WENTWORTHVILLE TOWN CENTRE
TRAFFIC STRATEGY MODELLING

FOR

HOLROYD CITY COUNCIL

Gold Coast
Suite 26, 58 Riverwalk Avenue
Robina QLD 4226
P: (07) 5562 5377
W: www.bitziosconsulting.com.au

Brisbane
Level 2, 428 Upper Edward Street
Spring Hill QLD 4000
P: (07) 3831 4442
E: admin@bitziosconsulting.com.au

Sydney
Studio 203, 3 Gladstone Street
Newtown NSW 2042
P: (02) 9557 6202

Project No: P2123 Version No: 002 Issue date: 17 September 2015

DOCUMENT CONTROL SHEET

Issue History

Report File Name	Prepared by	Reviewed by	Issued by	Date	Issued to
P2123.001P Wentworthville Town Centre Traffic Strategy Modelling	P. Bollavarem	D.Bitzios	D.Bitzios	2/9/2015	Natalie Stanowski – Holroyd City Council
P2123.002P Wentworthville Town Centre Traffic Strategy Modelling	P. Bollavarem	D.Bitzios	D.Bitzios	17/9/2015	Natalie Stanowski – Holroyd City Council

CONTENTS

Page

Tables

Figures

Appendices

1. INTRODUCTION

1.1 BACKGROUND

Bitzios Consulting completed the "Wentworthville Traffic and Transport Strategy - Peer Review" in July 2015. This report included a traffic and parking strategy to support and supplement the development scenarios being considered in the *Wentworthville Town Centre Revitalisation Planning Project*. A key traffic recommendation in this strategy was a local bypass of the Town Centre "main street" of Dunmore Street and part of Station Street. The strategy also raised the potential option of a left in/left out connection at the intersection of The Kingsway and the Cumberland Highway.

Holroyd City Council (HCC) identified the need to further assess these strategy elements to establish their needs and better understand their potential impacts.

Bitzios Consulting has subsequently been commissioned by HCC to undertake Paramics micro-simulation traffic modelling for the proposed Wentworthville town centre traffic improvements being considered as part of the appraisal of future land use scenarios. The scenarios assessed were:

- Scenario 2: Lower mid-rise height scale; and
- Scenario 3: Upper mid-rise height scale.

Both development scenarios were assessed against the current (i.e. year 2015 road network) and the road network proposed in the *Wentworthville Traffic and Transport Strategy Peer Review report* (2 July 2015, Bitzios Consulting).

1.2 STUDY AREA FOR TRAFFIC MODELLING

The study area for traffic modelling included the section of Wentworthville town centre between the railway line in the north, the Cumberland Highway in the west, Pritchard Street in the south and Finlaysons Creek in the east as shown in Figure 1.1.

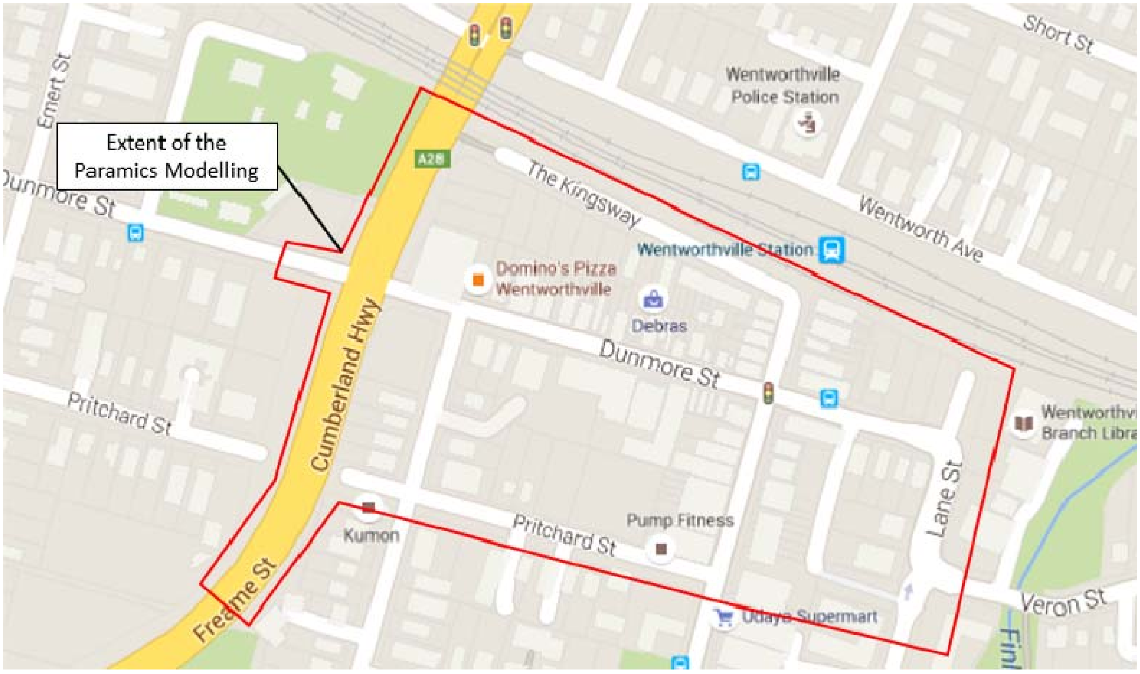


Figure 1.1: Study Area

The modelled area was considered to be sufficient to assess the impacts and benefits of the proposed bypass concept in particular.

1.3 SCOPE

Key activities undertaken in establishing the project-specific traffic models included:

- Review of available data and collection of new data;
- Development of year 2015 base models, involving:
  - collation of traffic counts and development of a “pattern” traffic matrices;
  - coding the model to represent the August 2015 road network in the modelled area;
  - undertaking matrix estimation using Paramics’ “matrix estimator”; and
  - validating the models to travel time data and checking against back of queue observations.
- Creation of future year (2036) traffic demands by determining the background traffic growth rates as well as future local development scenario traffic;
- Assessing the existing network configuration in 2036 under the traffic demands expected with development Scenario’s 2 and 3 traffic in order to demonstrate the impacts of fulfilment of the land use proposals without any traffic upgrades;
- Development of future year traffic strategy models to assess:
  - the impacts of “do-nothing” in terms of the traffic network under each development scenario and identifying the need for the bypass;
  - demonstrating typical operations without/with the bypass (using modelled travel times, queue lengths etc.); and
  - further detailing the intersection configurations needed at key locations based on the identified queue storage needs shown from the modelling.
- Sensitivity testing:
  - testing development Scenario 2 and development Scenario 3 traffic demands with and without the let in/left out arrangement proposed at The Kingsway/Cumberland Highway intersection.
- Reporting of the outcomes of the modelling.

The models were created for the morning peak (7:00am to 9:00am) and the evening peak (4:00pm to 6:00pm) periods.

Following the provision of Version 001 of this report, Council identified that it required further advice in relation to:

- What effects restricting/slowing traffic on Dunmore would have on relocating some through traffic to the alternative Pritchard Street-Garfield Street corridor;
- If a “half-bypass” between the Cumberland Highway and the Station Street/Pritchard Street intersection could be effective in attracting through traffic sway from Dunmore Street;
- Providing additional turning volume outputs and level of service outputs for all options/scenarios;
- Identifying a likely year that, if no works were undertaken the congestion conditions on Dunmore Street would be excessive, based on the duration and extent of queueing shown in the models;
- Identify potential broader traffic capacity improvement options on the strategic network surrounding Wentworthville that may assist in drawing some through traffic away from Dunmore Street;
- Prepare concept drawings and concept level cost estimates for the “full bypass” and “half bypass” options.

This subsequent work was undertaken and report in chapters 8-13 in this report. The modelling discussed in these chapters was based on the critical PM peak condition identified in the initial work.

1.4 MODELLING SOFTWARE

Paramics V6.9.3 was the software used to create the traffic simulation models. Traffic simulation models assess the path through the traffic network if each individual vehicle and how they react to other vehicles and the road environment. They are a sensitive form of modelling typically used in over-capacity situations or where intersection queuing and delays at adjacent intersections interact. The visual/observation benefits of traffic simulation models are also a key reason why they are used.

2. BASE MICRO-SIMULATION MODEL DEVELOPMENT

2.1 BASE MODEL NETWORK

The modelled traffic network was coded as per the existing conditions in terms of number of lanes, posted speed limits and traffic signal phasing/operation. Figure 2.1 shows the full extents of the modelled network.

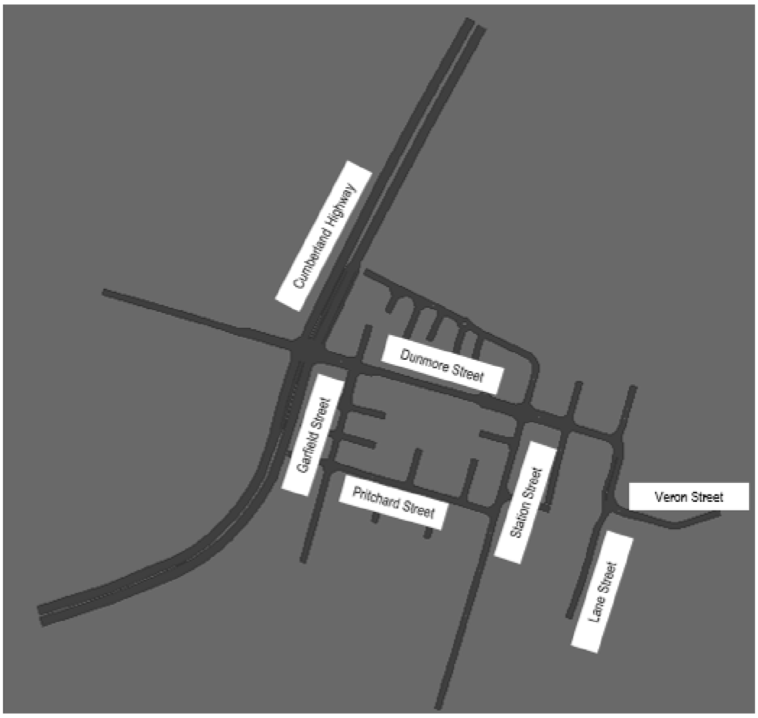


Figure 2.1: Modelled Traffic Network

2.2 ZONE SYSTEM

The zone system used included both "internal" and "external" zones. Typically, the internal zones define areas with specific land uses and access points while external zones represent the extremities of the model. The zone system used in the model included in a total of 29 traffic zones as shown in Figure 2.2.

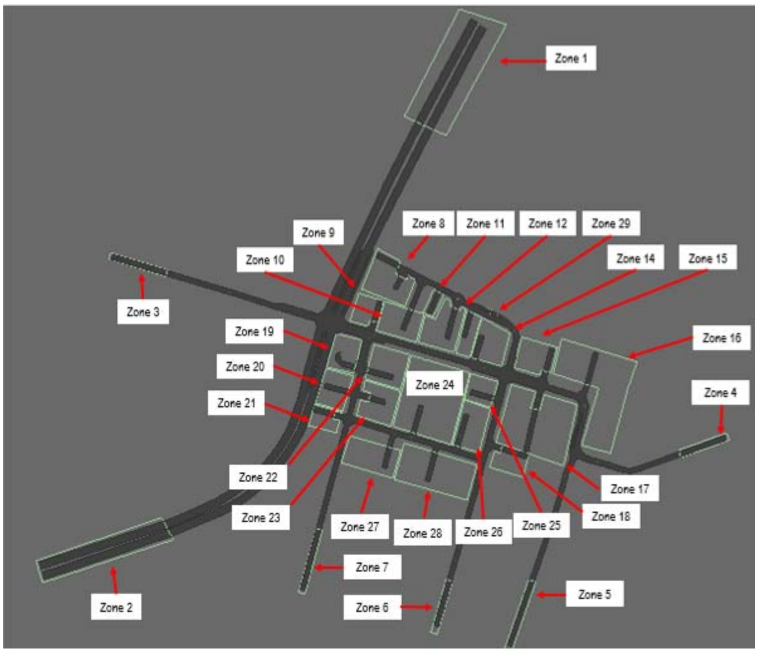


Figure 2.2: Paramics Model Zoning System

2.3 Simulation Time

Paramics models were developed for the AM peak period (7.00am - 9.00am) and the PM peak period (4.00pm - 6.00pm). To ensure that the peak periods had sufficient levels of traffic in the network when the peak period started, a 30 minute "warm-up" period was included at the start of each peak period whilst a 30 minute "cool-down" was also used to assess the potential residual queue effects.

2.4 Link Types

The modelled road network was based on the road network as at August 2015, including the intersection configurations, number of lanes, intersection priorities, posted speeds and other operational attributes.

Typically, the major road corridors (i.e. Cumberland Highway) were coded as "major links" while the other parts of the network (residential streets and lower hierarchy roads) were coded as "minor links". This has no influence in the traffic assignment but does affect turning priorities and specific traffic behaviours.

2.5 Traffic Signals

The base model contains two signalised intersections within the study area. All signal operational parameters (i.e. cycle times, phase times) were added to the model in accordance with the data collected from intersection video footage. During the model calibration phase, minor adjustments to phase times were made as required to ensure that the observed conditions were reflected accurately in the model. Typically, this consisted of adjusting green times by a few seconds (while keeping the cycle time consistent).

2.6 Traffic Volumes

2.6.1 Survey Data

Traffic counts, origin destination (OD) surveys and travel time surveys were undertaken on Saturday 28th July 2015 for the following times to coincide with the expected peak periods:

- AM peak – 6:30 am to 9:30 am; and
- PM peak – 3:30 pm to 6:30 pm.

The locations of the surveys in the study area are summarised in Figure 2.3.

Figure 2.3: Survey Locations

2.6.2 Traffic Volumes Summary

Two hour intersection volumes for the AM and PM peaks are shown in Figures 2.4 and 2.5.

Figure 2.4: AM Intersection Volumes (0700-0900)

Figure 2.5: PM Intersection Volumes (1600-1800)

The surveys reveal that the Cumberland Highway intersection with Dunmore Street dominates traffic patterns in the area with three times the traffic at the Station Street/Dunmore Street intersection. The Station Street/Pritchard Street and the Lake Street/Veron Street intersections are less heavily trafficked at about half the volume of traffic at the signalised intersection of Station Street/Dunmore Street.

2.6.3 Origin-Destination Survey Findings

Origin-destination surveys were taken between 7:00am – 9:00am and 4:00pm – 6:00pm at key locations can be seen in Figure 2.3. Tables 2.1 and 2.2 summarise the results.

Table 2.1: 7:00am – 9:00am Origin Destination Results

Vehicles with an Internal Destination	Vehicles with an External Destination	Total Vehicles
852	2194	3046

Table 2.2: 4:00pm – 6:00pm Origin Destination Results

Vehicles with an Internal Destination	Vehicles with an External Destination	Total Vehicles
705	2229	2934

The origin-destination surveys show that a large proportion of vehicles passing through the network and do not stop in the modelled area at all. In the morning two hour peak, 72% of vehicles pass through the network with only 28% parking at a local destination. Similarly, in the afternoon two hour peak, 76% of vehicles pass straight through the network.

2.6.4 Manipulation of Traffic Count Data and Development of the Pattern Matrix

The "pattern matrix" is an input into the matrix estimation process in Paramics. The pattern matrix was established based on the OD survey together with traffic count data and the estimated traffic generation of each building in the study area. Due to the nature of the estimation process and zone placement, surveyed traffic volumes are required to be "balanced" to ensure that adjacent intersections have consistent upstream and downstream volumes. This balancing process was undertaken prior to the traffic count data being entered into the model.

2.7 Demand Estimation

The total vehicle traffic demands for the AM and PM peak periods are summarised in Table 2.1.

Table 2.3: 2015 Total Vehicle Traffic Demands in the Modelled Area

Time Period	Total Vehicle Demand (No. Trips)
7:00 am – 9:00 am	11,164
4:00 pm – 6:00 pm	12,042

2.8 Vehicle Proportions

Total traffic demands were split into three separate matrices to represent the "light vehicles" (matrix 1), "heavy vehicles - highway" (matrix 2) and "heavy vehicles - local network" (matrix 3). Each of the matrices were given a proportion of heavy vehicles based on assumption derived from the traffic counts:

- 5% heavy vehicles for local roads (no semi-trailers included); and
- 10% heavy vehicles for the Cumberland Highway, including semi-trailers.

2.9 Traffic Assignment Method

Considering the size, route availability and operational characteristics of the traffic network, the assignment method used was "dynamic assignment" with perturbation. No feedback was selected due to the small scale of the network and the perturbation algorithm selected was "percentage". Time steps per second were left at the default value of 2 (as the RMS modelling guide).

2.10 VEHICLE RELEASE PROFILES

The model includes a vehicle release rate for its peak periods and this has been based on the traffic survey results. The release profiles are for 15 minute intervals aligned with the survey count intervals. Figure 2.6 and Figure 2.7 show the vehicle release profiles used in the AM and PM models.

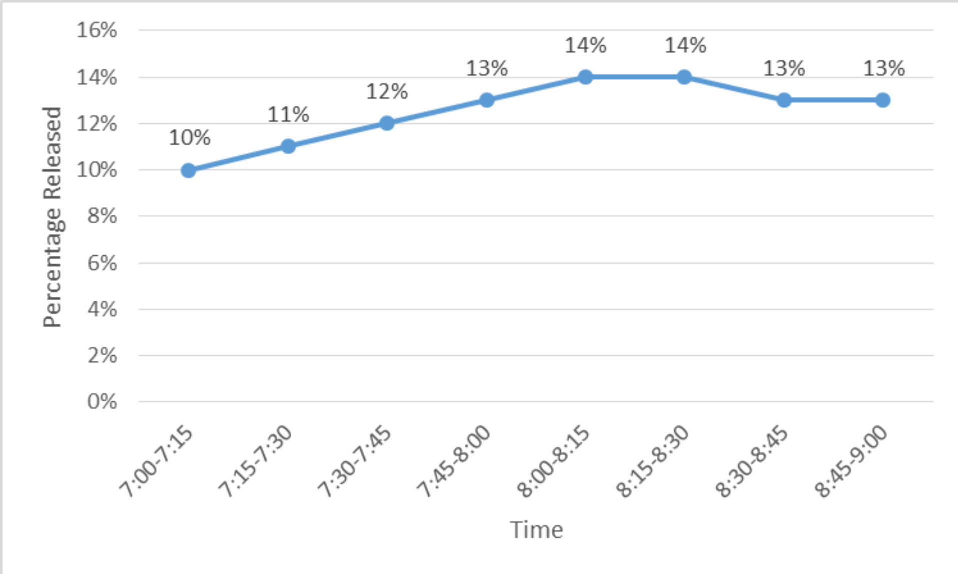


Figure 2.6: AM Base Model Vehicle Release Profile

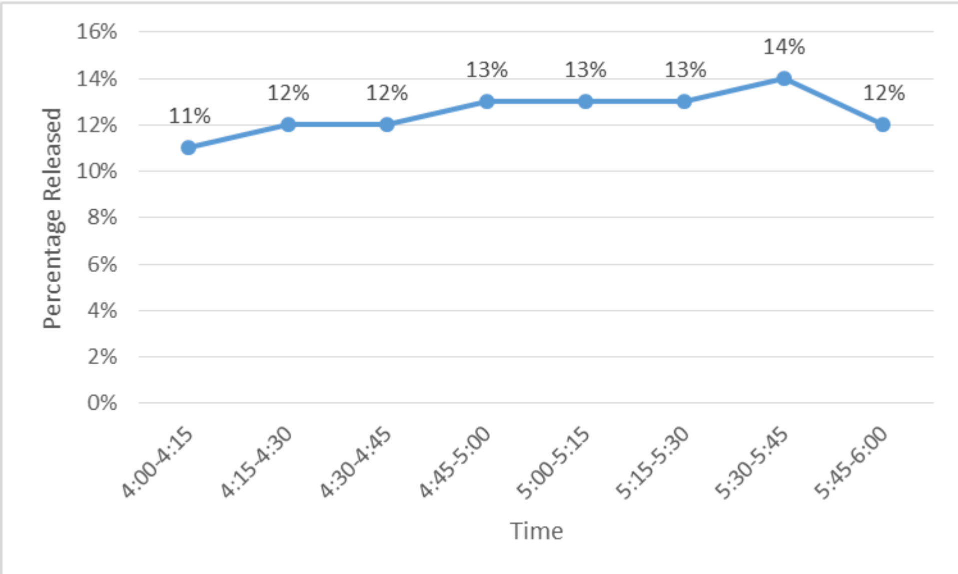


Figure 2.7: PM Base Model Vehicle Release Profile

The base models also include a 30 minute warm-up period before the peak periods start as well as 30 minute “cool down” period for each model.

2.11 SEED VALUES

The RMS modelling guidelines (which provide typical conventions for micro-simulation modelling in NSW) stipulate that models should be run for a minimum of five seed values to study the robustness of the model and assess its operation under variety of starting conditions.

There is no reason to use one seed value or group of seed values in particular. They simply represent different vehicle release conditions for the same network and OD matrix. However the "Paramics Microsimulation Modelling – RMS Manual" states that "the following ten seed values should be used to provide random variation of results: 560, 28, 7771, 86524, 2849, 5321, 137, 98812, 601027, 559". To comply with that requirement, the first five seeds were selected to be used in the model calibration process. Accordingly, the seed values used were:

- Seed #1 560;
- Seed #2 28;
- Seed #3 7771;
- Seed #4 86524; and
- Seed #5 2849.

3. BASE MODEL CALIBRATION AND VALIDATION

3.1 MODEL CALIBRATION

3.1.1 GEH Statistic

Balanced intersection count data at 6 locations was used to refine the existing OD demands matrix based on zone-to-zone movements within the study area through matrix estimation. The modelled turn data was then compared against the observed (count) data and the GEH statistic was calculated to check how closely the two datasets "matched". The GEH statistic is an equation used in traffic engineering, traffic forecasting and traffic modelling to compare two sets of traffic volumes and is the industry standard performance measure for model validation. The GEH statistic measures the degree of divergence of the modelled value from the observed value and implicitly accounts for the size of the volume, acknowledging that greater confidence is required for higher volume movements.

A GEH value less than 5 indicates there is very little variation between the modelled results and the observed counts whilst a GEH value of between 5 and 10 indicates that for the purposes of modelling, the variation is acceptable and that the model is validated. The equation used to calculate the GEH values is as follows:

$$GEH = \sqrt{\frac{(M-O)^2}{0 \cdot 5 * (M+O)}}$$

Where:

- M is the modelled or simulated flow: and
- O is the observed flow from the traffic counts.

3.1.2 Model Calibration Criteria

The model calibration criteria used to ensure the model was adequately calibrated were as follows:

- the average GEH value is < 5;
- a minimum of 85% of all turn volumes have a GEH value < 5; and
- no turn movements have a GEH value > 10.

The calibration comparisons were carried out for the peak period. This is generally viewed as good practice in simulation modelling guidelines and in accordance with industry guidelines (i.e. *RMS Paramics Micro-simulation Modelling Manual*). A summary of the calibration results is shown in Tables 3.1 and 3.2.

Table 3.1: Base Year (2015) Model Calibration Statistics- AM Peak

RTA Seeds	Average GEH	% of counts under a GEH of 5
Seed 560	1.7	100%
Seed 28	1.3	100%
Seed 7771	1.5	100%
Seed 86524	1.5	100%
Seed 2849	1.4	100%

Table 3.2: Base Year (2015) Model Calibration Statistics- PM Peak

RTA Seeds	Average GEH	% of counts under a GEH of 5
Seed 560	1.4	97.9%
Seed 28	1.4	97.9%
Seed 7771	1.5	97.9%
Seed 86524	1.5	97.9%
Seed 2849	1.5	95.7%

As shown in Tables 3.1 and 3.2, all modelled periods comply with the calibration criteria and are in accordance with the guidelines contained in the *RMS Paramics Micro-simulation Modelling Manual*. The results of all 5 seed runs can be found in Appendix A.

3.2 TRAVEL TIME VALIDATION

The travel time routes used for undertaking model travel time comparisons are shown in Figures 3.1 and 3.2. They cover the length of Dunmore Street with the first route turning down Lane Street and the second route turning south on Station Street.

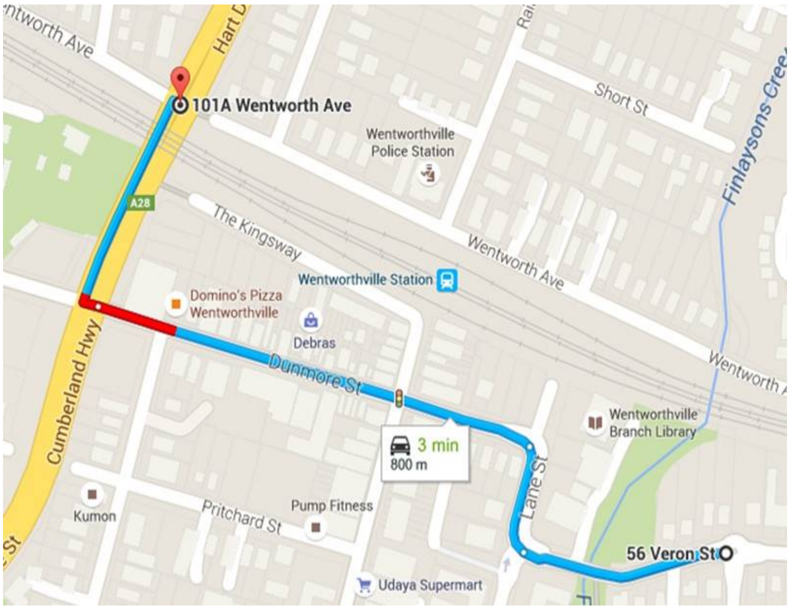


Figure 3.1: Travel Time Survey Route 1

Figure 3.2: Travel Time Survey Route 2

Travel time surveys along the routes shown in Figures 3.1 and 3.2 were undertaken on the 28th of July 2015. It is generally accepted that travel time validation is achieved when the modelled travel time lies within a range of ±15% of the observed travel times. This is the guideline given by the UK DMRB which is a typical industry convention standard for traffic model validation. The results of the comparison between the modelled and surveyed travel times are shown in Tables 3.3 and 3.4

Table 3.3: Travel Time Comparison Route 1

Route 1	AM Peak			PM Peak		
	Surveyed	Modelled	% Difference	Surveyed	Modelled	% Difference
East	1:49	1:37	-10%	1:54	1:39	-13%
West	2:49	2:23	-15%	3:50	3:34	-7%

Table 3.4: Travel Time Comparison Route 2

Route 2	AM Peak			PM Peak		
	Surveyed	Modelled	% Difference	Surveyed	Modelled	% Difference
East	3:21	2:57	-12%	3:14	2:46	-14%
West	1:47	1:44	-2%	2:34	2:26	-5%

The results in Tables 3.1 and 3.2 indicate that the model generally provides the required representation of surveyed travel times (i.e. within ±15% of the observed travel times).

3.3 Model Calibration/Validation Outcomes

The Paramics micro-simulation models for the AM and PM peak periods have been calibrated to meet the requirements normally used for traffic simulation models in NSW. The models appropriately reflect the traffic conditions observed during the site visits and are deemed suitable for the purpose of testing alternative network configuration options and for assessing the impacts of future traffic demands associated with future development in the study area.

4. 2036 DEVELOPMENT TRAFFIC SCENARIOS

4.1 LAND USE SCENARIOS

Two future developments scenarios have been assessed for the Wentworthville Town Centre as part of this study; namely Scenario 2 (lower mid-rise) and Scenario 3 (upper mid-rise) shown in Figures 4.1 and 4.2. The only difference with Scenario 3 compared to Scenario 2 is the allowance of residential towers on a selection of key sites.

Figure 4.1: Scenario 2 Development Concept

Figure 4.2: Scenario 3 Development Concept

Both scenarios consist of both residential and commercial space however Scenario 3 has increased residential development and reduced commercial space compared to Scenario 2. Table 4.1 provides the estimated ground floor areas for both residential and commercial space under each scenario.

Table 4.1: Scenario 2 and 3 Ground Floor Estimates

Use	Scenario 2	Scenario 3
Commercial	33,672 m^2	211,784 m^2
Residential	31,183 m^2	226,564 m^2

4.2 FUTURE YEAR TRAFFIC DEMANDS

Table 4.2 shows the total vehicle demands for the development in Scenarios 2 and 3. In addition to local development traffic, the external zones were increased at 1% p.a. (compounding) from 2015-2036 based on trend growth recorded in these locations.

Table 4.2: Paramics Model Traffic Demands 2036 (2 hour)

Proposed Scenario	Traffic Generation			
	AM Peak Total Trips 2036	*2015 AM Peak Comparison*	PM Peak Total Trips 2036	*2015 PM Peak Comparison*
Scenario 2	14,002	*11,164*	14,871	*12,042*
Scenario 3	14,042	*11,164*	14,947	*12,042*

As show in Table 4.2 the traffic demands are expected to increase by approximately 25% between year 2015 and 2036.

5. 2036 BASE CASE RESULTS

To demonstrate the impacts of the achievement of the development scenarios without any traffic upgrades at all, both the Scenario 2 and Scenario 3 traffic demands were applied to the base network model. Figure 5.1 and Figure 5.2 show how the network is expected to operate with the increased traffic demands associated with the additional development and no upgrades in place.

Figure 5.1: AM Base Model with Scenario 2 Year 2036 Demands

Figure 5.2: PM Base Model with Scenario 3 Year 2036 Demands

In both peaks and for both development scenarios, the network either could not cope with the future traffic demands or had traffic queuing back well beyond the networks extents.

Figure 5.3 provides a selection of links in the network for which traffic volumes were extracted as well as locations in which key travel times were recorded from the model.

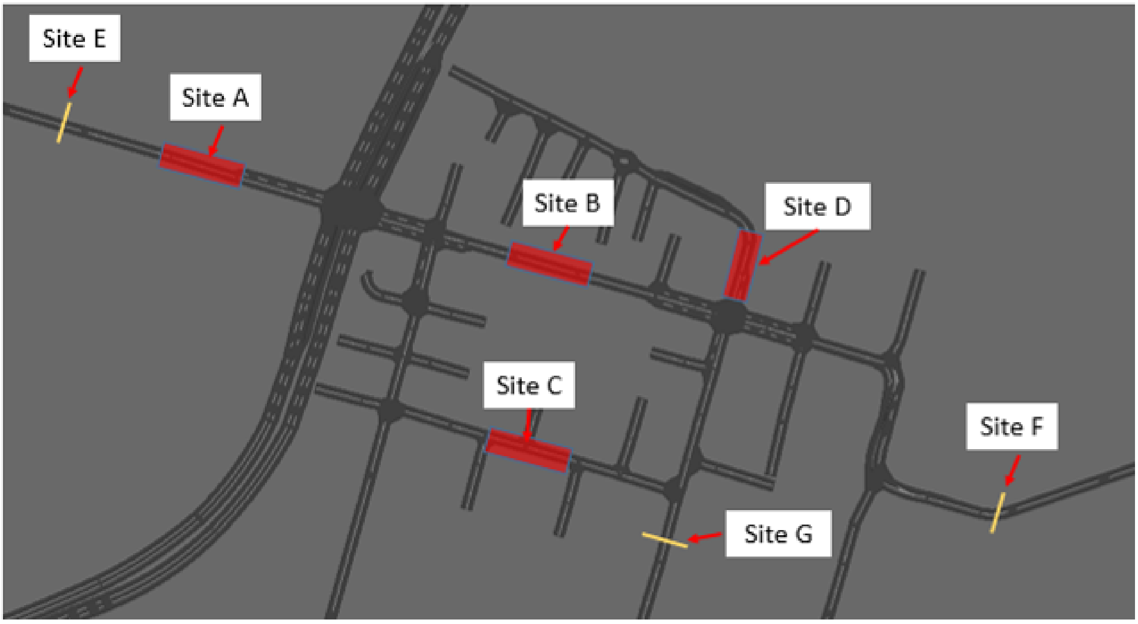


Figure 5.3: Traffic Volume Sites and Travel Time Recording Locations

Table 5.1 and Table 5.2 provide the traffic volumes at the key locations in Figure 5.3.

Table 5.1: Link Volumes for Scenario 2

Scenario 2	7:00AM - 9:00AM Peak				4:00PM – 6:00PM Peak			
	East Bound		West Bound		East Bound		West Bound	
	2036	*2015*	2036	*2015*	2036	*2015*	2036	*2015*
Site A	1333	*1173*	571	*483*	732	*569*	1203	*1073*
Site B	1566	*1555*	769	*543*	1267	*1009*	1307	*1089*
Site C	136	*68*	146	*52*	131	*83*	232	*201*
Site D	228	*101*	243	*333*	295	*279*	264	*195*

Table 5.2: Link Volumes for Scenario 3

Scenario 3	7:00AM - 9:00AM Peak				4:00PM – 6:00PM Peak			
	East Bound		West Bound		East Bound		West Bound	
	2036	*2015*	2036	*2015*	2036	*2015*	2036	*2015*
Site A	1383	*1173*	550	*483*	755	*569*	1220	*1073*
Site B	1558	*1555*	729	*543*	1312	*1009*	1294	*1089*
Site C	130	*68*	132	*52*	118	*83*	226	*201*
Site D	223	*101*	243	*333*	287	*279*	304	*195*

Whilst the volumes in 2036 output from the model are not much higher than in 2015 (in general) the network is shown to be severely constrained and hence limits the potential throughput achievable in any two hour period, with extensive queueing occurring as a consequence. Table 5.1 and 5.2 show that Dunmore Street effectively reaches its expected practical capacity of over 700 vehicles per hour (vph), with the volume on Pritchard Street much lower, but essentially still impacted by queues on the Dunmore – Station corridor.

Tables 5.3 and 5.4 provide the travel time comparisons related to the locations in Figure 5.3.

Table 5.3: Travel Times for Scenario 2

Scenario 2	7:00AM - 9:00AM Peak				4:00PM – 6:00PM Peak			
	East Bound		West Bound		East Bound		West Bound	
	2036	*2015*	2036	*2015*	2036	*2015*	2036	*2015*
Between Site E & Site F	4:10	*2:16*	5:02	*2:20*	5:16	*2:31*	3:37	*3:23*
Between Site E & Site G	4:25	*2:14*	7:36	*1:55*	5:26	*2:45*	3:08	*2:26*
Between Site F & Site G	3:21	*1:20*	6:02	*1:04*	2:07	*1:55*	1:42	*1:10*

Table 5.4: Travel Times Scenario 3

Scenario 3	7:00AM - 9:00AM Peak				4:00PM – 6:00PM Peak			
	East Bound		West Bound		East Bound		West Bound	
	2036	*2015*	2036	*2015*	2036	*2015*	2036	*2015*
Between Site E & Site F	4:46	*2:16*	7:10	*2:20*	3:57	*2:31*	3:19	*3:23*
Between Site E & Site G	5:02	*2:14*	6:45	*1:55*	4:08	*2:45*	2:56	*2:26*
Between Site F & Site G	5:29	*1:20*	4:15	*1:04*	1:48	*1:55*	1:27	*1:10*

The increase in traffic demands with no upgrades results in a substantial increase in travel times as seen in Tables 5.3 and 5.4. This increase in travel times are excessive with some trips taking up to 7 minutes to clear the network, over three times current travel times through the network. This is also demonstrated in Figure 5.3 which compares typical queue lengths at 5:00 PM in 2015 and in the 2036 base case.

2015, 5:00 PM

2036 Base Case, 5:00 PM

Figure 5.4: Queue Lengths (2015 v 2036 Scenario 2 Base Case)

6. BYPASS MODEL CONFIGURATION

6.1 NETWORK CONFIGURATION

Figure 6.1 outlines the proposed traffic improvements strategy to bypass Dunmore Street and feed traffic into Prichard Street which will have extension added to pass traffic through to Veron Street. The intent of the bypass is to divert a significant proportion of through traffic around the key pedestrian ad on street parking (high activity) areas of Station Street and Dunmore Street.

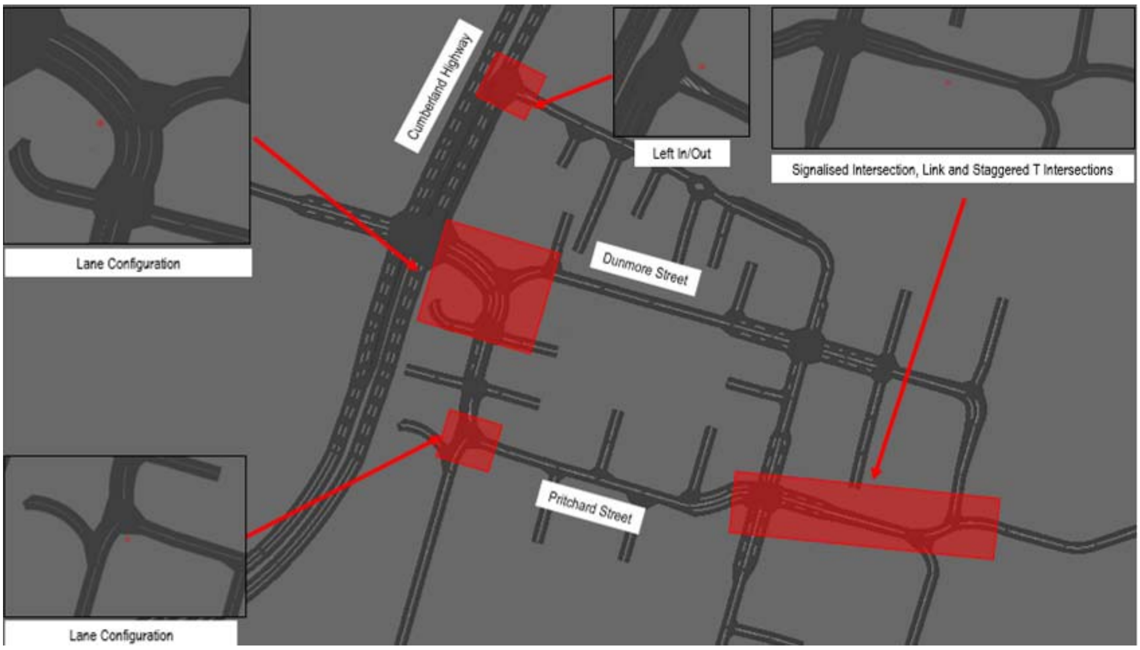


Figure 6.1: Proposed Traffic Improvements Strategy

The proposed traffic improvements strategy consists of 4 key elements:

- An extension of Pritchard Street from Station Street to Lane Street. To accommodate this, a signalised intersection will be introduced at the new four way intersection;
- A new intersection at Lane Street to connect to the new section of east-west road;
- Reconfiguring the intersection east of the signals along the Cumberland Highway so that the major movement of traffic is now down Garfield Street and not along Dunmore Street;
- The intersection between Pritchard Street and Garfield Street will have to be reconfigured to have that major movement turn down Pritchard Street; and
- Left in/out at Kingsway/Cumberland Highway intersection.

6.2 2036 Scenario 2 Results

Figure 6.2 shows the locations in which link volumes and travel time data was extracted from the model.

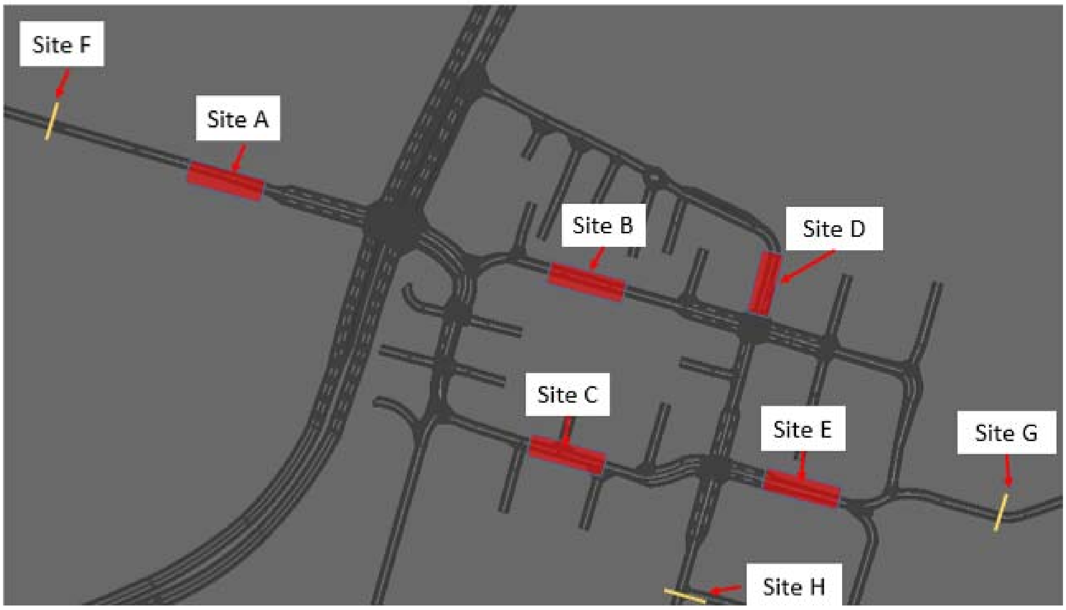


Figure 6.2: Traffic volume sites and travel time recording points

Table 6.1 and Table 6.2 provide the traffic volumes and travel times at the nominated locations in Figure 6.2 and compared to the 2036 base case (i.e. no network upgrades).

Table 6.1: Link volumes Scenario 2 v Base Case

Scenario 2	7:00AM - 9:00AM Peak (2036)				4:00PM – 6:00PM Peak (2036)			
	East Bound		West Bound		East Bound		West Bound	
	Bypass	*Base*	Bypass	*Base*	Bypass	*Base*	Bypass	*Base*
Site A	1512	*1333*	639	*571*	742	*732*	1246	*1203*
Site B	122	*1566*	192	*769*	166	*1267*	209	*1307*
Site C	1770	*136*	768	*146*	1141	*131*	1296	*232*
Site D	261	*228*	223	*243*	276	*295*	211	*264*
Site E	1417	-	506	-	747	-	883	-

Table 6.2: Travel Times Scenario 2 v Base Case

Scenario 2	7:00AM - 9:00 AM Peak (2036)				4:00PM – 6:00PM Peak (2036)			
	East Bound		West Bound		East Bound		West Bound	
	Bypass	*Base*	Bypass	*Base*	Bypass	*Base*	Bypass	*Base*
Between Site F & Site G	2:11	*4:10*	2:01	*5:02*	4:30	*5:16*	2:55	*3:37*
Between Site F & Site H	2:00	*4:25*	1:59	*7:36*	4:12	*5:26*	2:48	*3:08*
Between Site G & Site H	0:57	*3:21*	1:14	*6:02*	1:25	*2:07*	1:20	*1:42*

From the results shown in Tables 6.1 and 6.2 it can be seen that the AM travel times are greatly reduced in 2036 with the bypass in place and this link also facilitates and increased volume of traffic flowing through the network (i.e. less residual queueing held up). The PM peak also shows a decrease in travel times through the network. There is a substantial reduction in traffic in Dunmore Street (Site B) in particular, allowing this road to be prioritised for greater use by pedestrians and parking movements.

Figure 6.3 provides a comparison of typical queues at 5:00PM between the 2036 Scenario 2 base case and 2036 Scenario 2 with the bypass in place.

	
2036 Scenario 2 Base Case, 5:00 PM	2036 Scenario 2 with Bypass, 5:00 PM

Figure 6.3: Queue Lengths (2036 Scenario 2 Bae Case v 2036 Scenario 2 with Bypass)

6.3 2036 SCENARIO 3 RESULTS

Figure 6.4 shows the locations in which link volumes and travel time data was extracted from the model.

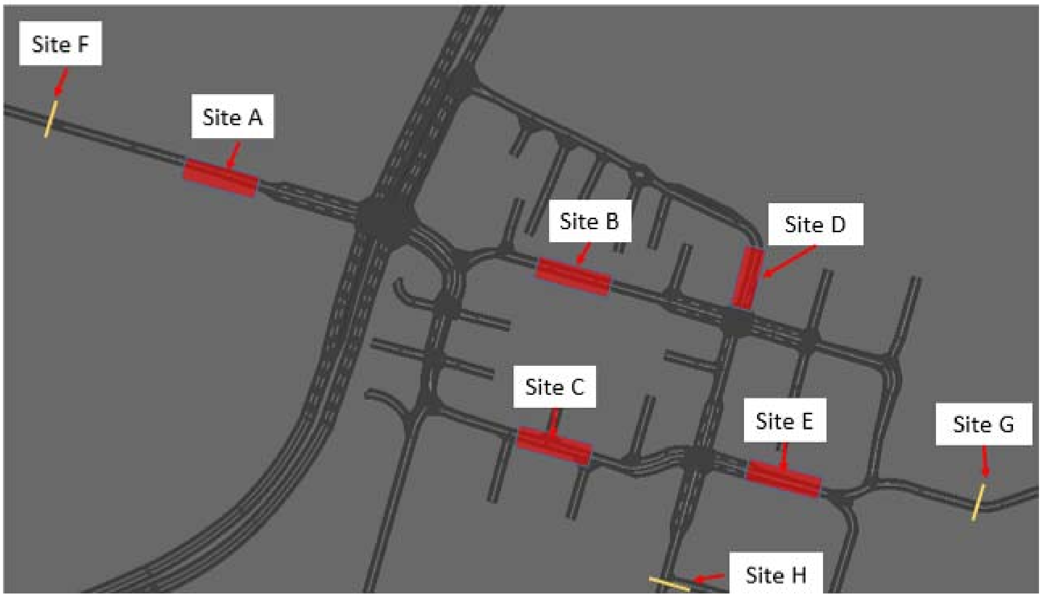


Figure 6.4: Traffic volume sites and travel time recording points

Table 6.3 and Table 6.4 provide the traffic volumes and travel times at the nominated locations in Figure 6.4 and compared to the 2036 base case (i.e. no network upgrades).

Table 6.3: Link volumes for Scenario 3

Scenario 3	7:00AM - 9:00AM Peak 2036				4:00PM – 6:00PM Peak 2036			
	East Bound		West Bound		East Bound		West Bound	
	Bypass	*Base*	Bypass	*Base*	Bypass	*Base*	Bypass	*Base*
Site A	1515	*1383*	645	*550*	755	*755*	1264	*1220*
Site B	120	*1558*	198	*729*	190	*1312*	215	*1294*
Site C	1791	*130*	749	*132*	1135	*118*	1257	*226*
Site D	265	*223*	228	*243*	270	*287*	242	*304*
Site E	1437	-	496	-	746	-	866	-

Table 6.4: Travel Times for Scenario 3

Scenario 3	7:00AM - 9:00AM Peak 2036				4:00PM – 6:00PM Peak 2036			
	East Bound		West Bound		East Bound		West Bound	
	Bypass	*Base*	Bypass	*Base*	Bypass	*Base*	Bypass	*Base*
Between Site F & Site G	2:11	*4:46*	2:00	*7:10*	3:50	*3:57*	2:49	*3:19*
Between Site F & Site H	2:00	*5:02*	1:59	*6:45*	3:51	*4:08*	2:34	*2:56*
Between Site G & Site H	0:56	*5:29*	1:14	*4:15*	1:22	*1:48*	1:21	*1:27*

The traffic demands in Scenario 3 are very similar to those in Scenario 2 with a substitution of commercial traffic for more residential traffic. The model results in Table 6.3 and 6.4 and the outcomes are also similar for Scenario 3 compared to Scenario 2.

7. CUMBERLAND HIGHWAY/THE KINGSWAY LEFT IN/OUT ASSESSMENT

7.1 PURPOSE

The proposed left in/out arrangement at the Cumberland Highway/The Kingsway intersection allows traffic arriving from the north to enter The Kingsway without having to use the more circuitous route of Dunmore Street-Station Street-The Kingsway. This includes traffic accessing the Park and Ride or the Kiss and Ride area near the station as well as the general public parking in this area.

There is potential for such an intersection connection to not be approved by RMS due to sight distance and intersection spacing concerns. The purpose of the sensitivity testing was to determine the impacts on Dunmore Street and the bypass arrangement if the left in/out at the Cumberland Highway was no included in the network.

7.2 RESULTS

To understand the differences associated with not having the left in/out intersection, traffic volumes were extracted from the model at the three locations shown in Figure 7.1.

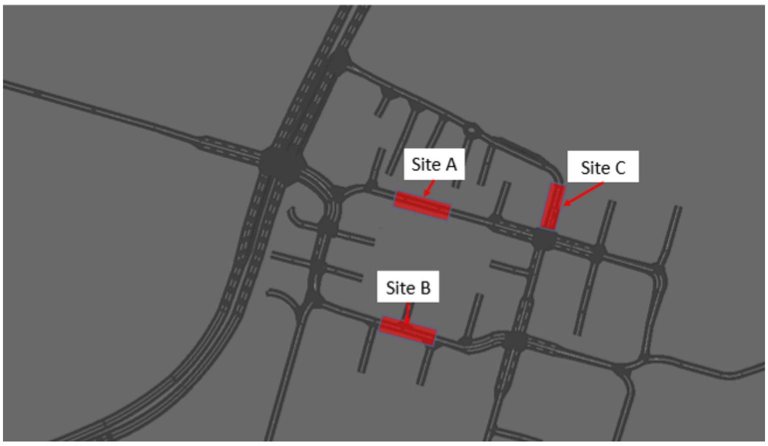


Figure 7.1: Locations of Link Volumes

Table 7.1 provides the traffic volumes extracted from the models for the sensitivity testing (using Scenario 2) traffic.

Table 7.1: Link Volumes under Scenario 2

Scenario 2	7:00AM - 9:00AM Peak 2036				4:00PM – 6:00PM Peak 2036			
	East Bound		West Bound		East Bound		West Bound	
	Without Left In/Out	*With Left In/Out*	Without Left In/Out	*With Left In/Out*	Without Left In/Out	*With Left In/Out*	Without Left In/Out	*With Left In/Out*
Site A	178	*122*	220	*192*	228	*166*	229	*209*
Site B	1770	*1770*	771	*768*	1131	*1141*	1297	*1296*
Site C	293	*261*	279	*223*	295	*276*	271	*211*

The traffic volumes shown in Table 7.1 identify that the removal of the left in/left out proposal simply moves this traffic to Dunmore Street with changes in the order of 25 vph per direction with no real change on the bypass. These impacts are considered negligible and suggest that whilst the left in/out reduces some traffic circulation, it has no significant impact on the bypass scheme or the benefits of the bypass to reducing traffic on Dunmore Street and Station Street.

The Scenario 3 results for this test were very similar to those reported for Scenario 2 above.

8. Dunmore Street Traffic Calming Option Assessment

8.1 Purpose

Current traffic conditions are that the majority of through traffic passes through Dunmore Street with the Prichard - Garfield Street route being relatively underutilised for through traffic movements. To assess what traffic diversions from Dunmore Street could be achievable, the effective target speed along Dunmore Street (Station to Garfield) and Station Street (Dunmore to Pritchard) was reduced from 50kph to 30kph assuming speed reduction devises, pedestrian interruption etc (the exact mechanisms to achieve the average speed would need to be determined at a later stage). The network configuration was otherwise based on the 2036 Scenario 2 base model.

8.2 Results

To understand the implications and benefits of "pushing" more traffic away from Dunmore Street, traffic volumes were extracted from the model at the three key locations shown in Figure 7.1 (Sites A, B and C) Travel time recording points (D, E, F) are also shown as for travel time comparisons.

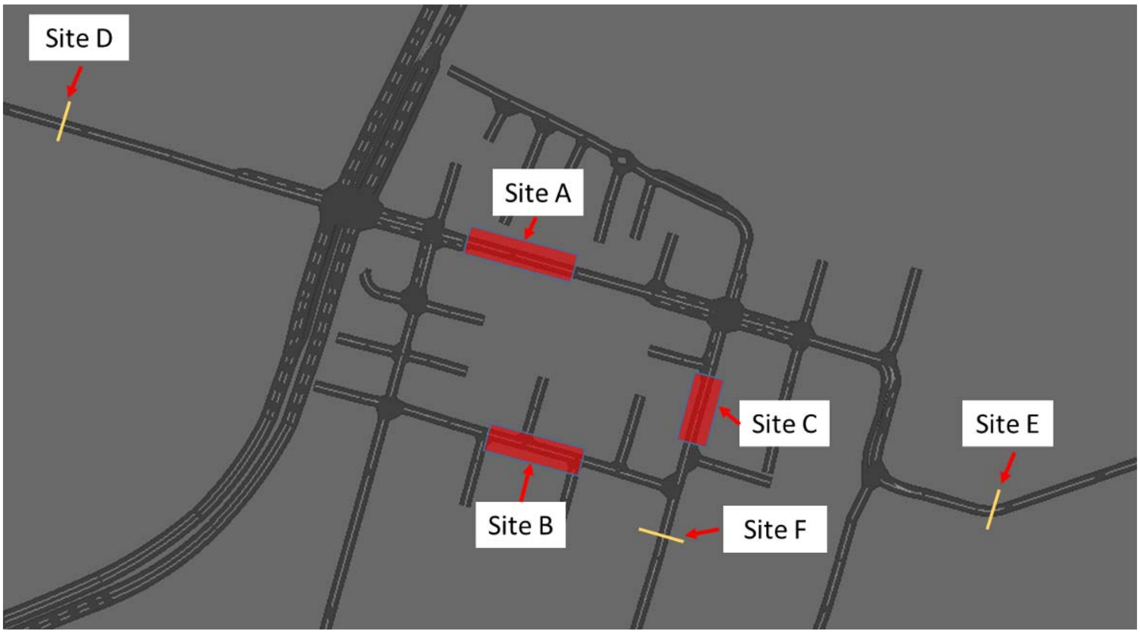


Figure 8.1: Traffic volume sites and travel time recording points

Table 8.1 and Table 8.2 provide the traffic volumes and travel times at the nominated locations in Figure 8.1 compared to the 2036 base case (i.e. no network upgrades). LATM refers to the option of including a traffic management scheme in Dunmore Street (Station to Garfield) and in Station Street (Dunmore to Pritchard) to reduce "target" link speeds to 30 kph.

Table 8.1: LATM Option v Base Case (Without LATM) Link Volumes

Scenario 2	7:00AM - 9:00AM Peak 2036				4:00PM – 6:00PM Peak 2036			
	Eastbound (Southbound)		Westbound (Northbound)		Eastbound (Southbound)		Westbound (Northbound)	
	LATM	*Without LATM*	LATM	*Without LATM*	LATM	*Without LATM*	LATM	*Without LATM*
Site A	1469	*1566*	501	*543*	1236	*1267*	755	*1089*
Site B	193	*136*	467	*136*	131	*131*	777	*232*
Site C	761	*766*	441	*614*	974	*909*	321	*798*

Table 8.2: LATM Option v Base Case (Without LATM)

Scenario 2	7:00AM - 9:00AM Peak 2036				4:00PM – 6:00PM Peak 2036			
	East Bound		West Bound		East Bound		West Bound	
	LATM	*Without LATM*	LATM	*Without LATM*	LATM	*Without LATM*	LATM	*Without LATM*
Between Site D & Site E	5:37	*4:46*	4:41	*7:10*	5:24	*3:57*	3:14	*3:19*
Between Site D & Site F	5:37	*5:02*	5:05	*6:45*	5:54	*4:08*	3:37	*2:56*
Between Site E & Site F	3:24	*5:29*	2:25	*4:15*	2:23	*1:48*	1:50	*1:27*

This option of constraining Dunmore Street and trying "push" traffic to the alternative Pritchard – Garfield route has only marginal effects in the AM peak with minimal traffic re-routing.

However in the PM peak and particularly in the westbound direction, approximately 30% of Dunmore Street traffic shifted in 2036. The primary reason the AM peak eastbound traffic did not show similar diversion is because of the right turn ban in place from Dunmore Street into Garfield Street prohibiting this from occurring.

9. HALF-BYPASS OPTION ASSESSMENT

9.1 PURPOSE

To assess the effectiveness and necessity of a "full bypass", "a half-bypass" option has been proposed. This option involves not including the proposed western end of the bypass (the new link) connecting Station Street and Lane Street. When running this model it was identified that due to the model continuing to route all westbound through traffic down Dunmore Street it was necessary to modify the Dunmore Street/Garfield Street intersection so that right turns from Dunmore Street were barred (i.e. a left in/out arrangement at this location). The proposed layout can been seen in Figure 9.1.

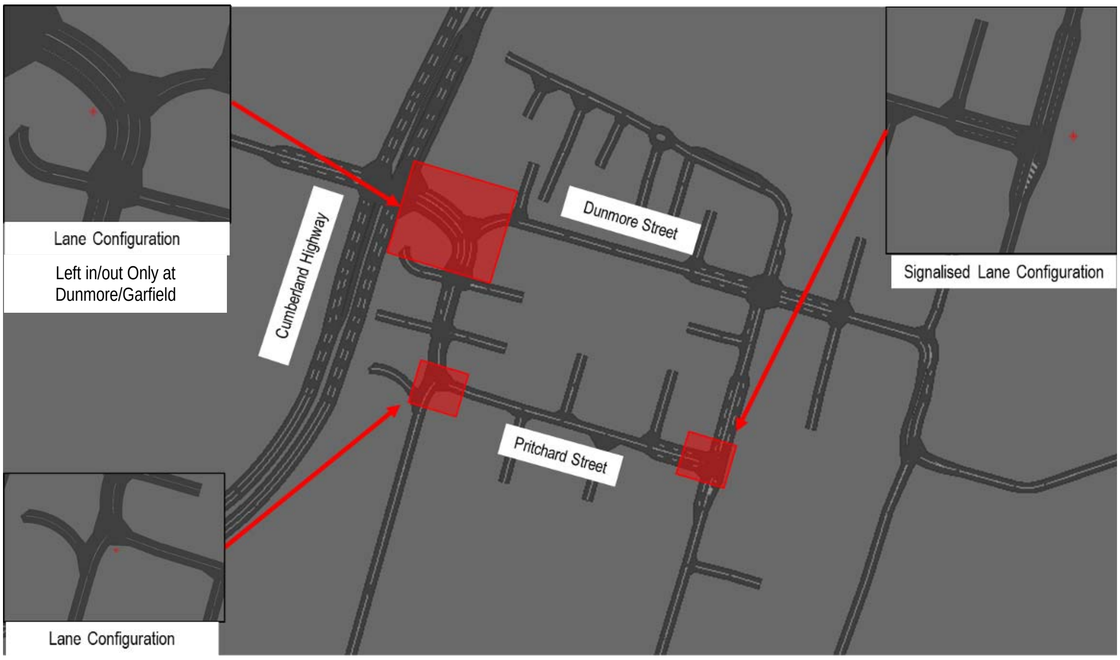


Figure 9.1: Half-Bypass Configuration

9.2 RESULTS

To understand the likely effects of this option, traffic volumes were extracted from the model at the three locations shown in Figure 9.2 (travel time recording points are also shown).

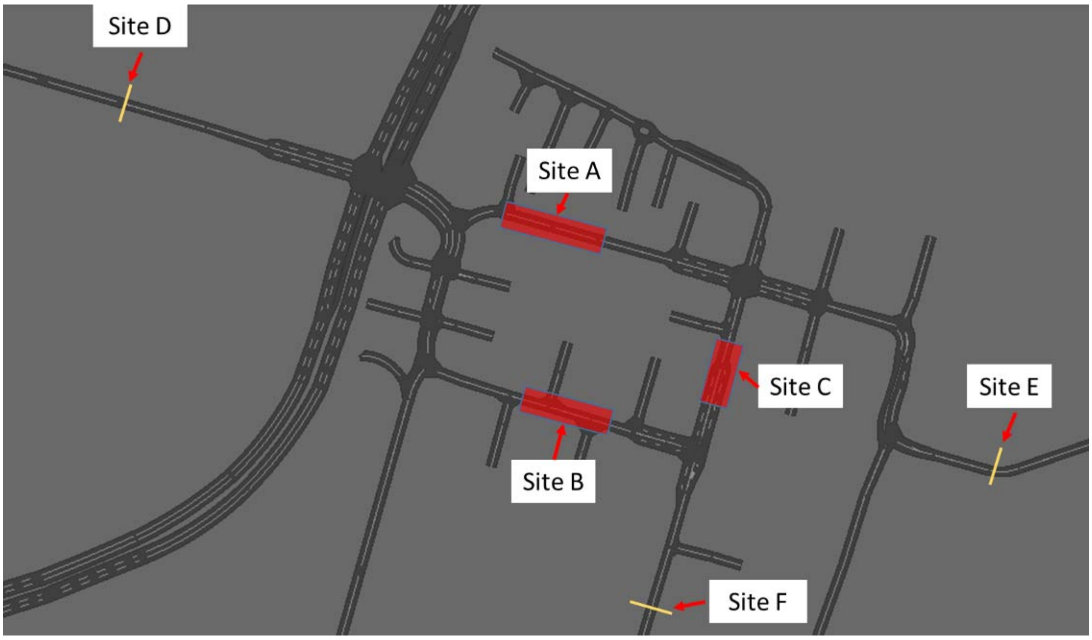


Figure 9.2: Traffic Volume Sites and Travel Time Recording Points

Table 9.1 and Table 9.2 provide the traffic volumes and travel times at the nominated locations for the half bypass option shown in Figure 9.1 and compared to the 2036 full bypass option.

Table 9.1: Link Volumes, Half-Bypass v Full Bypass

Scenario 2	7:00AM - 9:00AM Peak 2036				4:00PM – 6:00PM Peak 2036			
	East Bound (South Bound)		West Bound (North Bound)		East Bound (South Bound)		West Bound (North Bound)	
	Half-Bypass	*Full Bypass*	Half-Bypass	*Full Bypass*	Half-Bypass	*Full Bypass*	Half-Bypass	*Full Bypass*
Site A	1056	*1469*	43	*543*	567	*1236*	54	*1089*
Site B	616	*193*	961	*136*	473	*131*	1482	*232*
Site C	800	*761*	469	*614*	1241	*974*	354	*798*

**Both half and full bypass results are for the network which does not include the Kingsway/Cumberland left in/out*

Table 9.2: Travel Times, Half-Bypass v Full Bypass

Scenario 3	7:00AM - 9:00AM Peak 2036				4:00PM – 6:00PM Peak 2036			
	East Bound		West Bound		East Bound		West Bound	
	Half-Bypass	*Full Bypass*	Half-Bypass	*Full Bypass*	Half-Bypass	*Full Bypass*	Half-Bypass	*Full Bypass*
Between Site D & Site E	3:08	*2:12*	2:31	*2:00*	6:29	*5:28*	3:02	*2:52*
Between Site D & Site F	2:45	*2:03*	1:46	*2:05*	6:46	*5:29*	2:43	*2:40*
Between Site E & Site F	1:27	*0:57*	1:43	*1:13*	1:33	*1:25*	2:38	*1:18*

**Both half and full bypass results are for the network which does not include the Kingsway/Cumberland left in/out*

The effects of the half-bypass compared to the full bypass option were highly "directional". That is, in the eastbound direction between 30% and 50% of traffic was "diverted" to the bypass route, mostly associated with trips toward Station Street South, whilst traffic heading east continues to use Dunmore Street (with relatively easy left turn and through movements).

In the westbound direction, through traffic is effectively "forced" to use the half-bypass by the left in/out configuration at Dunmore / Garfield. This configuration is necessary as otherwise excessive queuing for right turns from Dunmore into Garfield create both capacity issues and safety concerns.

Due to the longer vehicle travel paths in the half-bypass option compared to the full bypass option, travel times are generally longer in this option.

10. TURN VOLUMES AND LEVELS OF SERVICE

10.1 PURPOSE

This section presents summaries of turning volumes at key intersections and delay-based Levels of Service (LOS) from the Paramics models.

10.2 TURNING VOLUMES

Figure 10.1, Figure 10.2, Figure 10.3, Figure 10.4 and Figure 10.5 provide the afternoon peak turning volumes at the key intersections for each option for the critical PM peak period. The 2036 results are based on land use scenario 2 traffic and are all based on two hour peak results (1600 – 1800).

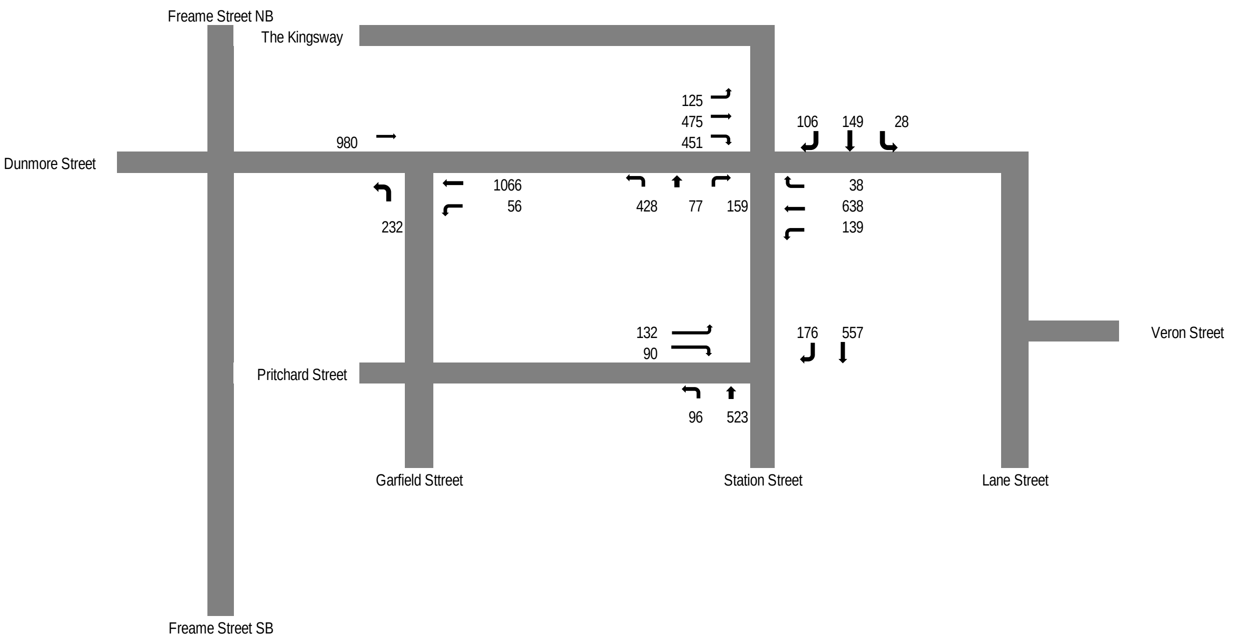


Figure 10.1: 2015 PM Peak Turning Volumes (4:00PM – 6:00PM)

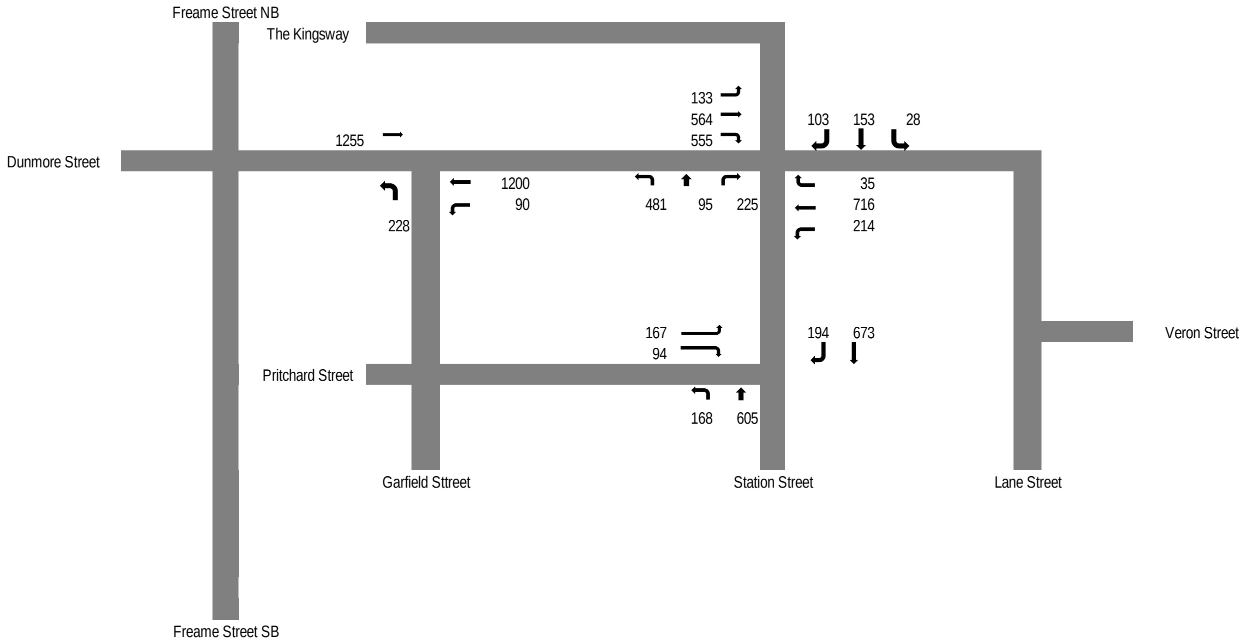


Figure 10.2: 2036 PM Peak Base Case Turning Volumes (4:00PM – 6:00PM)

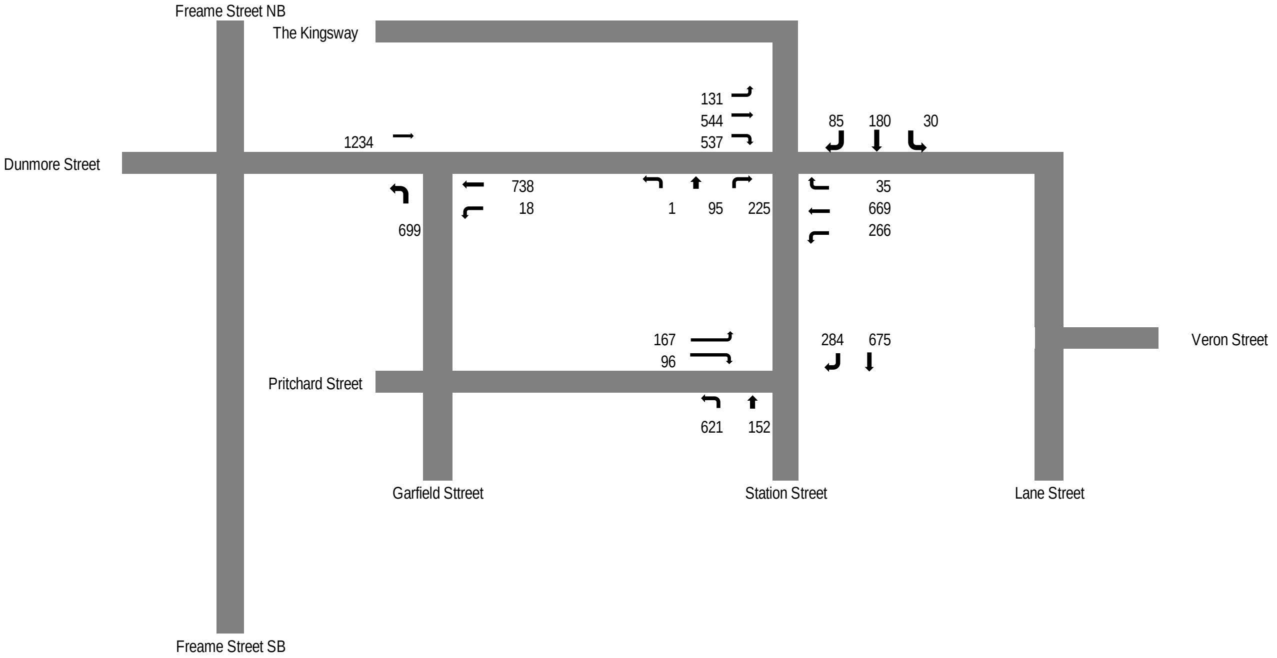


Figure 10.3: 2036 PM Peak LATM Option Turning Volumes

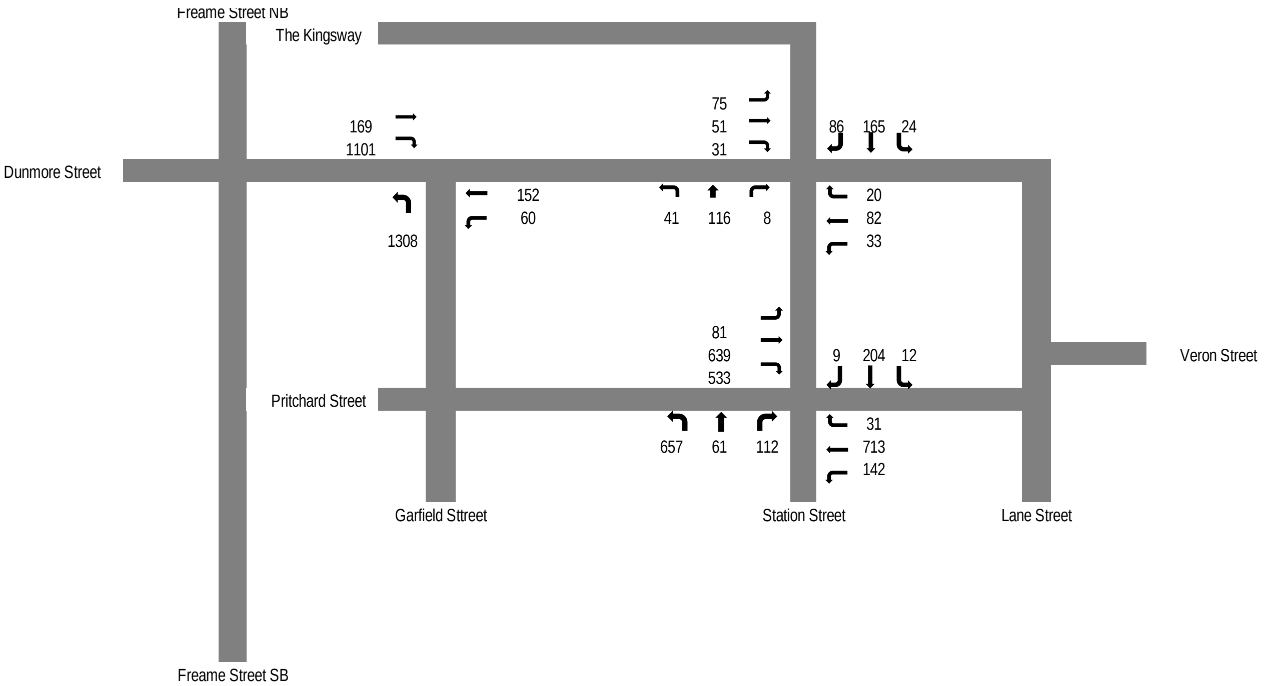


Figure 10.4: 2036 PM Peak Full Bypass Option Turning Volumes

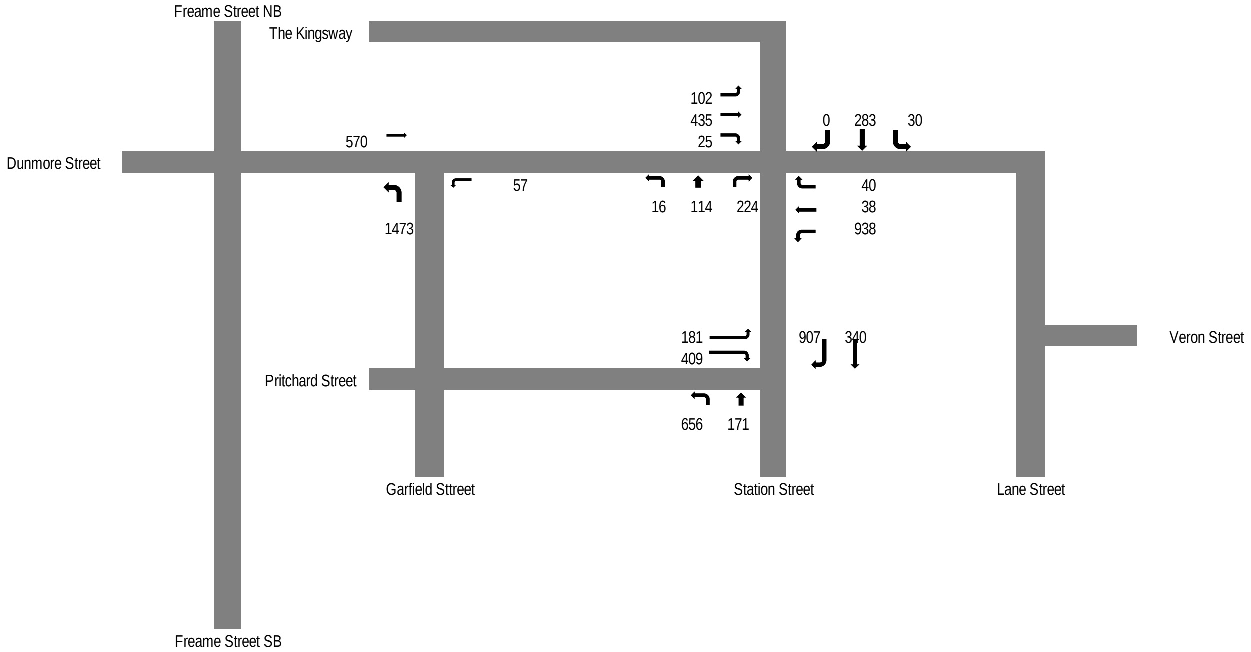


Figure 10.5: 2036 PM Peak Half- Bypass Option Turning Volumes

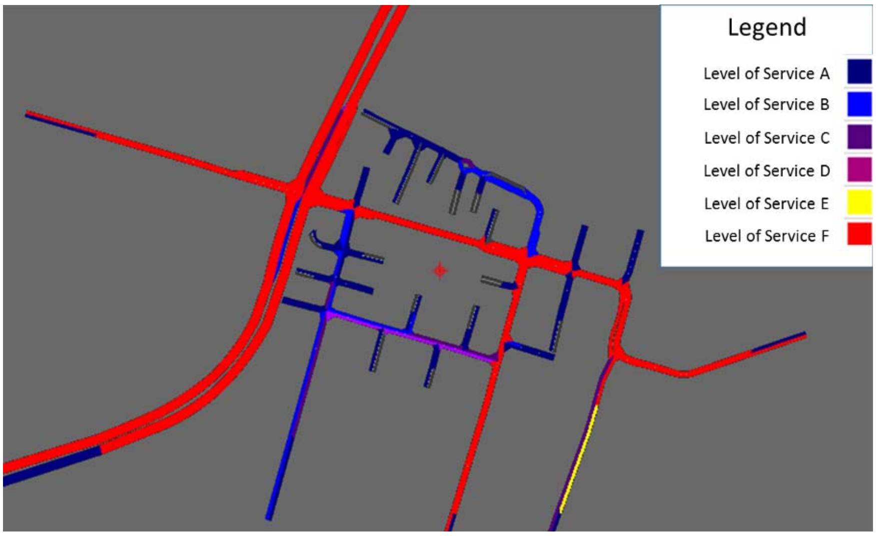
10.3 LEVELS OF SERVICE

Figure 10.6, Figure 10.7, Figure 10.8, Figure 10.9 and Figure 10.10 provide the critical afternoon peak level of service for the traffic network in the peak 15 minute period in the network. The Level of Service was determined using *RMS's Traffic Modelling Guidelines* definitions of delay times and LOS.

It is important to interpret Levels of Service results with extreme caution in congested networks as pinch points in one location can positively or negatively affect results in other parts of the network.

*Level of service is delay based per link

Figure 10.6: 2015 PM Peak Level of Service (5:00PM – 5:15PM)



*Level of service is delay based per link

Figure 10.7: 2036 PM Peak Base Case Level of Service (5:00PM – 5:15PM)

*Level of service is delay based per link

Figure 10.8: 2036 PM Peak Full Bypass Option Level of Service (5:00PM – 5:15PM

*Level of service is delay based per link

Figure 10.9: 2036 PM Peak LATM Option Level of Service (5:00PM – 5:15PM

*Level of service is delay based per link

Figure 10.10: 2036 PM Peak Half-Bypass Option Level of Service (5:00PM – 5:15PM)

The above figures suggest that doing nothing causes significant congestion issues by 2036 and that the full bypass option improves the situation significantly, the half bypass also achieves major benefits and that the LATM scheme for Dunmore Street pushes issues more into Garfield Street, although overall is moderately better than do nothing.

11. THRESHOLD ANALYSIS

11.1 PURPOSE

By 2036 (as evidenced in year 2036 modelling) the current road network was unable to effectively accommodate the proposed DCP development plus background traffic growth. To determine the point in which the traffic network becomes unable to “reasonably” accommodate traffic demands, the base model was progressively run between 2015 and 2036 with DCP development and background traffic growth escalated linearly from year to year. The criteria that was used to determine the year in which congestion was “unreasonable” was defined as when the queue along Dunmore Street reaches Station Street for more than half an hour in the peak hour. This assessment was run for the critical PM peak period.

11.2 RESULTS

Figure 11.1 shows the queues in 2022 between 4:45pm and 5:15pm. The analysis identified this year as the point when the existing traffic network is unable to reasonably accommodate further increases in traffic demands in the network.

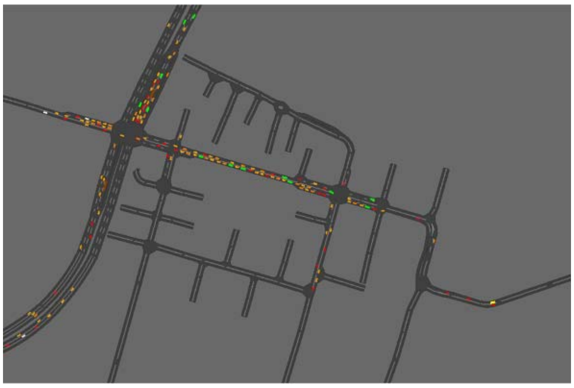
Queues in 2022 4:45pm	Queues in 2022 5:15pm
	

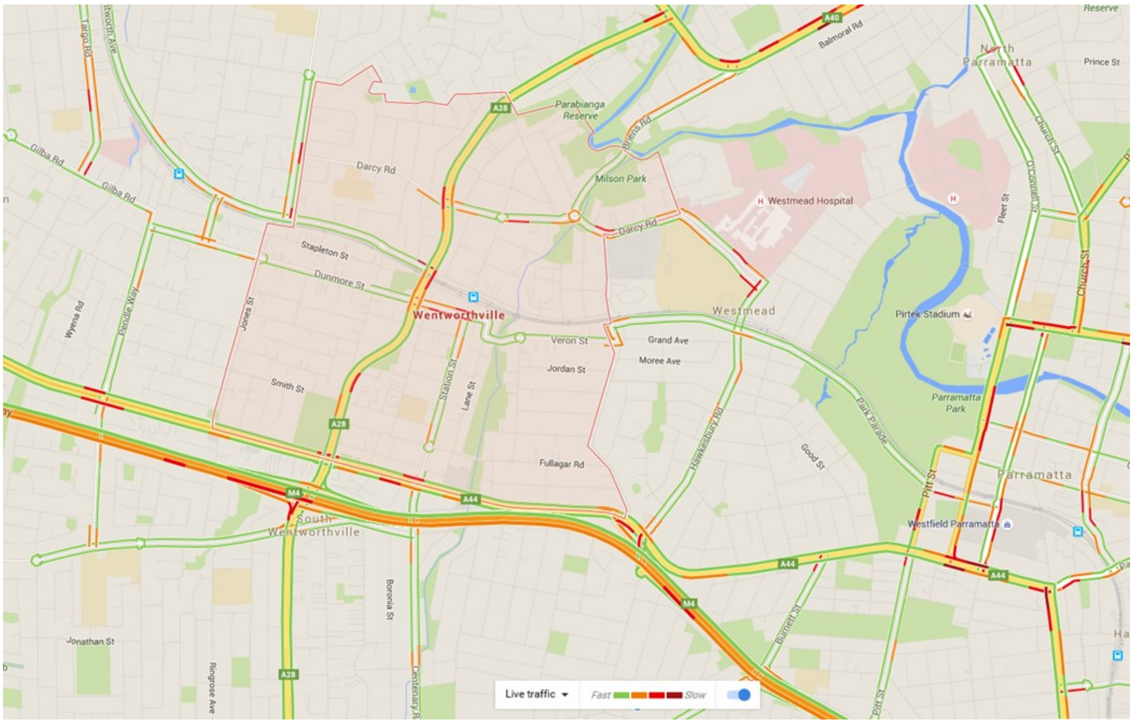
Figure 11.1: 2022 PM Peak Queue Lengths – Base Network

By 2022, the queues along Dunmore Street began to show that they were unable to be cleared in the avaialbe green time at the Cumberland Highway intersection, with queues shown to consistently extend beyond Station Street. On this basis, year 2022, or approximately one-third of the level f developent envisaged in development scenario 2 would appea to b the congestion “tipping point” based on the criteria defined above.

12. BROADER TRAFFIC MANAGEMENT OPTIONS

12.1 BROADER ISSUES

Figure 12.1 shows an extract of *google traffic* congestion in a typical weekday afternoon peak period at approximately 5:00PM.



Source:https://www.google.com.au/maps/place/Wentworthville

Figure 12.1: Indicative Regional Congestion

The Veron Street-Dunmore Street corridor is part of a fairly direct link between the Parramatta CBD and Girraween/Toongabbie with the railway line providing a barrier to north-south connectivity to the only real alternative route for this movement – Wentworth Avenue. Similarly, Station Street provides a convenient access from areas funnelling in from the south of the M4 and destined to the north, north-west of Wentworthville (and vice-versa).

In essence, it is the sparsity of north-south and east west “secondary” roads in this area coupled with limited rail line crossings that makes Dunmore Street such an attractive route for through traffic moving between adjacent suburbs (expected to be mostly in arrange of 2-3 suburbs from Wentworthville).

12.2 POTENTIAL BROADER OPTIONS

Without any detailed assessment undertaken, potential broader road upgrade options that might reduce the volume of through traffic using Dunmore Street include:

- Removal of turn bans and allowing the greater use of Wentworth Avenue on the northern side of the railway line to The Kingsway, and possibly extending this road eastwards to Westmead (albeit difficult to achieve);
- Extending Darcy Road further west to Wentworth Road (resumptions and impact involved); and
- Connecting Berth Road under the M4 to create another north-south connection so as not to rely on Station Street as the only reasonable nearby alternative to the Cumberland Highway.

Overall, the use of Dunmore Street stems from a lack of direct secondary roads linking Westmead and Parramatta to the north, north-west and the areas south of the M4 to the north-north-west. Station Road and Dunmore Street are direct connections that allow for passing through these areas to get around barriers like the M4 and the rail line and no simple, practical arterial road solution to this issue appears to exist.

13. DESIGN CONSIDERATIONS AND COST ESTIMATES

Appendix B contains the concept design for both the half bypass and full bypass options. It also includes cost estimates for both.

The following items were taken into account during the design and estimating:

- land acquisition;
- asphalt surfacing;
- construction of speed platforms/pedestrian facilities in Dunmore Street;
- demolition of existing pavement, kerb etc., where required to be augmented or modified;
- concreting;
- pavement; and
- roadside furniture.

The half-bypass has an estimated total cost of approximately $1.1M and the full bypass revealed an estimated total cost of $4.8M. A significant component of the variation in cost between the two options is due to the estimated cost of land acquisition for the full bypass at approximately $3M.

There may be opportunities to offset these costs through increased development rights on other parts of the impacted sites depending on future amalgamation patterns, the commercial feasibility of heights increases and practical limitations of building footprints on balance lands.

14. CONCLUSIONS

The Wentworthville Town Centre is already showing early signs of congestion-related impacts of through traffic using Dunmore Street. From the traffic survey results it is clear that about three quarters of the traffic in Dunmore Street in peak periods is passing through the area, and hence is not locally generated from within the centre. A broad analysis has revealed that the use of Dunmore Street stems for through trips from a lack of direct secondary roads linking Westmead and Parramatta to suburbs to the north, north-west and linking the areas south of the M4 to the north-north-west. Station Road and Dunmore Street are direct connections that allow for passing through these areas to get around barriers like the M4 and the rail line and no simple, practical arterial road solutions to this issue appear to exist.

The traffic modelling suggests that with through traffic growth, coupled with some moderate local traffic growth due to redevelopment proposals (either under Scenario 2 lower mid-rise or Scenario 3 upper mid-rise) the level of peak congestion and queueing in Dunmore Street will grow rapidly with consequential queuing impacts into Station Street and even Pritchard Street. This would result in travel times approximately three times current travel times for passing through the Town Centre. Such a decline in accessibility would inevitably affect local business in the town centre.

Significant traffic calming along Dunmore Street and along Station Street in the town centre showed a 30% approximate shift in traffic from Dunmore Street to Prichard Street in the PM peak but proved ineffective in the AM peak due to the current right turn ban from Dunmore into Garfield. The 30% shift would delay the onset of congested-related impacts shown in the “do nothing” modelling which identified conditions to significantly worsen by 2022 (to potentially unacceptable levels).

The modelling has also shown that the introduction of the town centre bypass counter-acts these accessibility impacts and essentially maintains 2036 travel times through the centre near 2015 levels. By splitting through and local traffic, it also allows Dunmore Street, Station Street and The Kingsway to be designed to better cater for pedestrians, local access and on street parking.

Testing of the left in/out intersection proposal at the extension of The Kingsway to the Cumberland Highway identified that not having this intersection has not significant impact on the need or usage of the bypass and simply elevates traffic marginally in Dunmore Street and in Station Street north of Dunmore Street. This intersection reduces the circuity of the access route for some traffic to the station area and does help to “activate” The Kingsway, but has no significant traffic capacity benefits.

Testing of a “half-bypass” provided traffic diversion results that were highly “directional” with effectively 30% to 50% of westbound traffic diverted to the bypass route, as traffic was “forced” onto Prichard Street by the left in/out configuration at Dunmore / Garfield under this concept. Travel times were also longer than the full bypass option due to the increased distanced required to travel compared to the full bypass. The half bypass is an effective means of managing westbound traffic but is less effective in managing eastbound traffic compared to the full bypass given the more direct path it provides.

On the basis of the modelling, it is clear that constraining through traffic use of Dunmore Street may force some through traffic to Pritchard Street-Garfield Street without formalising this route as a “bypass”. Formalising this route as a bypass using mostly its current alignment (the half-bypass concept) at $1.1M approx. diverts a large proportion of westbound through traffic out of Dunmore Street but does little to discourage eastbound through traffic usage. The full bypass, with land resumptions requirements and an estimated cost of $4.8M is more effective in diverting both directions of through traffic out of Dunmore Street, but at a significant cost.

Overall, the diversion of through traffic out of Dunmore Street is a worthy objective as the town centre intensifies with local development to maintain the accessibility of the centre and promote public and active transport through its “main streets” rather than through traffic. The means of achieving this and the degree to which this is achieved varies with the suite of options available to be implemented as part of the town centre strategy.

APPENDIX A

MODEL VALIDATION RESULTS

AM Peak

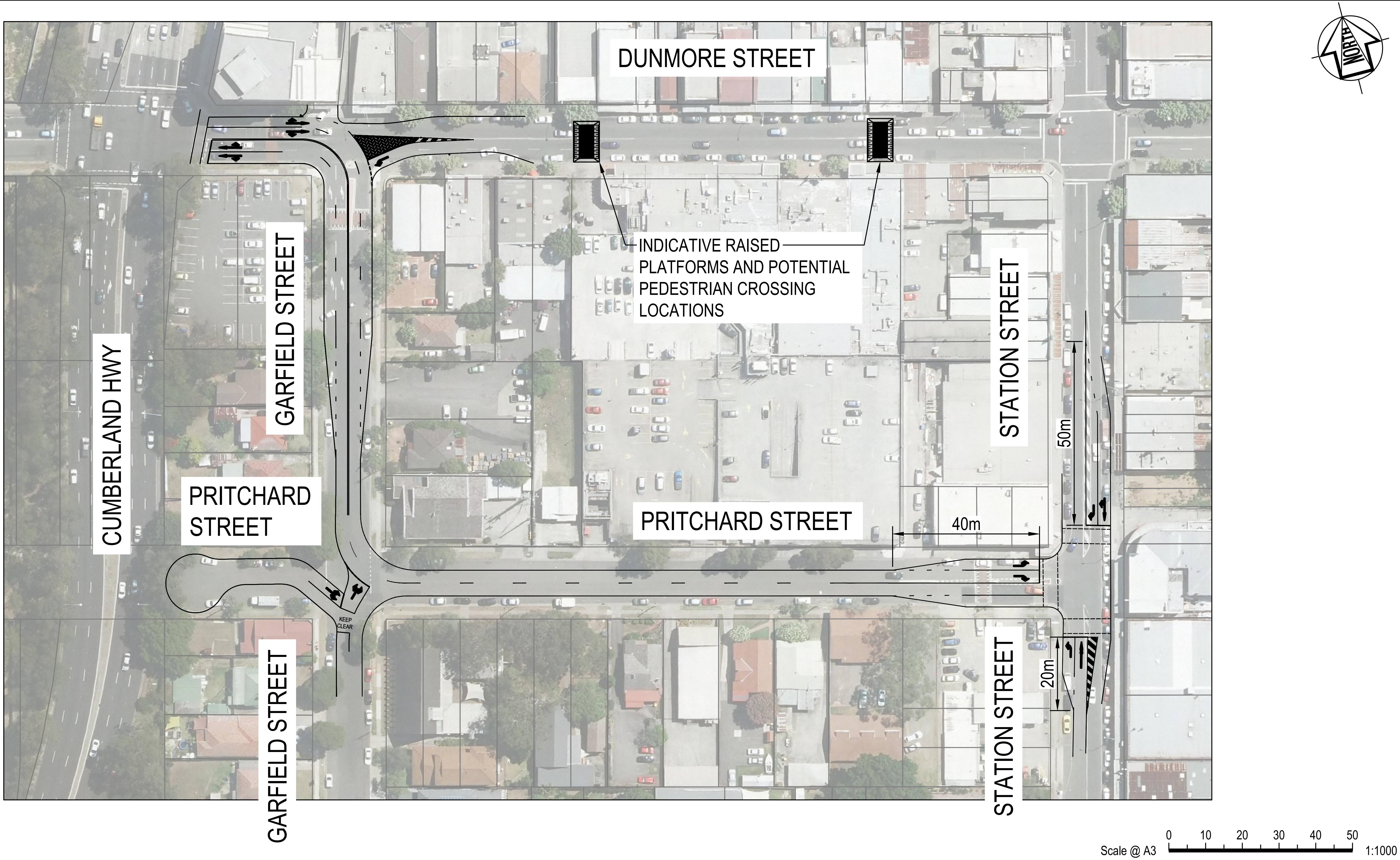
				Seed 560		Seed 7771		Seed 28		Seed 2849		Seed 86524	
Intersection	Direction	Movement	Count Data 07:00-09:00	Modelled	GEH	Modelled	GEH	Modelled	GEH	Modelled	GEH	Modelled	GEH
Freame Street/Dunmore Street	NB	Left	40	29	1.9	35	0.8	30	1.7	42	0.3	31	1.5
		Through	3732	3639	1.5	3696	0.6	3657	1.2	3607	2.1	3736	0.1
		Right	118	89	2.9	106	1.1	110	0.7	122	0.4	101	1.6
	WB	Left	75	68	0.8	62	1.6	80	0.6	90	1.7	67	0.9
		Through	331	306	1.4	288	2.4	315	0.9	326	0.3	308	1.3
		Right	286	262	1.4	259	1.6	275	0.7	291	0.3	264	1.3
	SB	Left	788	766	0.8	759	1.0	776	0.4	796	0.3	752	1.3
		Through	3095	2949	2.7	3008	1.6	3070	0.5	3027	1.2	3103	0.1
		Right	165	175	0.8	166	0.1	158	0.6	183	1.4	141	1.9
	EB	Left	324	297	1.5	345	1.1	322	0.1	311	0.7	343	1.0
		Through	784	801	0.6	808	0.9	772	0.4	784	0.0	745	1.4
		Right	112	112	0.0	103	0.9	122	0.9	109	0.3	123	1.0
Garfield Street/Pritchard Street	NB	Left	5	7	0.8	3	1.0	2	1.6	7	0.8	3	1.0
		Through	97	73	2.6	83	1.5	72	2.7	82	1.6	88	0.9
		Right	71	52	2.4	53	2.3	46	3.3	47	3.1	42	3.9
	WB	Left	27	7	4.9	9	4.2	14	2.9	15	2.6	14	2.9
		Through	1	0	1.4	0	1.4	0	1.4	0	1.4	0	1.4
		Right	52	30	3.4	39	1.9	45	1.0	31	3.3	36	2.4
	SB	Left	11	21	2.5	17	1.6	7	1.3	18	1.8	16	1.4
		Through	18	6	3.5	10	2.1	12	1.5	15	0.7	14	1.0
		Right	1	0	1.4	0	1.4	0	1.4	0	1.4	0	1.4
	EB	Left	1	0	1.4	0	1.4	0	1.4	0	1.4	0	1.4
		Through	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
		Right	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
The Kingsway roundabout	WB	Link	280	325	2.6	312	1.9	334	3.1	344	3.6	300	1.2
	EB	Link	165	124	3.4	133	2.6	125	3.3	128	3.1	117	4.0
Dunmore Street/Station Street	NB	Left	246	236	0.6	220	1.7	241	0.3	250	0.3	239	0.4
		Through	138	121	1.5	125	1.1	120	1.6	126	1.0	103	3.2
		Right	154	133	1.8	165	0.9	155	0.1	169	1.2	143	0.9
	WB	Left	94	80	1.5	100	0.6	102	0.8	87	0.7	92	0.2
		Through	318	313	0.3	289	1.7	340	1.2	364	2.5	295	1.3
		Right	43	50	1.0	36	1.1	49	0.9	43	0.0	38	0.8
	SB	Left	28	34	1.1	34	1.1	30	0.4	19	1.9	21	1.4
		Through	71	49	2.8	50	2.7	46	3.3	50	2.7	49	2.8
		Right	54	41	1.9	49	0.7	49	0.7	59	0.7	47	1.0
	EB	Left	140	154	1.2	150	0.8	165	2.0	175	2.8	158	1.5
		Through	935	966	1.0	979	1.4	986	1.6	1023	2.8	945	0.3
		Right	515	495	0.9	500	0.7	468	2.1	469	2.1	466	2.2
Pritchard Street/Station Street	NB	Left	59	45	1.9	69	1.3	59	0.0	67	1.0	53	0.8
		Through	490	434	2.6	436	2.5	461	1.3	479	0.5	430	2.8
	SB	Through	571	505	2.8	534	1.6	504	2.9	498	3.2	498	3.2
		Right	104	112	0.8	114	1.0	102	0.2	94	1.0	102	0.2
	EB	Left	59	52	0.9	69	1.3	54	0.7	64	0.6	51	1.1
		Right	16	22	1.4	11	1.4	12	1.1	26	2.2	16	0.0
Lane Street/Veron Street	NB	Through	83	82	0.1	52	3.8	64	2.2	85	0.2	69	1.6
		Right	108	78	3.1	77	3.2	85	2.3	73	3.7	78	3.1
	SB	Left	1043	1006	1.2	1057	0.4	1053	0.3	1086	1.3	1012	1.0
		Through	104	90	1.4	76	3.0	76	3.0	101	0.3	77	2.8
	EB	Left	41	45	0.6	34	1.1	38	0.5	35	1.0	29	2.0
		Right	375	363	0.6	355	1.0	407	1.6	394	1.0	343	1.7

PM Peak

				Seed 560		Seed 7771		Seed 28		Seed 2849		Seed 86524	
Intersection	Direction	Movement	Count Data 16:00-18:00	Modelled	GEH	Modelled	GEH	Modelled	GEH	Modelled	GEH	Modelled	GEH
Freame Street/Dunmore Street	NB	Left	107	126	1.8	103	0.4	116	0.9	109	0.2	124	1.6
		Through	3315	3430	2.0	3312	0.1	3260	1.0	3276	0.7	3238	1.3
		Right	93	80	1.4	61	3.6	51	4.9	67	2.9	81	1.3
	WB	Left	127	115	1.1	87	3.9	91	3.4	98	2.7	85	4.1
		Through	770	750	0.7	744	0.9	756	0.5	748	0.8	713	2.1
		Right	559	481	3.4	502	2.5	508	2.2	518	1.8	500	2.6
	SB	Left	531	546	0.6	568	1.6	547	0.7	561	1.3	527	0.2
		Through	4064	4097	0.5	4094	0.5	4078	0.2	4172	1.7	4097	0.5
		Right	256	252	0.3	232	1.5	256	0.0	237	1.2	248	0.5
	EB	Left	131	148	1.4	125	0.5	128	0.3	124	0.6	120	1.0
		Through	395	385	0.5	385	0.5	371	1.2	398	0.2	364	1.6
		Right	83	66	2.0	78	0.6	68	1.7	70	1.5	75	0.9
Garfield Street/Pritchard Street	NB	Left	10	0	4.5	0	4.5	0	4.5	0	4.5	0	4.5
		Through	103	85	1.9	75	3.0	86	1.7	73	3.2	90	1.3
		Right	39	44	0.8	45	0.9	48	1.4	39	0.0	52	1.9
	WB	Left	106	98	0.8	100	0.6	101	0.5	97	0.9	107	0.1
		Through	12	4	2.8	6	2.0	2	3.8	13	0.3	8	1.3
		Right	159	128	2.6	105	4.7	129	2.5	125	2.9	107	4.5
	SB	Left	43	42	0.2	31	2.0	34	1.5	43	0.0	35	1.3
		Through	59	47	1.6	70	1.4	69	1.3	72	1.6	57	0.3
		Right	3	0	2.4	0	2.4	0	2.4	0	2.4	0	2.4
	EB	Left	7	9	0.7	8	0.4	2	2.4	3	1.8	2	2.4
		Through	6	0	3.5	0	3.5	0	3.5	0	3.5	0	3.5
		Right	10	15	1.4	5	1.8	6	1.4	10	0.0	9	0.3
The Kingsway roundabout	WB	Link	195	241	3.1	190	0.4	198	0.2	178	1.2	205	0.7
	EB	Link	169	283	7.6	326	10.0	296	8.3	290	8.0	282	7.5
Dunmore Street/Station Street	NB	Left	448	428	1.0	466	0.8	434	0.7	464	0.7	435	0.6
		Through	77	77	0.0	61	1.9	70	0.8	62	1.8	66	1.3
		Right	155	159	0.3	138	1.4	145	0.8	171	1.3	162	0.6
	WB	Left	163	139	2.0	163	0.0	161	0.2	133	2.5	125	3.2
		Through	656	638	0.7	604	2.1	652	0.2	608	1.9	611	1.8
		Right	39	38	0.2	39	0.0	41	0.3	20	3.5	43	0.6
	SB	Left	45	28	2.8	42	0.5	30	2.4	42	0.5	36	1.4
		Through	172	149	1.8	159	1.0	148	1.9	106	5.6	125	3.9
		Right	124	106	1.7	125	0.1	118	0.5	142	1.6	121	0.3
	EB	Left	109	125	1.5	91	1.8	87	2.2	97	1.2	97	1.2
		Through	475	475	0.0	504	1.3	501	1.2	511	1.6	446	1.4
		Right	463	451	0.6	450	0.6	459	0.2	465	0.1	462	0.0
Pritchard Street/Station Street	NB	Left	122	96	2.5	131	0.8	119	0.3	107	1.4	128	0.5
		Through	503	523	0.9	543	1.7	523	0.9	550	2.0	537	1.5
	SB	Through	527	557	1.3	600	3.1	579	2.2	510	0.7	524	0.1
		Right	189	176	1.0	167	1.6	185	0.3	181	0.6	182	0.5
	EB	Left	132	132	0.0	112	1.8	112	1.8	126	0.5	117	1.3
		Right	82	90	0.9	101	2.0	107	2.6	92	1.1	104	2.3
Lane Street/Veron Street	NB	Through	108	98	1.0	105	0.3	93	1.5	95	1.3	96	1.2
		Right	98	83	1.6	88	1.0	83	1.6	106	0.8	84	1.5
	SB	Left	460	423	1.8	452	0.4	439	1.0	465	0.2	410	2.4
		Through	181	167	1.1	172	0.7	175	0.4	188	0.5	175	0.4
	EB	Left	161	129	2.7	164	0.2	159	0.2	123	3.2	163	0.2
		Right	676	656	0.8	641	1.4	689	0.5	598	3.1	644	1.2

APPENDIX B

CONCEPT DESIGN AND COST ESTIMATES



BITZIOS consulting
traffic engineering transport planning

Gold Coast
Suite 26, 58 Riverwalk Avenue, Robina QLD 4226.
P: (07) 5562-5377
W: www.bitziosconsulting.com.au

Brisbane
Level 2, 428 Upper Edward Street, Spring Hill 4000.
P: (07) 3831-4442
E: admin@bitziosconsulting.com.au

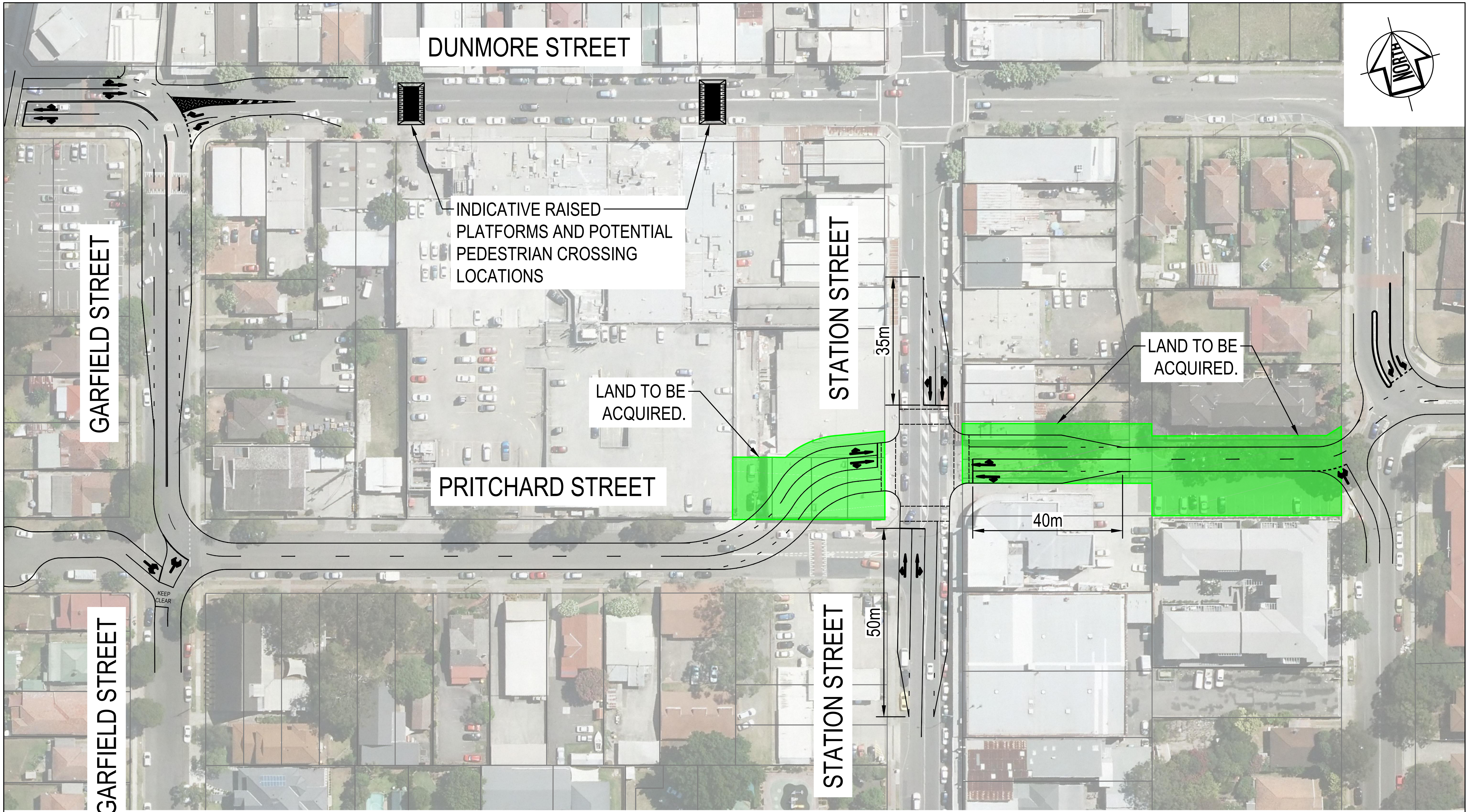
Sydney
Studio 203, 3 Gladstone Street, Newtown NSW 2042.
P: (02) 9557 6202

Project	Title	Design	Drawn	Checked
WENTWORTHVILLE BYPASS CONCEPT	OPTION 1 BYPASS CONCEPT PLAN SHEET 1 OF 1	D.C	D.C	D.B

CONCEPT ONLY

Date:

Project Number / Sheet	Issue
P2123 / 001	A



BITZIOS consulting
traffic engineering transport planning

Gold Coast
Suite 26, 58 Riverwalk Avenue, Robina QLD 4226.
P: (07) 5562-5377
W: www.bitziosconsulting.com.au

Brisbane
Level 2, 428 Upper Edward Street, Spring Hill 4000.
P: (07) 3831-4442
E: admin@bitziosconsulting.com.au

Sydney
Studio 203, 3 Gladstone Street, Newtown NSW 2042.
P: (02) 9557 6202

Project	Title	Design	Drawn	Checked
WENTWORTHVILLE BYPASS CONCEPT	OPTION 2 BYPASS CONCEPT PLAN SHEET 1 OF 1	D.C	D.C	D.B
		CONCEPT ONLY		Date
		Project Number / Sheet: P2123 / 002		Issue: A