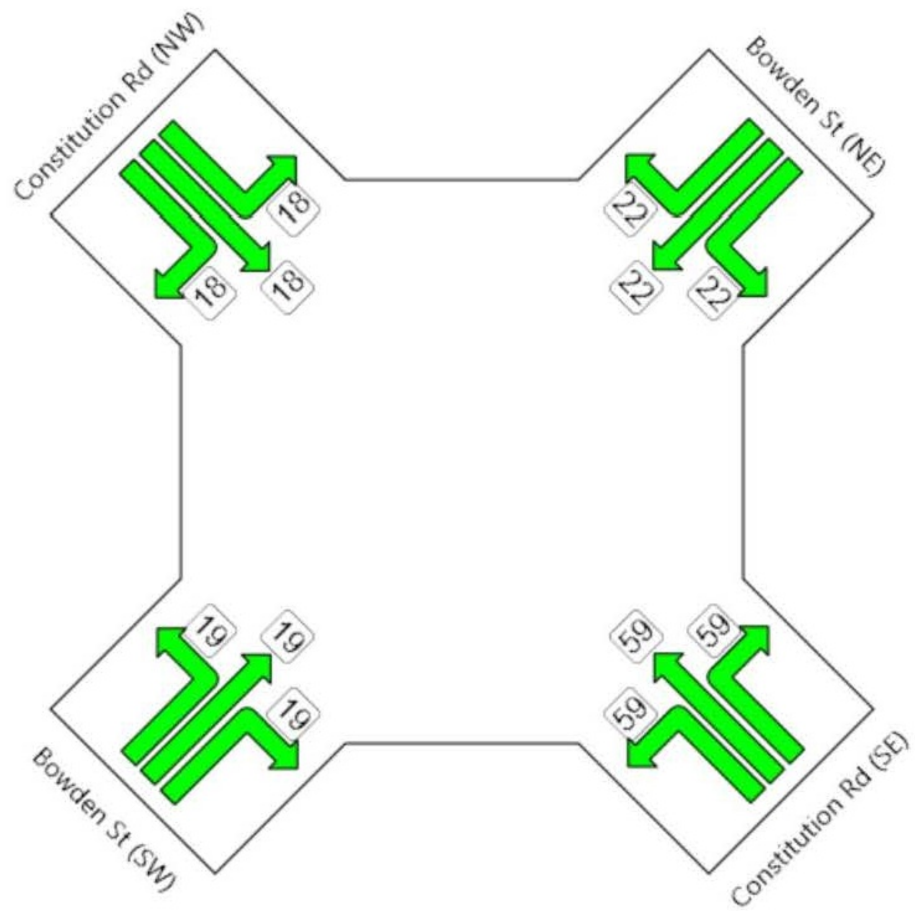
[< 0.6] [0.6 – 0.7] [0.7 – 0.8] [0.8 – 0.9] [0.9 – 1.0] [> 1.0] Continuous

Figure 30: Queues - Constitution Road and Bowden Street 2010 PM Peak

QUEUE DISTANCE Site: Existing PM 2010

Largest 95% Back of Queue for any lane used by movement (metres)

Constitution Rd & Bowden St
Roundabout



	Southeast	Northeast	Northwest	Southwest	Intersection
Queue Distance	59	22	18	19	59

Colour code based on Queue Storage Ratio

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

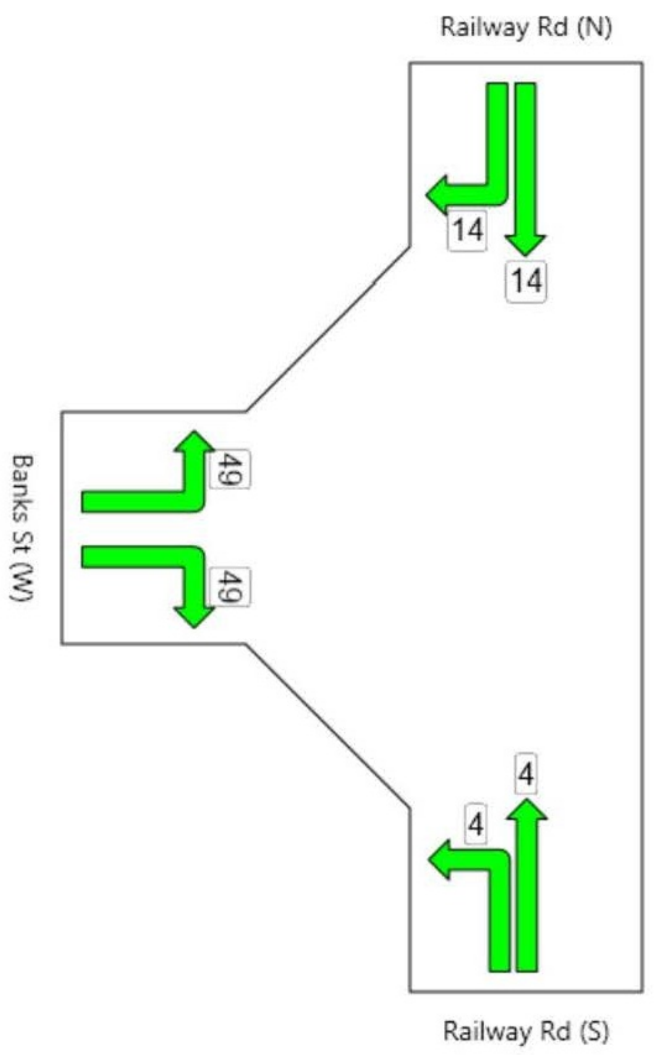
Figure 31: Queues - Railway Road and Bank Street 2010 AM Peak

QUEUE DISTANCE

Largest 95% Back of Queue for any lane used by movement (metres)

Site: Existing AM 2010

Railway Rd & Banks St
Roundabout



	South	North	West	Intersection
Queue Distance	4	14	49	49

Colour code based on Queue Storage Ratio

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

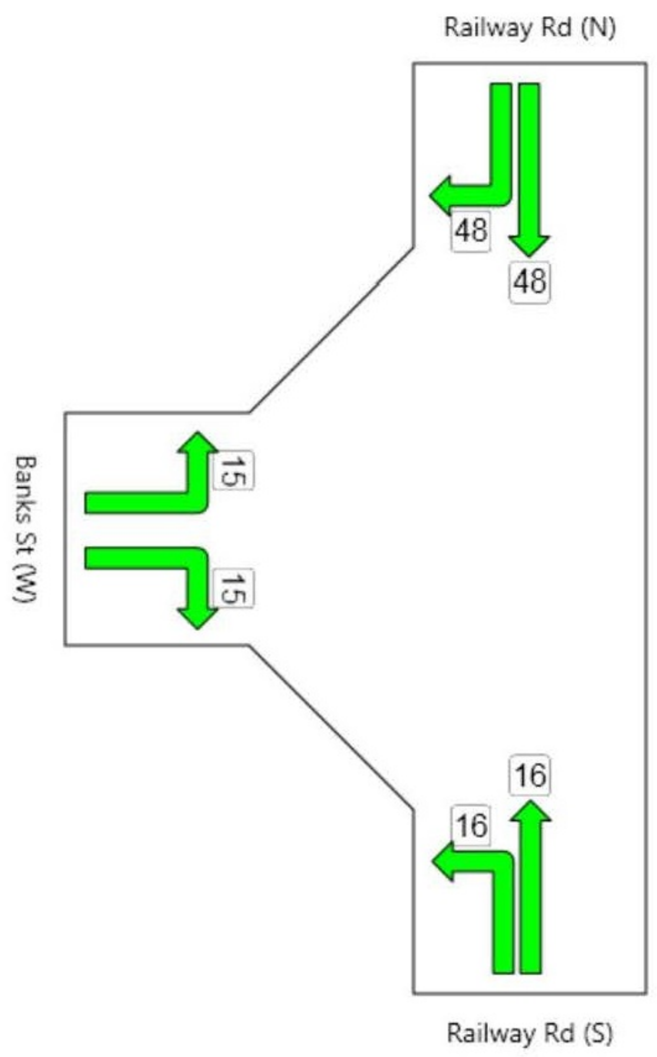
Figure 32: Queues - Railway Road and Bank Street 2010 AM Peak

QUEUE DISTANCE

Largest 95% Back of Queue for any lane used by movement (metres)

Site: Existing PM 2010

Railway Rd & Banks St
Roundabout



	South	North	West	Intersection
Queue Distance	16	48	15	48

Colour code based on Queue Storage Ratio

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

2026 FULL DEVELOPMENT INTERSECTION CONFIGURATIONS

Figure 33: Layout - Belmore Street and Junction Street

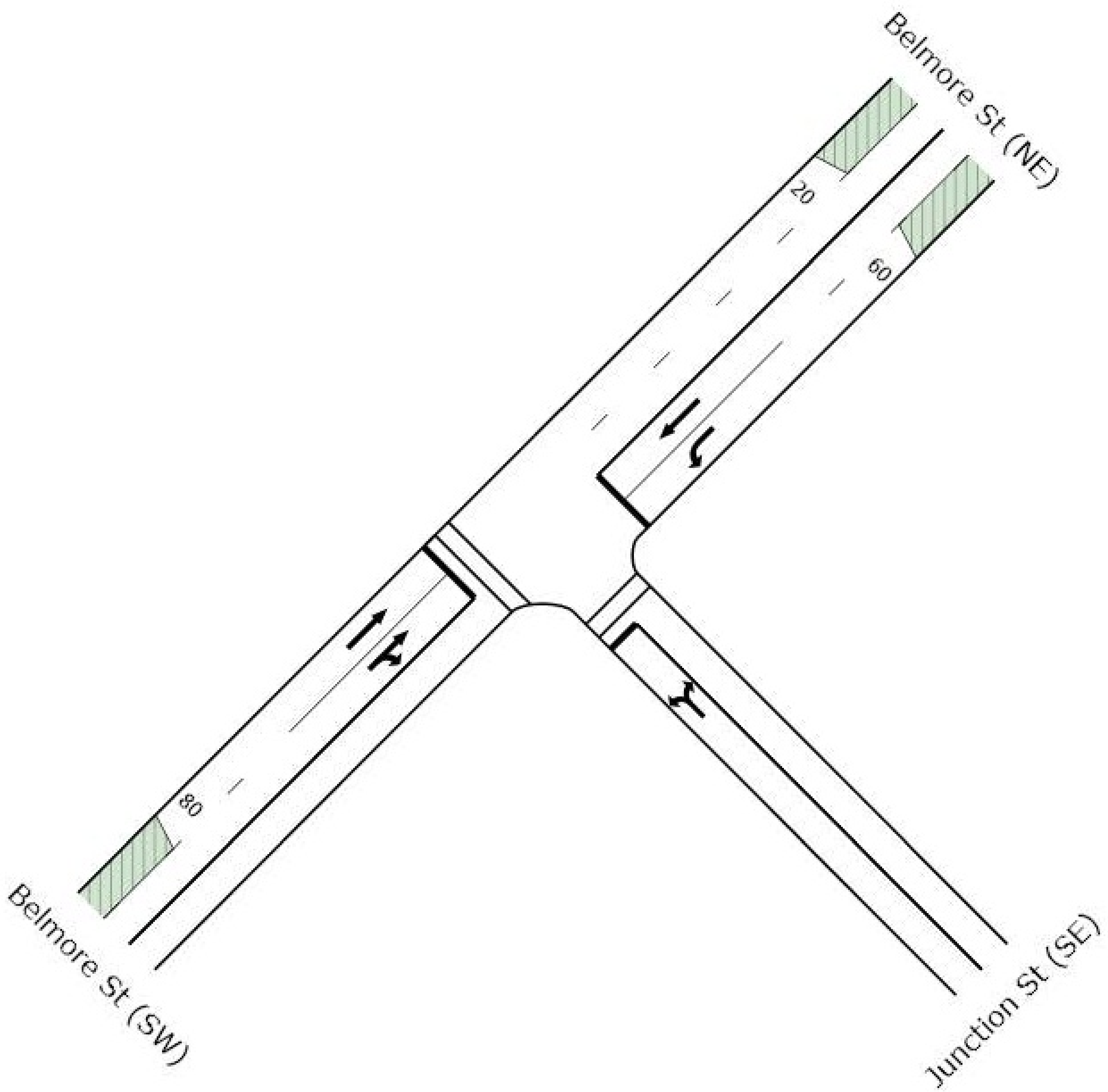


Figure 34: Layout - Belmore Street and Constitution Road

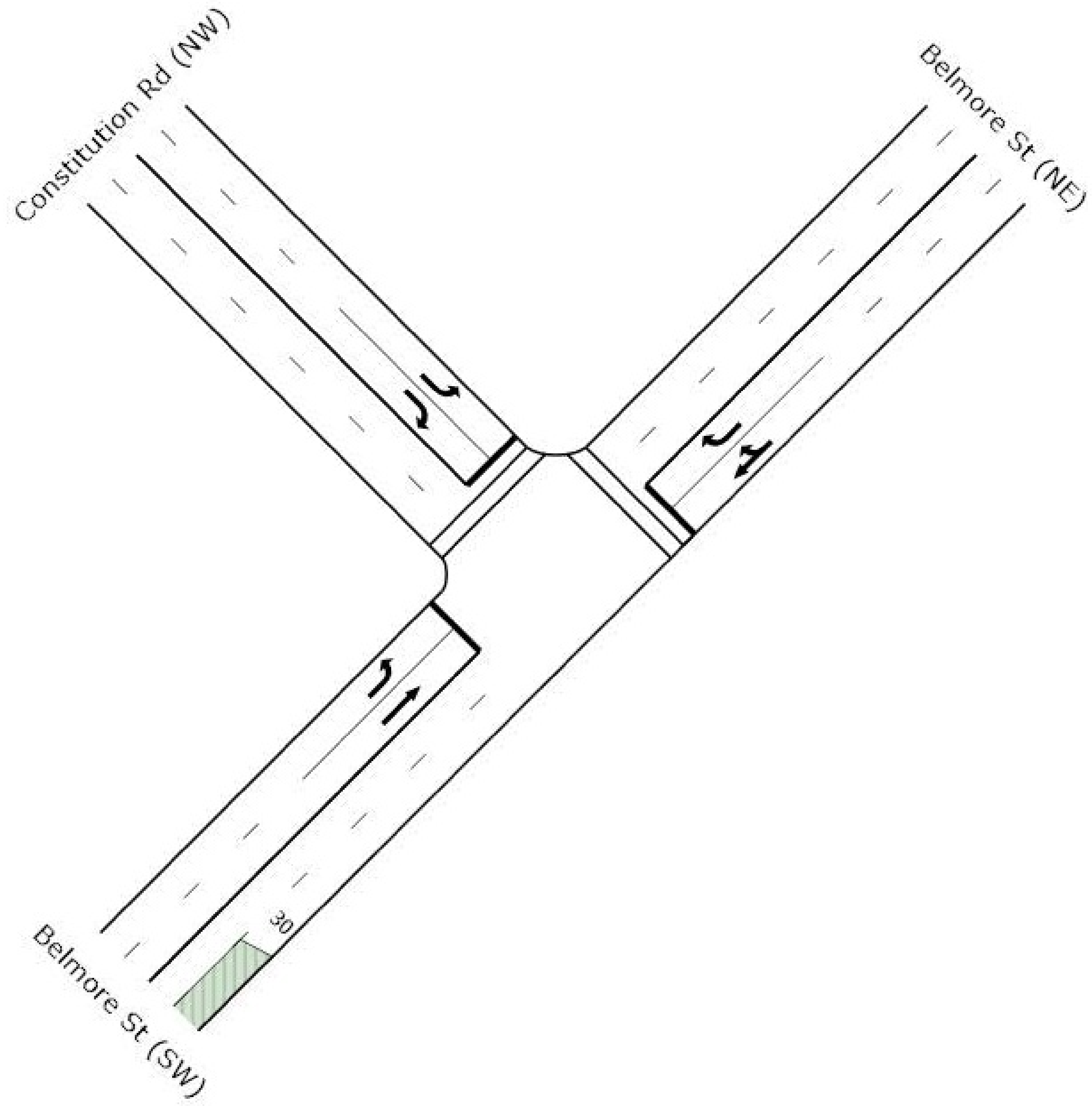


Figure 35: Layout - Parsonage Street, Porter Street and Loop Road

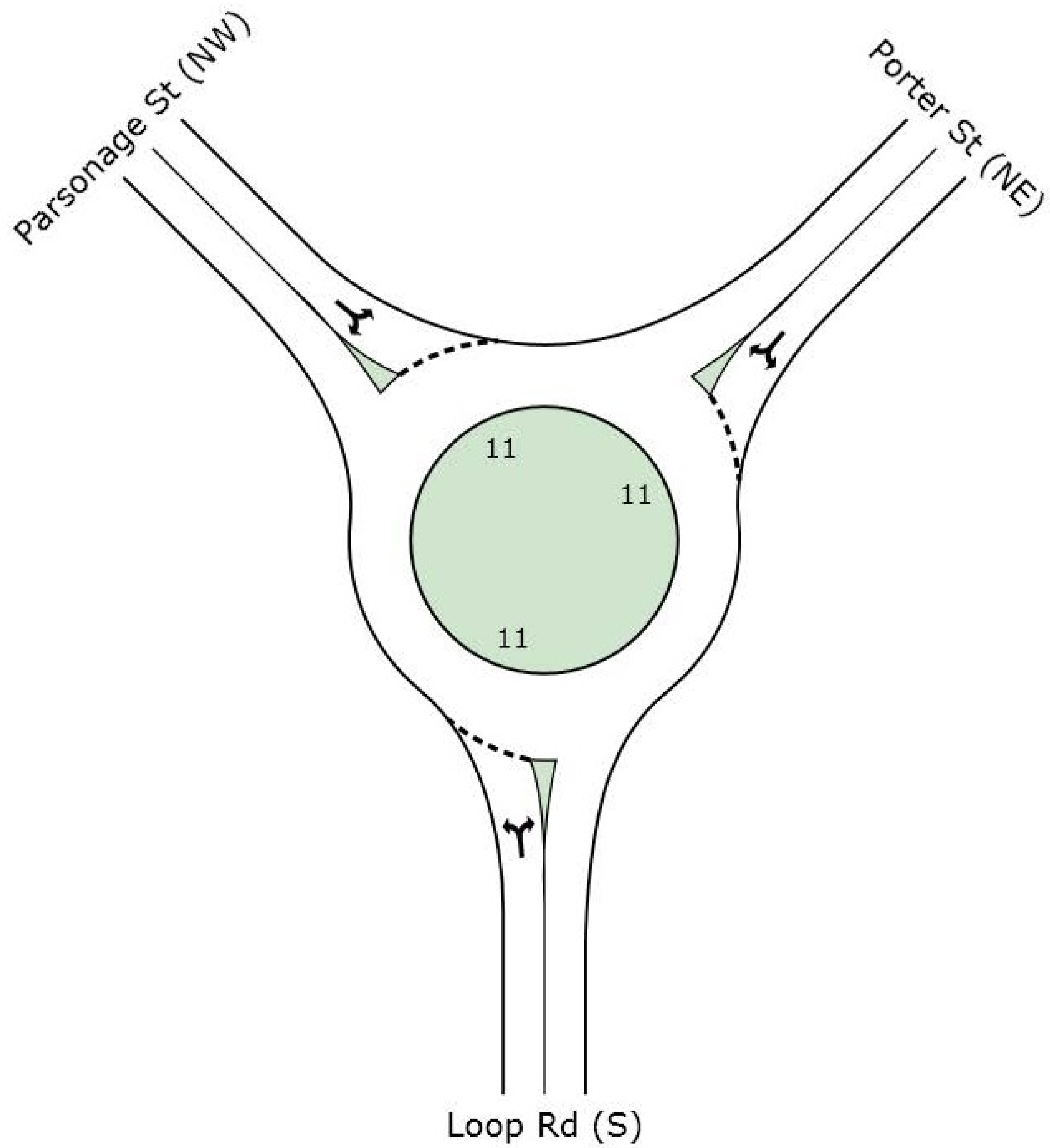


Figure 36: Layout - Constitution Road and Bowden Street

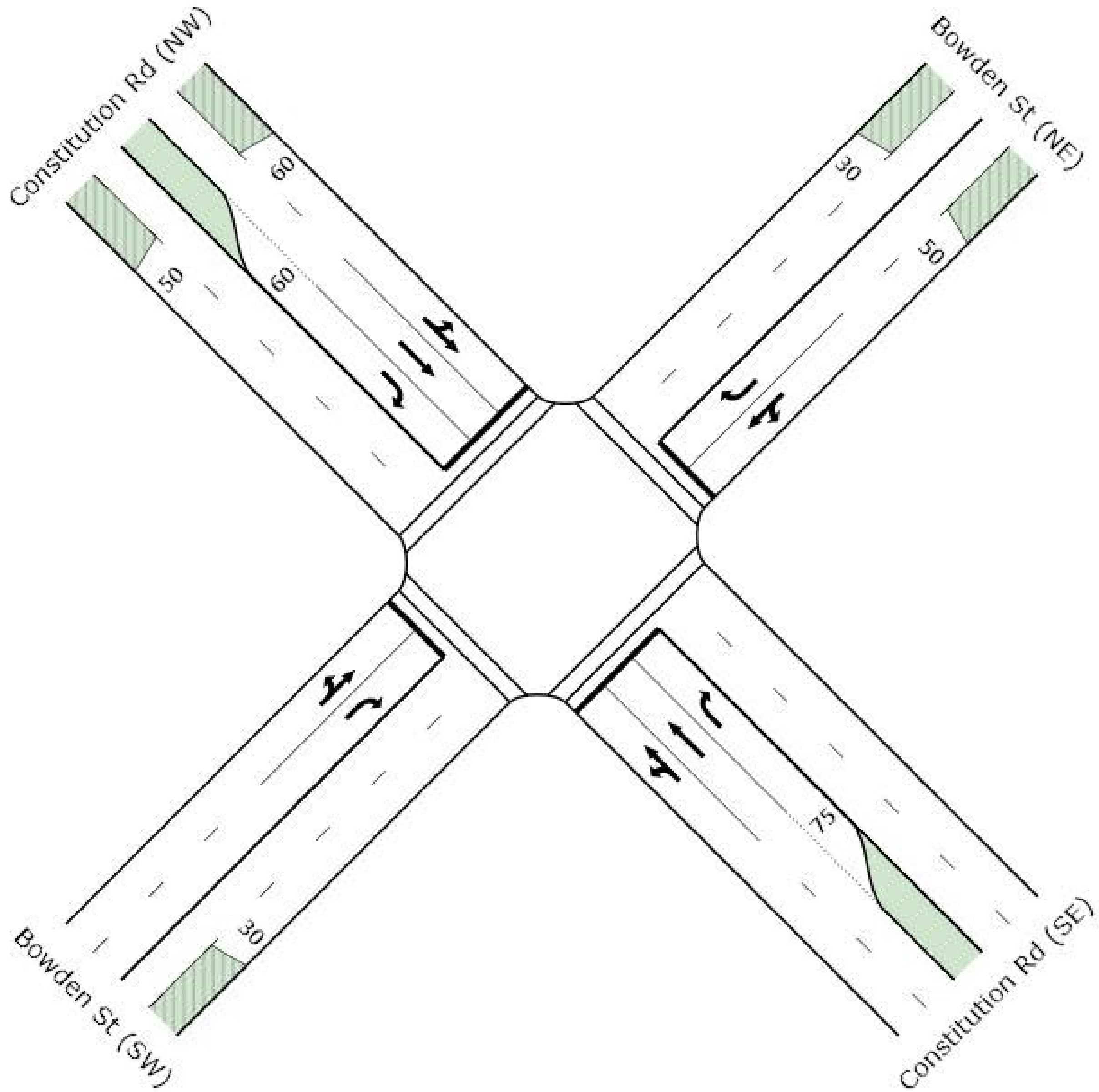


Figure 37: Layout - Railway Road and Bank Street

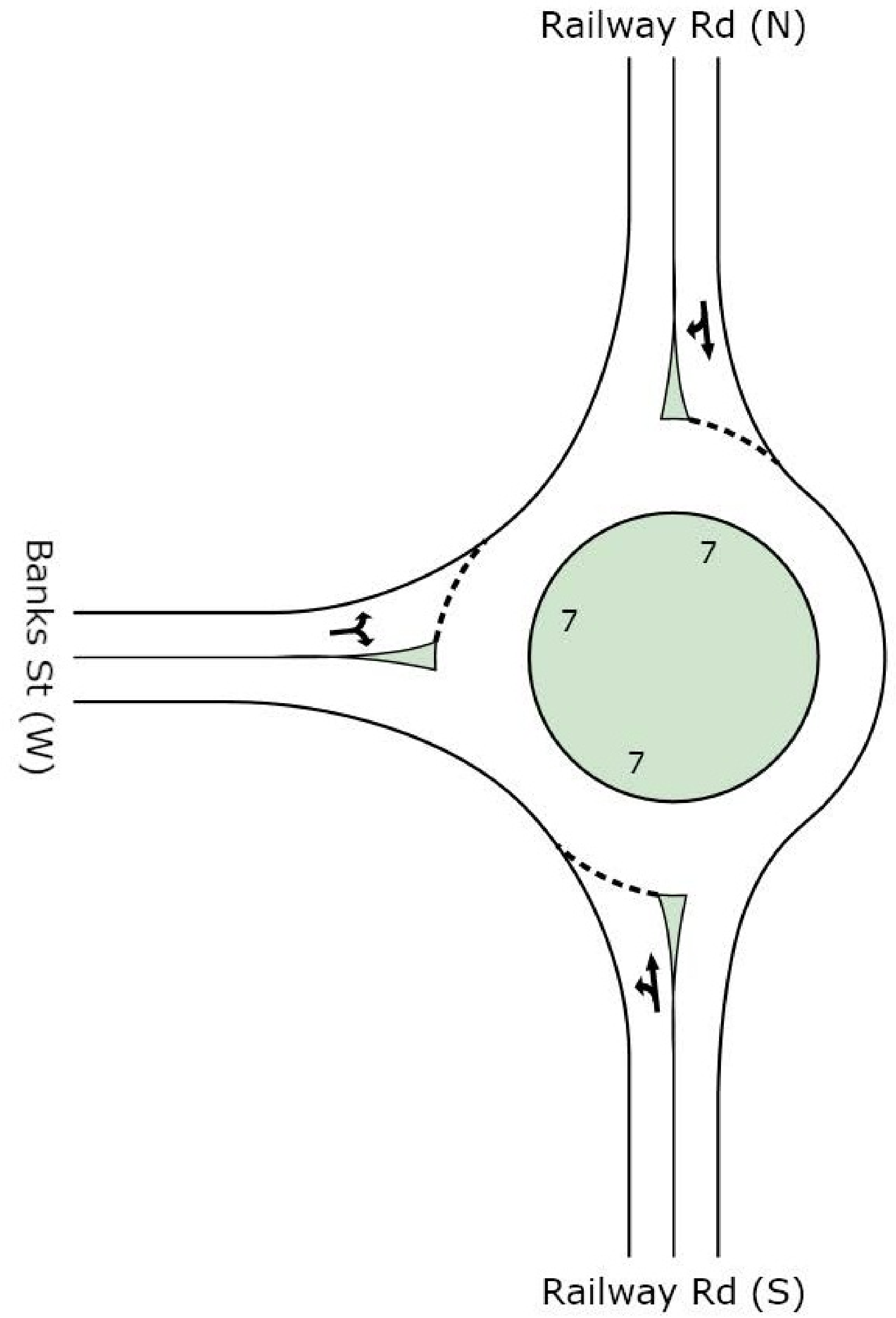


Figure 38: Layout - Belmore Street and Nancarrow Avenue

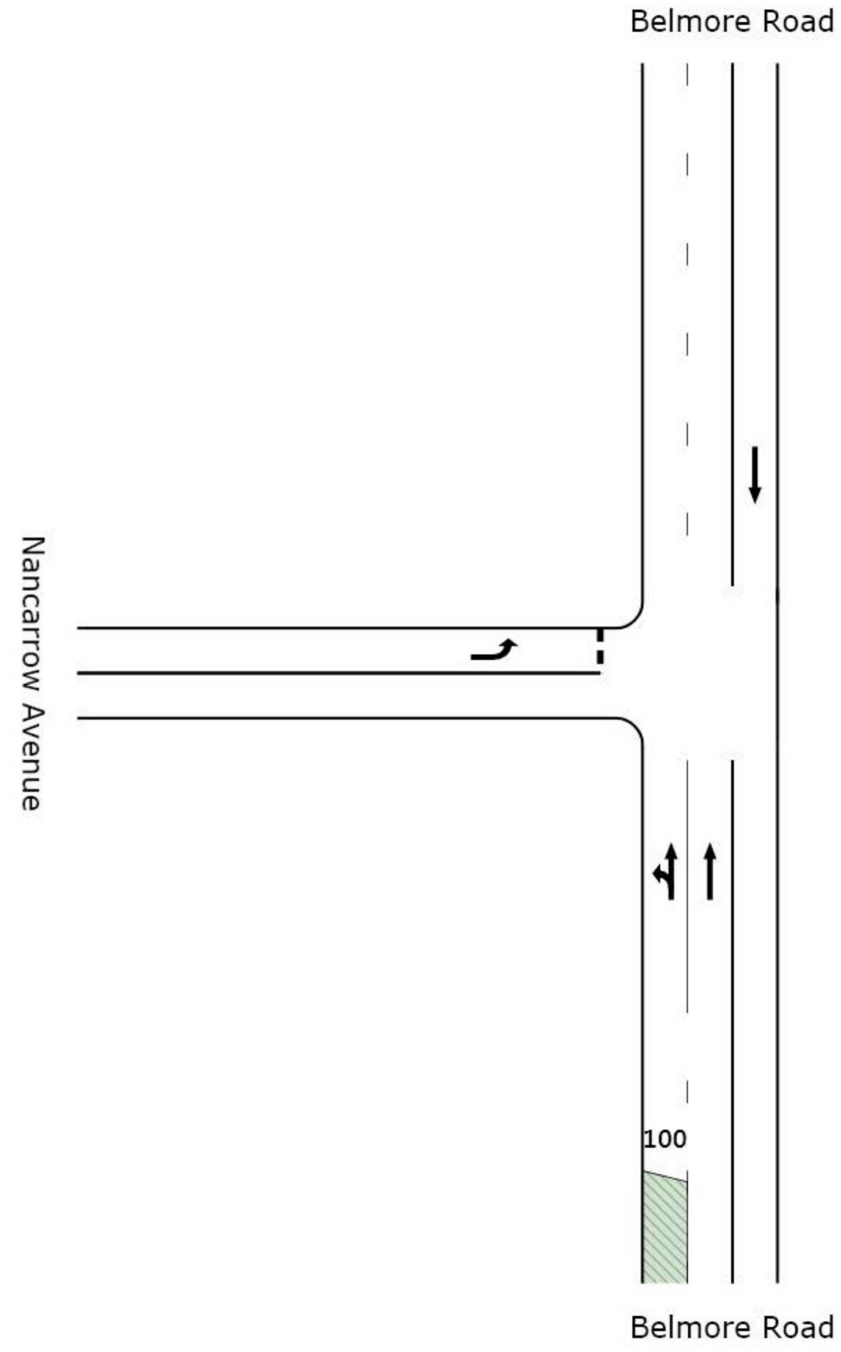


Figure 39: Layout - Bowden Street and Nancarrow Avenue (Sign Priority)

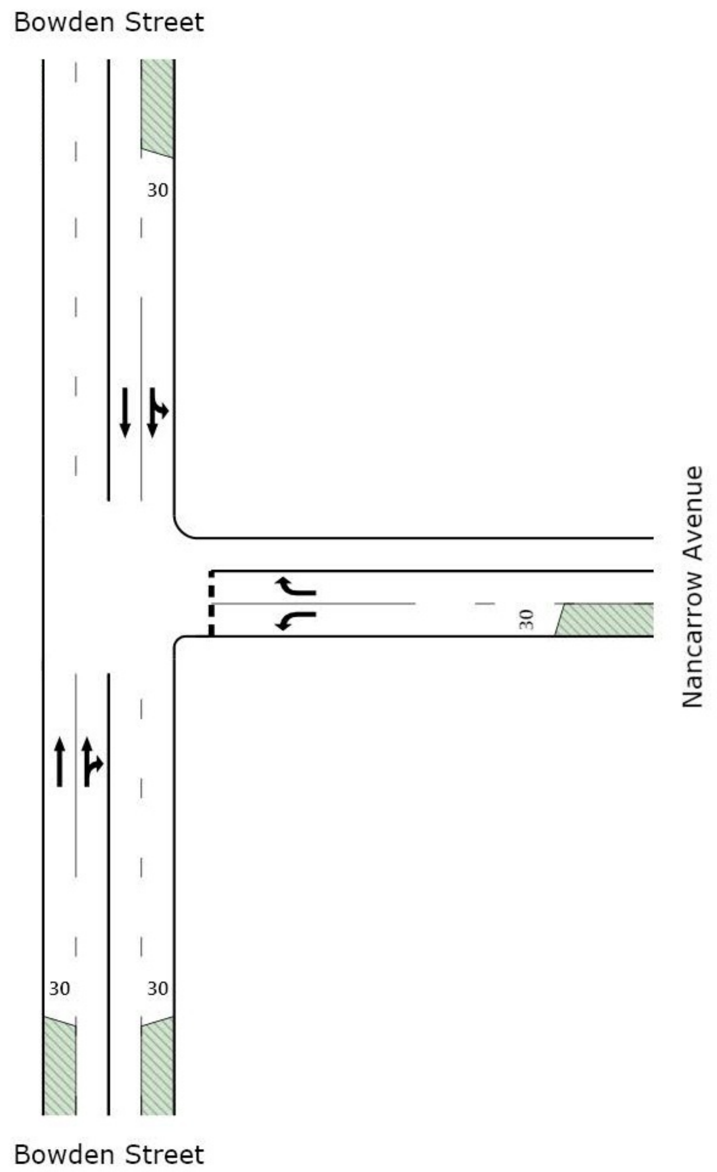
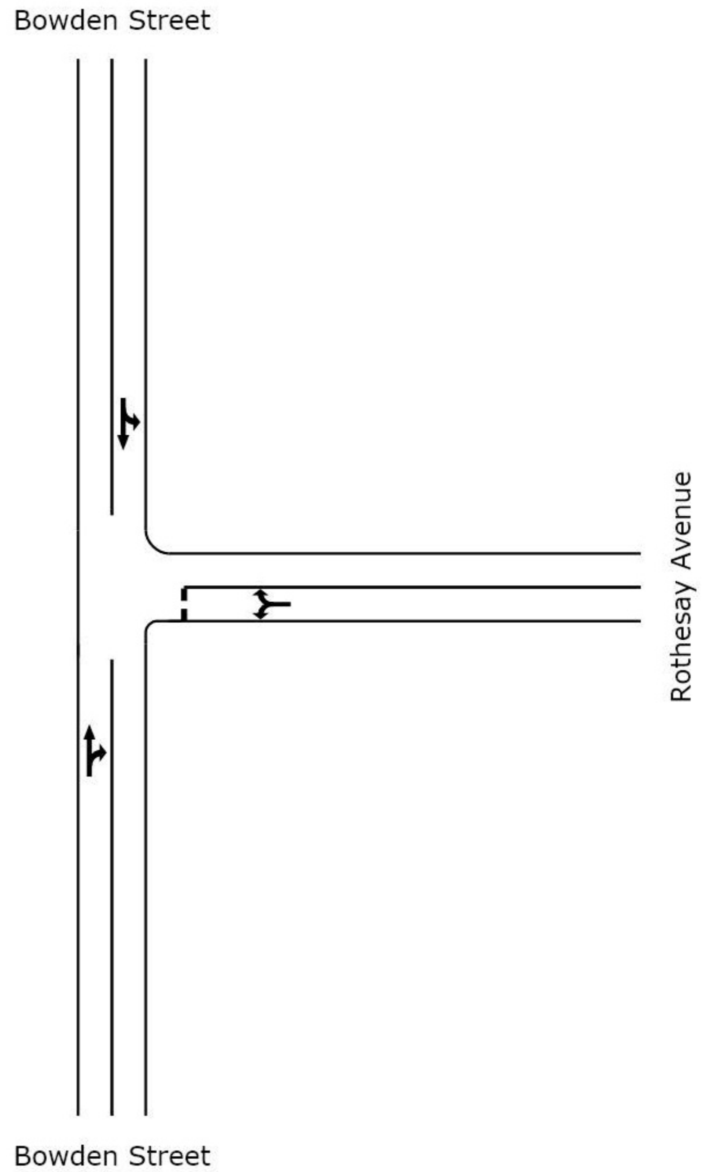


Figure 40: Layout - Bowden Street and Rothesay Avenue (Sign Priority)



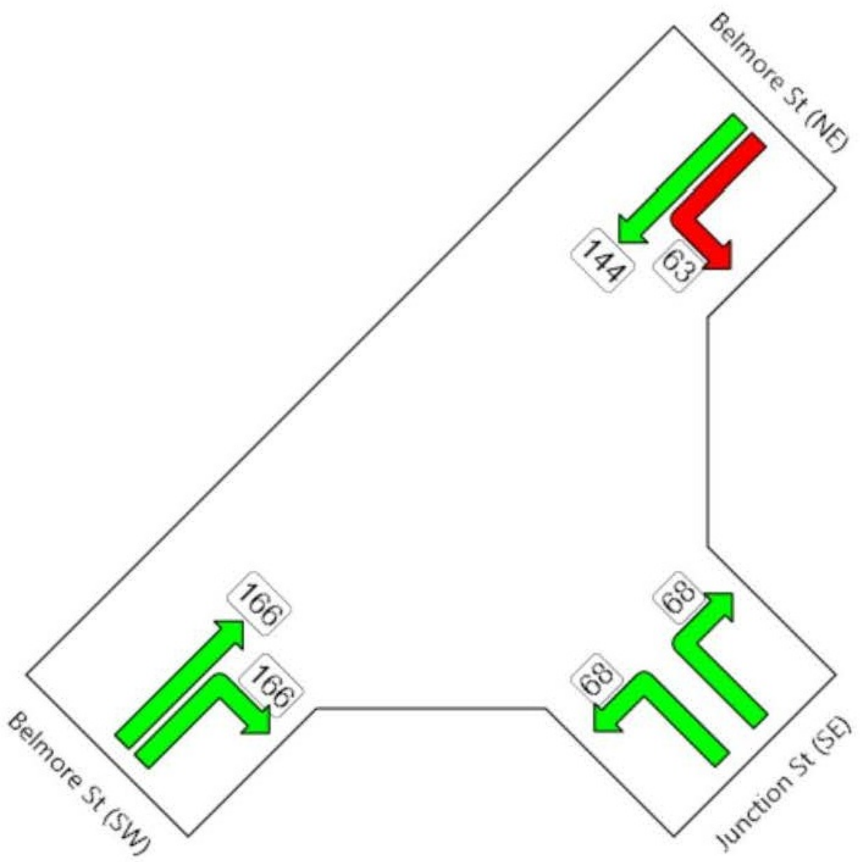
YEAR 2026 INTERSECTION QUEUE LENGTHS

Figure 41: Queues - Belmore Street and Junction Street 2026 AM Peak

QUEUE DISTANCE — **Site: Proposed AM 2026**

Largest 95% Back of Queue for any lane used by movement (metres)

Belmore St & Junction St
Signals - Fixed Time Cycle Time = 120 seconds (Optimum Cycle Time - Minimum Delay)



	Southeast	Northeast	Southwest	Intersection
Queue Distance	68	144	166	166

Colour code based on Queue Storage Ratio

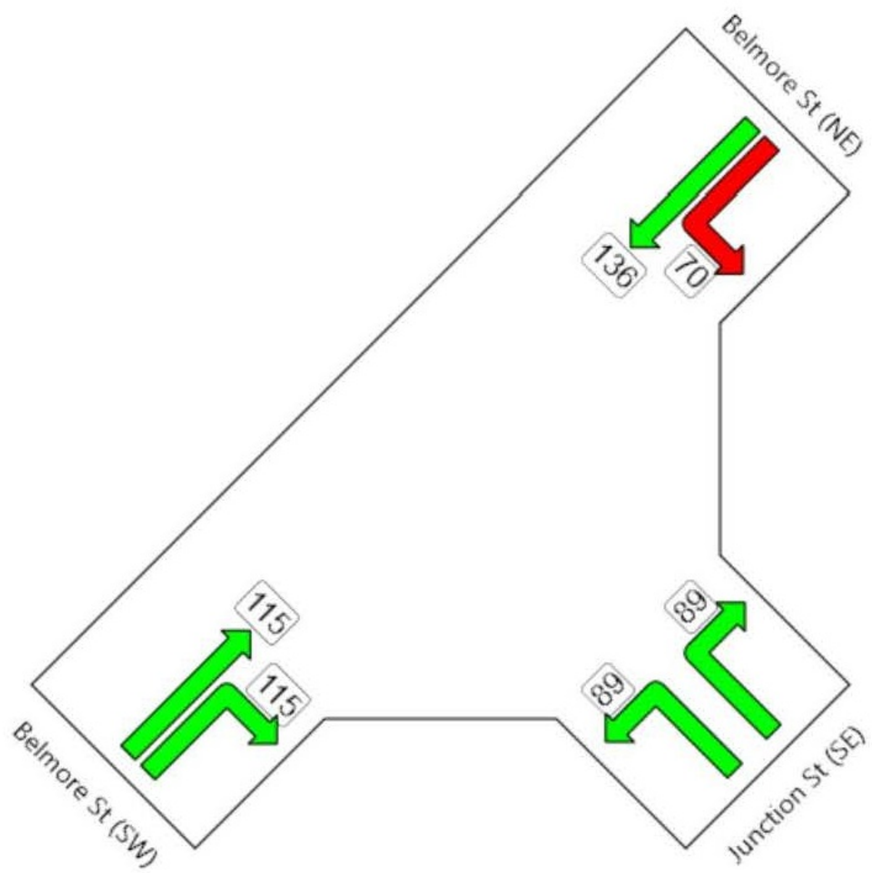
[< 0.6] [0.6 – 0.7] [0.7 – 0.8] [0.8 – 0.9] [0.9 – 1.0] [> 1.0] Continuous

Figure 42:Queues - Belmore Street and Junction Street 2026 PM Peak

QUEUE DISTANCE — **Site: Proposed PM 2026**

Largest 95% Back of Queue for any lane used by movement (metres)

Belmore St & Junction St
Signals - Fixed Time Cycle Time = 120 seconds (Optimum Cycle Time - Minimum Delay)



	Southeast	Northeast	Southwest	Intersection
Queue Distance	89	136	115	136

Colour code based on Queue Storage Ratio

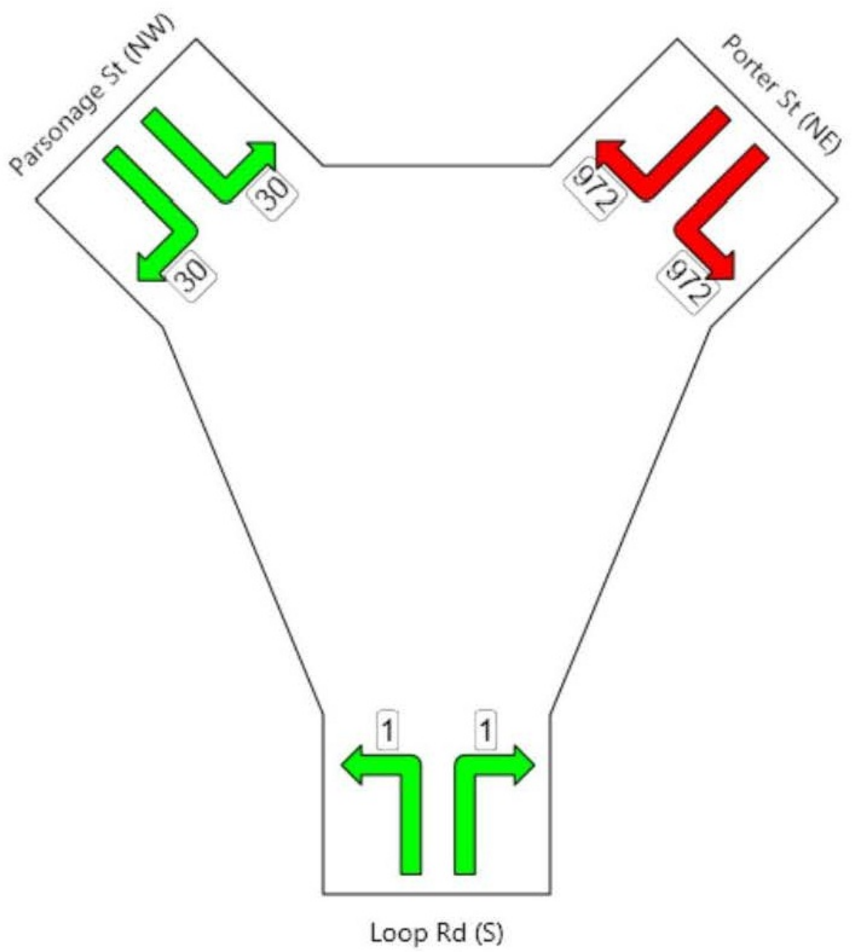
[< 0.6] [0.6 – 0.7] [0.7 – 0.8] [0.8 – 0.9] [0.9 – 1.0] [> 1.0] Continuous

Figure 43: Queues - Porter Street and Loop Street and Parsonage Street 2026 AM Peak

QUEUE DISTANCE Site: Existing AM 2026

Largest 95% Back of Queue for any lane used by movement (metres)

Porter St & Parsonage St
Roundabout



	South	Northeast	Northwest	Intersection
Queue Distance	1	972	30	972

Colour code based on Queue Storage Ratio

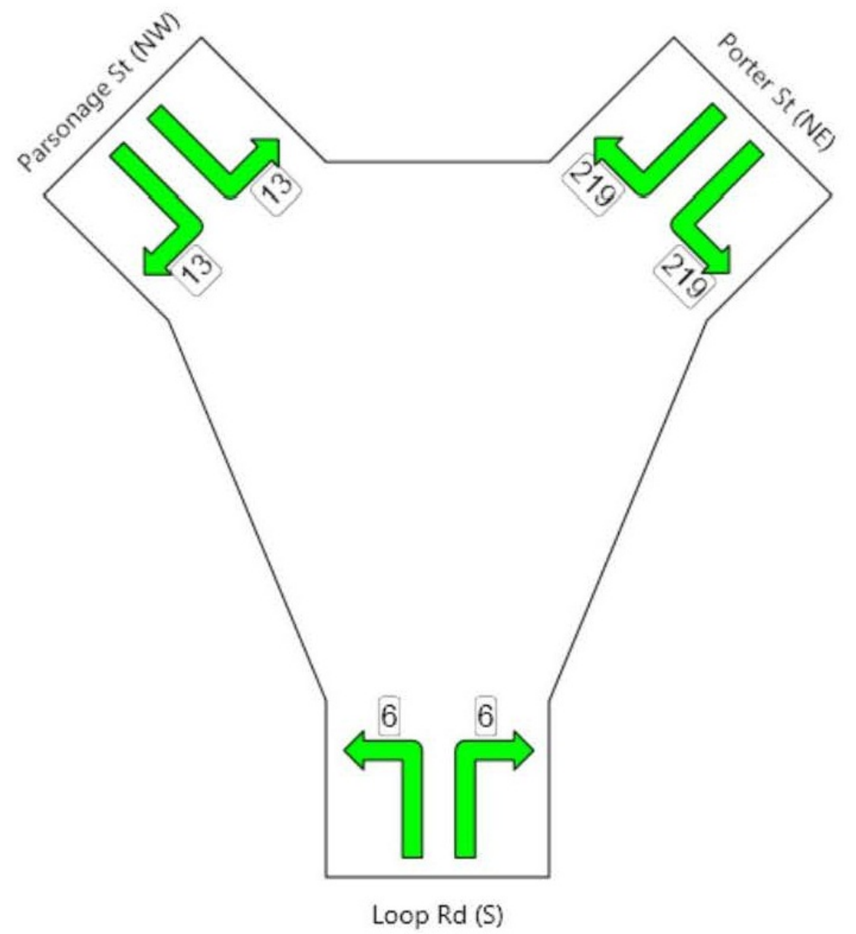
[< 0.6] [0.6 – 0.7] [0.7 – 0.8] [0.8 – 0.9] [0.9 – 1.0] [> 1.0] Continuous

Figure 44: Queues - Porter Street and Loop Street and Parsonage Street 2026 PM Peak

QUEUE DISTANCE Site: Existing PM 2026

Largest 95% Back of Queue for any lane used by movement (metres)

Porter St & Parsonage St
Roundabout



	South	Northeast	Northwest	Intersection
Queue Distance	6	219	13	219

Colour code based on Queue Storage Ratio

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

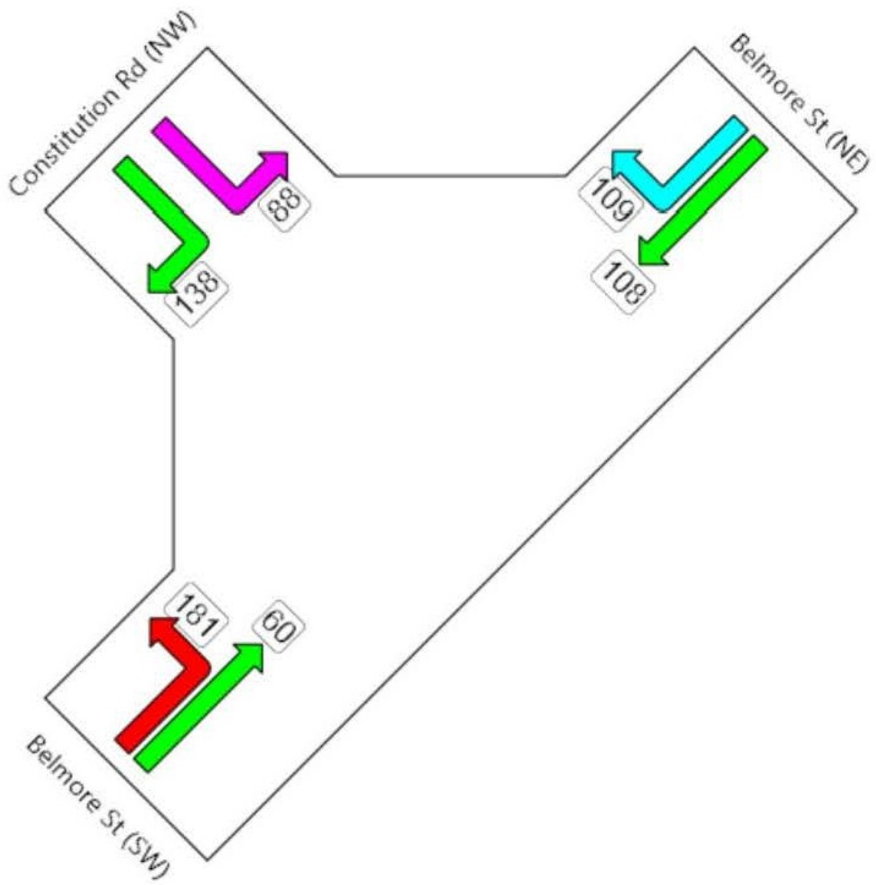
Figure 45: Queues - Belmore Street and Constitution Road 2026 AM Peak

QUEUE DISTANCE

Site: Proposed AM 2026

Largest 95% Back of Queue for any lane used by movement (metres)

Belmore St & Constitution Rd
Signals - Fixed Time   Cycle Time = 120 seconds (Optimum Cycle Time - Minimum Delay)



	Northeast	Northwest	Southwest	Intersection
Queue Distance	109	138	181	181

Colour code based on Queue Storage Ratio

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

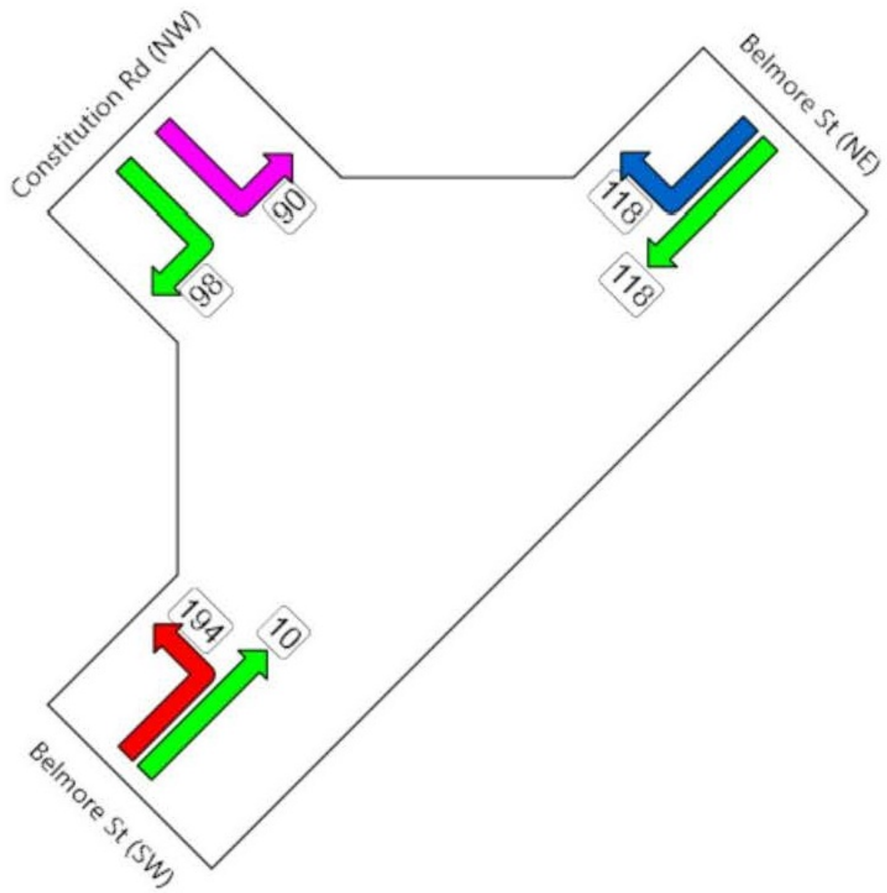
Figure 46: Queues - Belmore Street and Constitution Road 2026 PM Peak

QUEUE DISTANCE

Site: Proposed PM 2026

Largest 95% Back of Queue for any lane used by movement (metres)

Belmore St & Constitution Rd
Signals - Fixed Time   Cycle Time = 120 seconds (Optimum Cycle Time - Minimum Delay)



	Northeast	Northwest	Southwest	Intersection
Queue Distance	118	98	194	194

Colour code based on Queue Storage Ratio

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

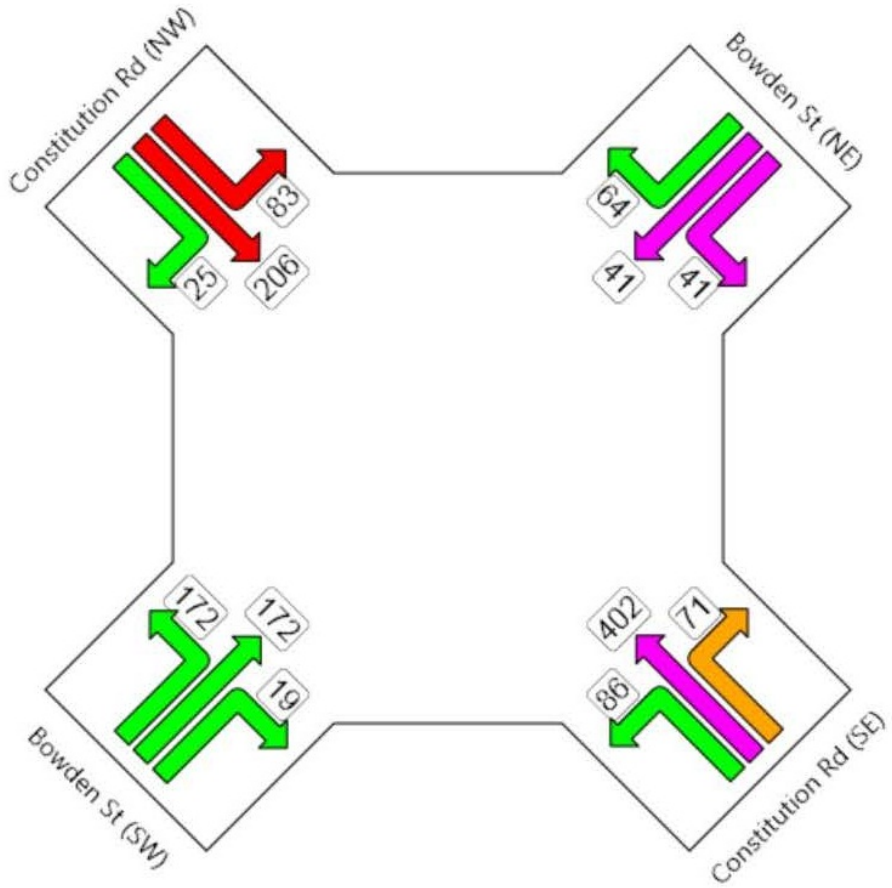
Figure 47: Queues - Constitution Road and Bowden Street 2026 AM Peak

QUEUE DISTANCE

Site: Proposed AM 2026 - Conversion

Largest 95% Back of Queue for any lane used by movement (metres)

Constitution Rd & Bowden St
Signals - Fixed Time   Cycle Time = 150 seconds (Practical Cycle Time)



	Southeast	Northeast	Northwest	Southwest	Intersection
Queue Distance	402	64	206	172	402

Colour code based on Queue Storage Ratio

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

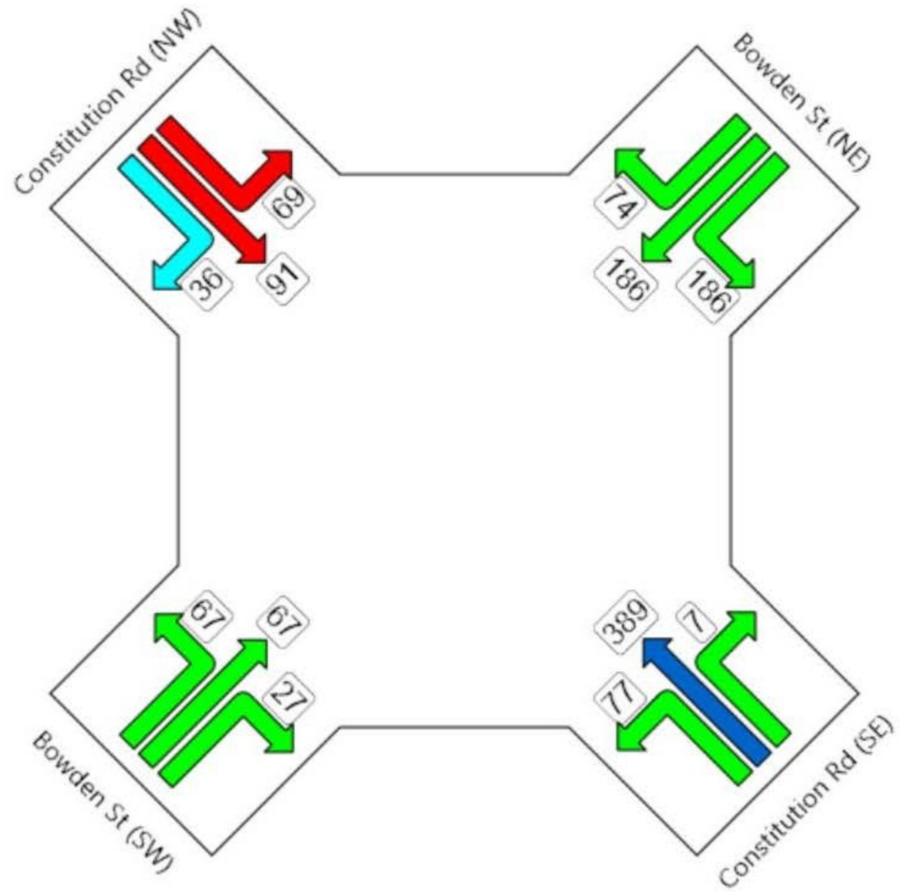
Figure 48: Queues - Constitution Road and Bowden Street 2026 PM Peak

QUEUE DISTANCE

Site: Proposed PM 2026 - Conversion

Largest 95% Back of Queue for any lane used by movement (metres)

Constitution Rd & Bowden St
Signals - Fixed Time   Cycle Time = 130 seconds (Practical Cycle Time)



	Southeast	Northeast	Northwest	Southwest	Intersection
Queue Distance	389	186	91	67	389

Colour code based on Queue Storage Ratio

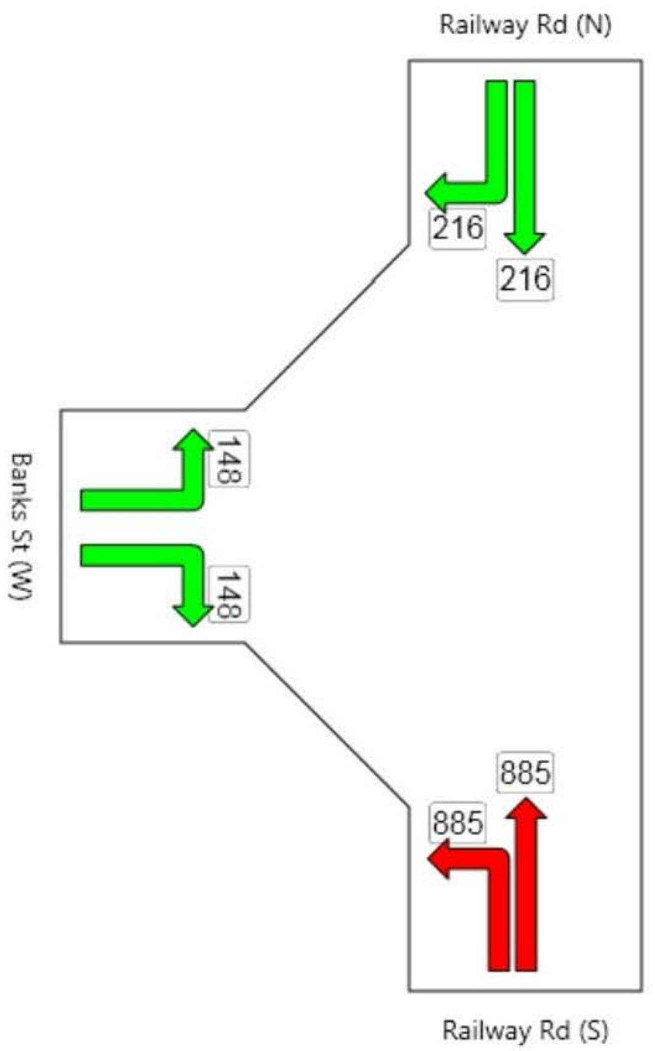
[< 0.6] [0.6 – 0.7] [0.7 – 0.8] [0.8 – 0.9] [0.9 – 1.0] [> 1.0] Continuous

Figure 49: Queues - Railway Road and Bank Street 2026 AM Peak

QUEUE DISTANCE Site: Proposed AM 2026

Largest 95% Back of Queue for any lane used by movement (metres)

Railway Rd & Banks St
Roundabout



	South	North	West	Intersection
Queue Distance	885	216	148	885

Colour code based on Queue Storage Ratio

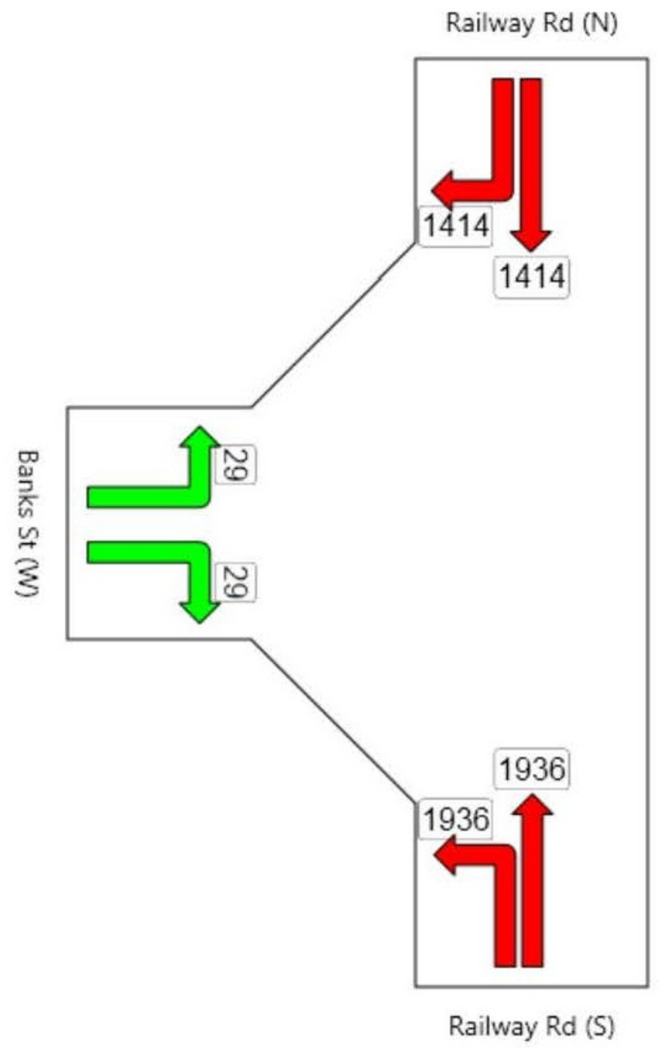
[< 0.6] [0.6 – 0.7] [0.7 – 0.8] [0.8 – 0.9] [0.9 – 1.0] [> 1.0] Continuous

Figure 50: Queues - Railway Road and Bank Street 2026 AM Peak

QUEUE DISTANCE Site: Proposed PM 2026

Largest 95% Back of Queue for any lane used by movement (metres)

Railway Rd & Banks St
Roundabout



	South	North	West	Intersection
Queue Distance	1936	1414	29	1936

Colour code based on Queue Storage Ratio

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

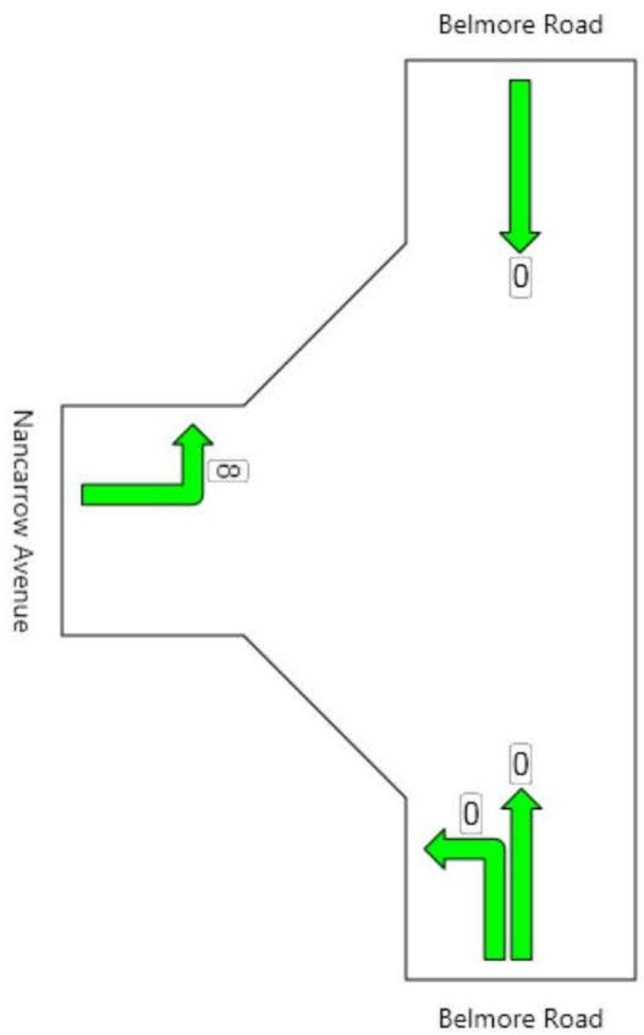
Figure 51: Queues - Belmore Street and Nancarrow Avenue 2026 AM Peak

QUEUE DISTANCE

Site: 2026 Dev AM Belmore and Nancarrow

Largest 95% Back of Queue for any lane used by movement (metres)

Belmore and Nancarrow 2026 AM Development Model
Giveway / Yield (Two-Way)



	South	North	West	Intersection
Queue Distance	0	0	8	8

Colour code based on Queue Storage Ratio

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

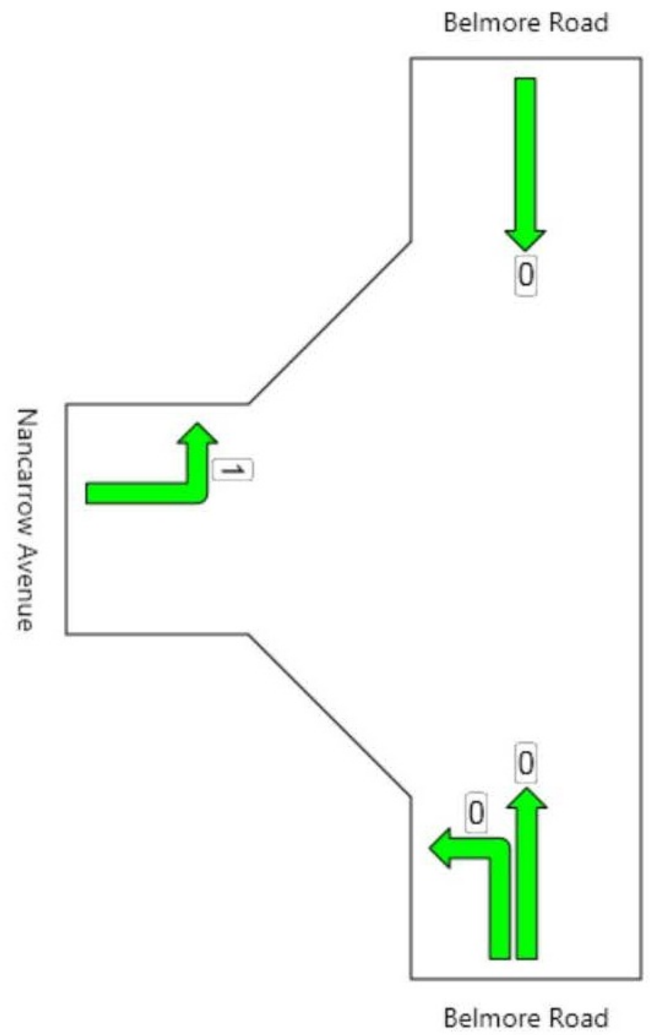
Figure 52: Queues - Belmore Street and Nancarrow Avenue 2026 AM Peak

QUEUE DISTANCE

Site: 2026 Dev PM Belmore and Nancarrow

Largest 95% Back of Queue for any lane used by movement (metres)

Belmore and Nancarrow 2026 AM Development Model
Giveway / Yield (Two-Way)



	South	North	West	Intersection
Queue Distance	0	0	1	1

Colour code based on Queue Storage Ratio

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

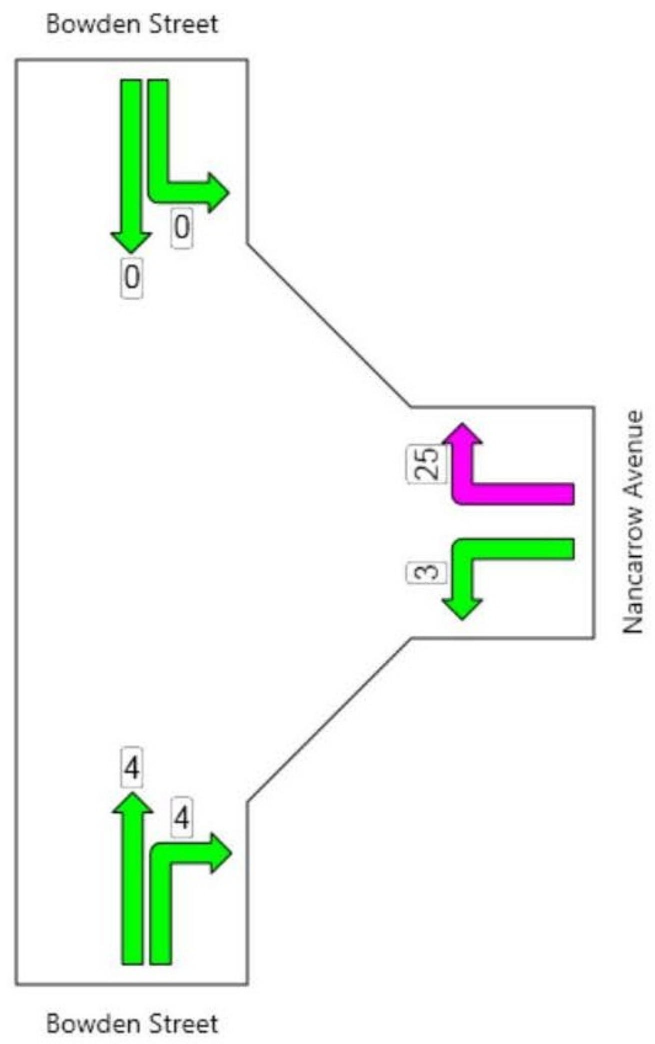
Figure 53: Queues - Bowden Street and Nancarrow Avenue 2026 AM Peak

QUEUE DISTANCE

Site: 2026 AM Development Bowden and Nancarrow

Largest 95% Back of Queue for any lane used by movement (metres)

2026 PM Development Bowden Street and Nancarrow Avenue
Giveway / Yield (Two-Way)



	South	East	North	Intersection
Queue Distance	4	25	0	25

Colour code based on Queue Storage Ratio

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

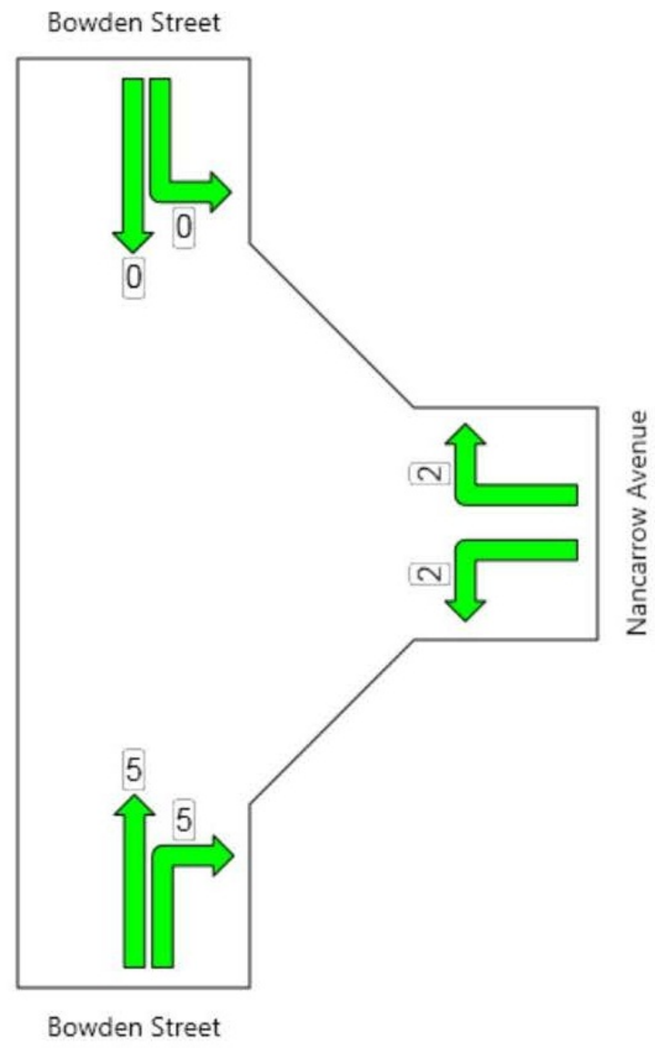
Figure 54: Queues - Bowden Street and Nancarrow Avenue 2026 PM Peak

QUEUE DISTANCE

Site: 2026 PM Development Bowden and Nancarrow

Largest 95% Back of Queue for any lane used by movement (metres)

2026 PM Development Bowden Street and Nancarrow Avenue
Giveway / Yield (Two-Way)



	South	East	North	Intersection
Queue Distance	5	2	0	5

Colour code based on Queue Storage Ratio

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

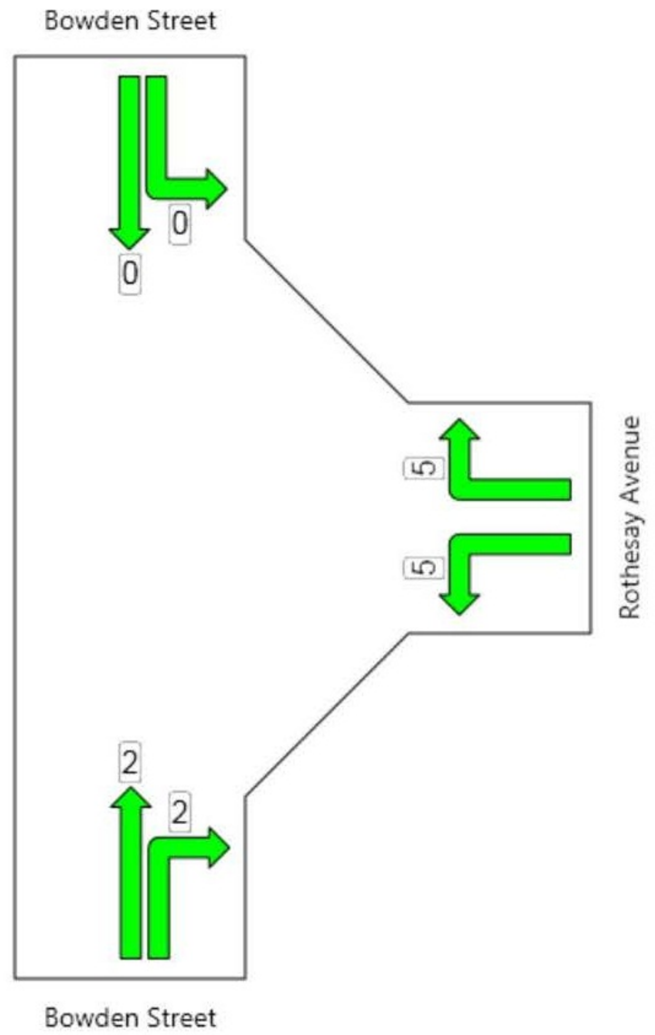
Figure 55: Queues - Bowden Street and Rothesay Avenue 2026 AM Peak

QUEUE DISTANCE

Site: 2026 AM Development Bowden and Rothesay

Largest 95% Back of Queue for any lane used by movement (metres)

2026 PM Development Bowden Street and Rothesay Avenue
Giveway / Yield (Two-Way)



	South	East	North	Intersection
Queue Distance	2	5	0	5

Colour code based on Queue Storage Ratio

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

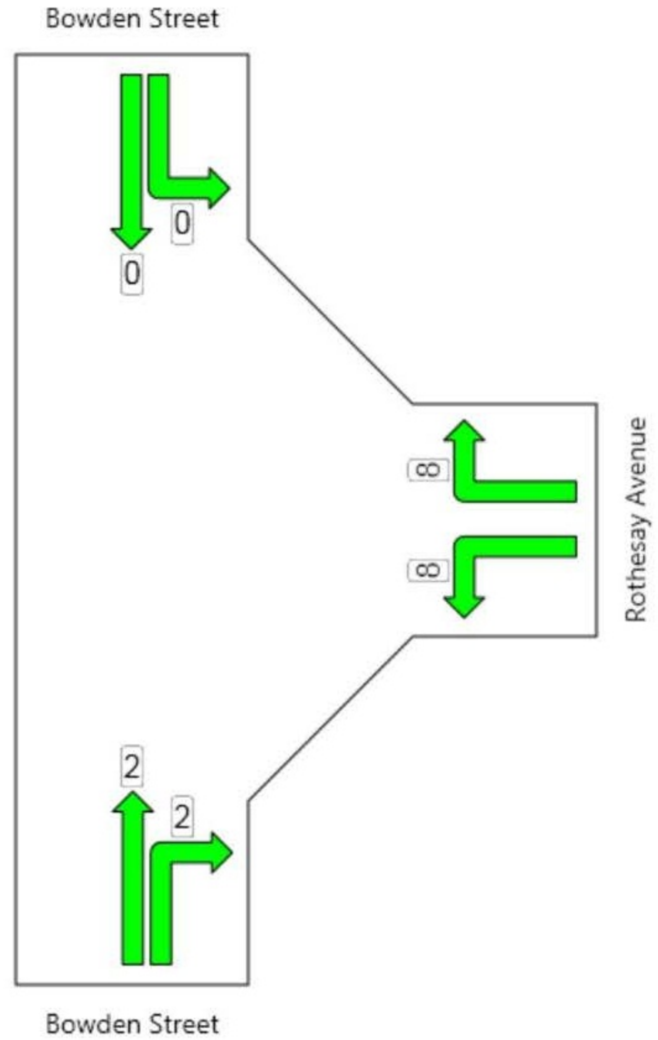
Figure 56: Queues - Bowden Street and Rothesay Avenue 2026 PM Peak

QUEUE DISTANCE

Site: 2026 PM Development Bowden and Rothesay

Largest 95% Back of Queue for any lane used by movement (metres)

2026 PM Development Bowden Street and Rothesay Avenue
Giveway / Yield (Two-Way)



	South	East	North	Intersection
Queue Distance	2	8	0	8

Colour code based on Queue Storage Ratio

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

APPENDIX D – INFRASTRUCTURE PERFORMANCE INDICATORS

LEVEL OF SERVICE (LOS)

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

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

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

AVERAGE VEHICLE DELAY (AVD)

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

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

DEGREE OF SATURATION (DS)

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

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

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

Table 7: Performance Indicators by Control Method

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

Table 8: Qualified Level of Service by Control Method

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