Prospect Highway Upgrade

Traffic Model Calibration

Contract Number: 13.2592.1599

For: Roads and Maritime Services
Date: 13 December, 2013

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1. INTRODUCTION

1.1 Background

SMEC Australia Pty Ltd (SMEC) was commissioned by Roads and Maritime Services (Roads and Maritime) to prepare a Transport Impact Assessment for the Prospect Highway (MR644) Upgrade, between Reservoir Road at Prospect and St Martins Crescent at Blacktown. This study involves conducting a micro-simulation traffic modelling assessment and scenario testing.

The road network within the study area is approaching capacity and experiences significant delays during the AM and PM peak periods. Traffic volumes are forecast to increase with the development of Greystanes Southern Employment Lands Estate and the Wet 'n' Wild Sydney water theme park, south of the study area. The aim of the Prospect Highway Upgrade is to ensure that sufficient traffic capacity is available to service the corridor.

The Transport Impact Assessment will determine the existing transport environment and its performance, describe the proposal, assess the impacts for all road users during operation and construction and identify management and mitigation measures for minimising the impacts. The impacts of the upgrade will be assessed by examining the results of the micro-simulation modelling, with a focus on travel times and speeds on the corridor, reliability of travel times, intersection performance, aggregate network statistics, environmental measures and throughput of traffic on the corridor.

1.2 Model purpose

The purpose of the micro-simulation model is to test the suitability of a number of design scenarios over multiple future years. Traffic data was collected in October 2013 for the purpose of calibrating the base model. By calibrating the base model, SMEC can model the future year scenarios with confidence that the model is reflective of the current conditions and travel behaviour along the corridor.

1.3 Software package

The AIMSUN, version 7.0.3 micro-simulation software package is being used for the purpose of this study.

1.4 Time periods

Two one-hour peak models have been created to represent the AM and PM peak periods. Matrices were provided by Roads and Maritime (from EMME) for two periods:

- The morning peak period (7am to 9am).
- The afternoon peak period (4pm to 6pm).

For the AIMSUN model, SMEC examined the traffic counts to identify the busiest hour overall, in each peak period. The peak hours were identified as 8am to 9am for the morning and 5pm to 6pm for the afternoon.

SMEC allowed a 30 minute warm-up period using the built in warm up function within AIMSUN.

1.5 Project location

The project area is located in the Prospect Highway / Blacktown Road corridor in Prospect, which is around 28 kilometres west of the Sydney CBD, as shown in Figure 1.1.

Figure 1.1: Project location

1.6 Model study area

The AIMSUN model includes the Prospect Highway corridor from Reconciliation Road, south of Reservoir Road to north of Bungarribee Road as shown in Figure 1.2. The modelled area includes all of the intersecting streets along the corridor length as well as Cavendish Avenue, Columbia Road and a section of Ellam Drive. Due to the corridor nature of the project, there is no core area defined.

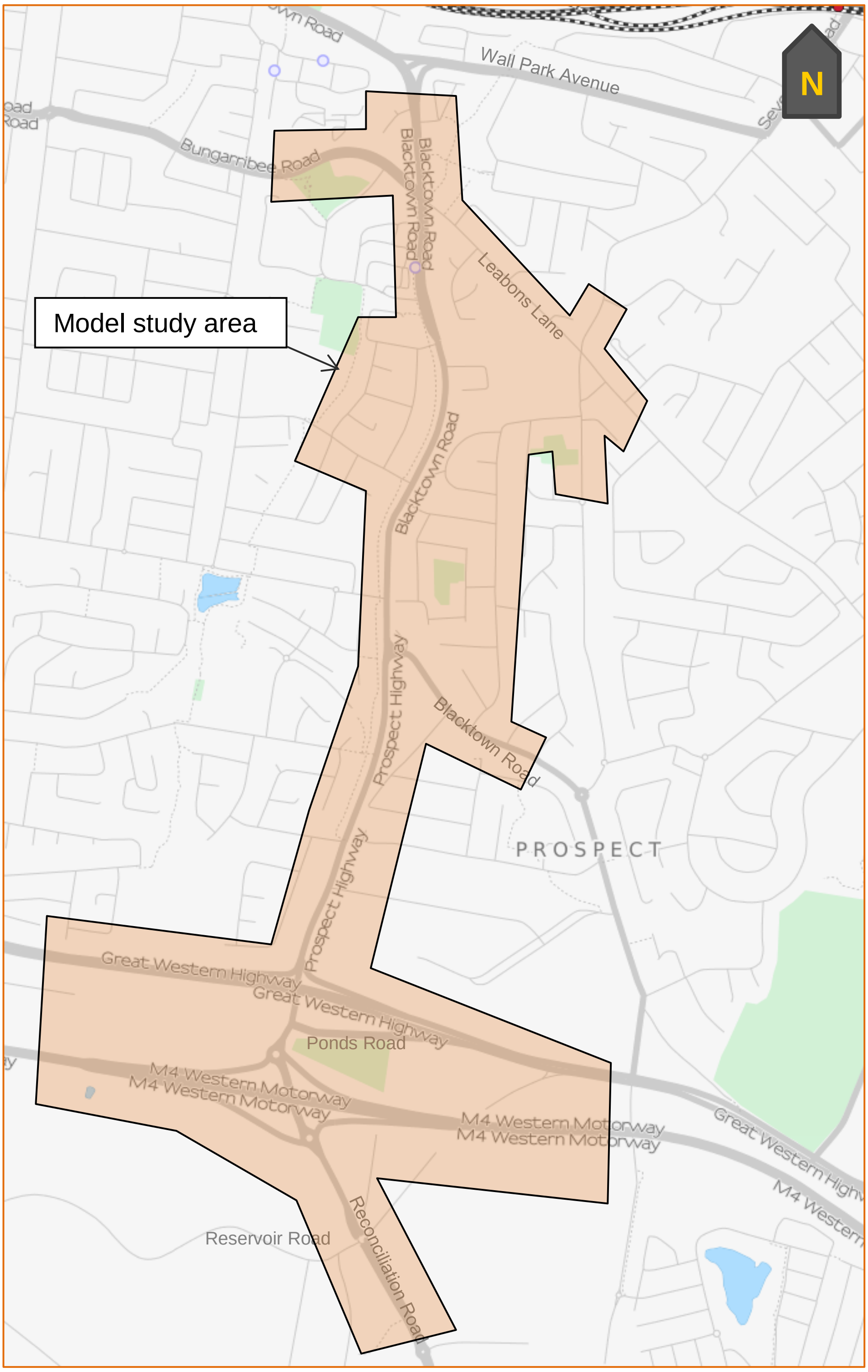


Figure 1.2: Project study area

2. DATA COLLECTION

2.1 Site visit

Two site visits were conducted on the following days:

- 8 November 2013: During this site visit a survey of the bus dwell times at a number of bus stops was conducted along the Prospect Highway corridor. This data was used to input into the model in order to accurately code the bus travel times along the corridor.
- 26 November 2013: During this site visit, the queue lengths at key locations along the Prospect Highway corridor were observed to confirm that the queue lengths demonstrated by the calibrated AM and PM peak models were representative of the current situation.

2.2 Classified mid-block counts

Two key sources of traffic data were collected for the project:

- Classified traffic counts.
- Turning movement counts from SCATS..

Eight classified traffic counts were carried out between 8 and 14 October 2013. These counts recorded 15-minute interval traffic volumes by vehicle classification. The counts were located at:

- Reconciliation Road, south of Reservoir Road.
- The Prospect Highway, 200 metres north of the Great Western Highway.
- Blacktown Road, just south of Roger Place.
- Blacktown Road, east of Mitumba Road.
- Cavendish Avenue, just north of Ridley Place.
- Columbia Road, north of Jade Place.
- Columbia Road, north of Sierra Place.
- Elam Drive, north of Myuna Crescent.

2.3 Intersection counts

Counts of turning movements at signalised intersections were obtained from SCATS data for the same days that the classified counts were taken. This data provides 15-minute interval traffic counts of all vehicles. No classification is available through this data source. These intersections are:

- Prospect Highway and Harrod Street.
- Prospect Highway and Blacktown Road.

- Blacktown Road and Lancelot Street.
- Blacktown Road and Keyworth Drive.
- Blacktown Road and St Martins Crescent.
- Blacktown Road and Bungarribee Road / Leabons Lane.

An additional set of turning movements at the interchange of Prospect Highway and the Great Western Highway were counted separately on two days in October 2012. The difference in the dates of data collection introduces a potential source of variance into the data and consequently, SMEC treated these counts at a lower level of priority than the more recent data collected.

3. NETWORK DEVELOPMENT

3.1 Base model network

The base model network is shown in Figure 3.1. The section south of St Martins Crescent has been based on the previous modelling conducted by SMEC (15 July 2013) and has been updated to match the existing conditions. The section north of this location and the parallel roads (Cavendish Avenue, Beaufort Road, Columbia Road) have been coded into the model based on aerial survey data provided by Roads and Maritime.

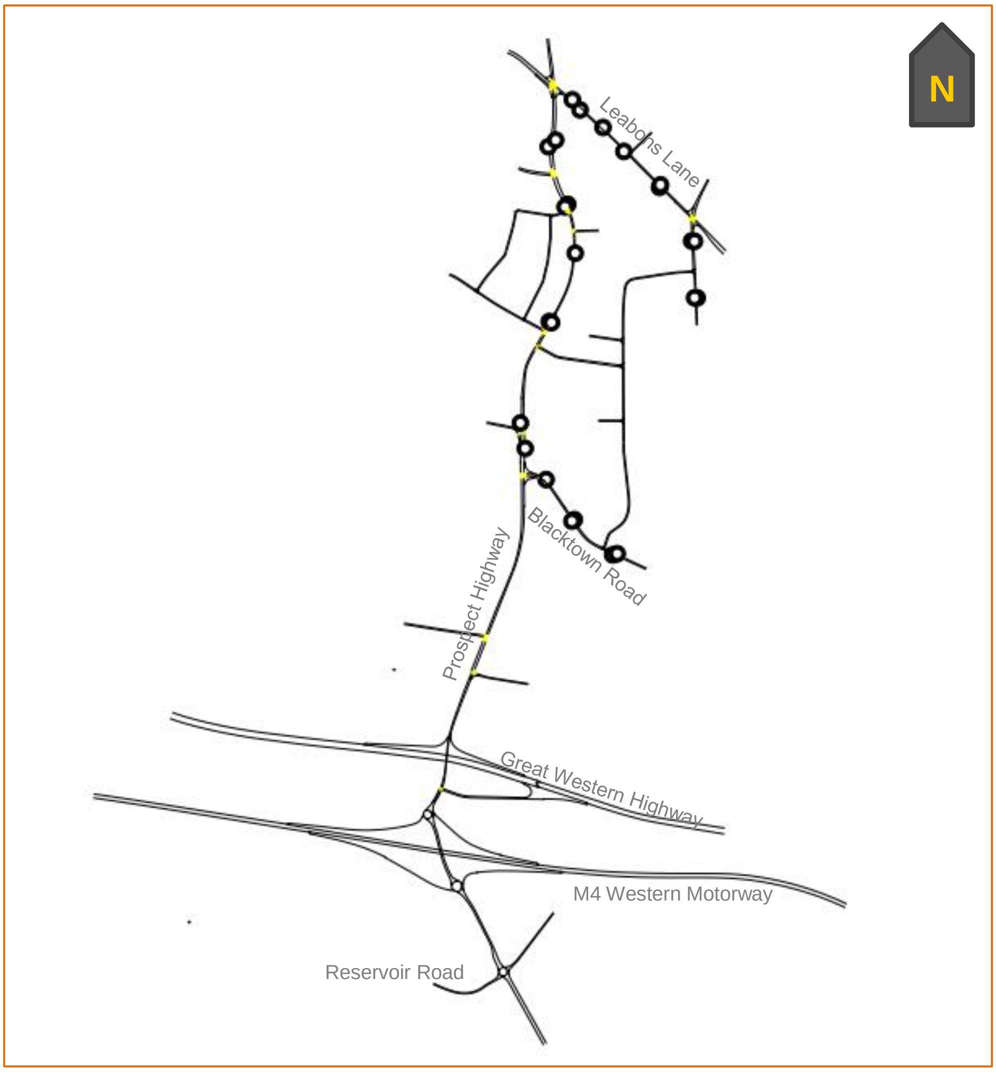


Figure 3.1: Base model network

3.2 Design speed limits

The speed limits on the modelled roads have been coded as per the posted speed limits and are summarised as follows:

- Prospect Highway – 60 km/h.
- M4 Western Motorway– 100 km/h.
- M4 Western Motorway ramps – 60 km/h.

- Great Western Highway – 80 km/h.
- Reservoir Road – 60 km/h.
- Blacktown Road – 60 km/h.
- Bungarribee Road – 60 km/h.
- All other local roads – 50 km/h.

3.3 Traffic signals

There are eight (8) signalised intersections included in the Aimsun model. The intersections include:

- Blacktown Road / Leabons Lane / Bungarribee Road, site number 2566.
- Blacktown Road / St Martins Crescent, site number 2375.
- Blacktown Road / Keyworth Drive, site number 2439.
- Blacktown Road / Lancelot Street, site number 4131.
- Prospect Highway / Blacktown Road, site number 3022.
- Prospect Highway / Harrod Street, site number 3327.
- Leabons Lane / Seven Hills Road South / Bowen Place, site number 4167.
- Prospect Highway/ M4 Western Motorway westbound exit and entry ramps, site number 4523.

3.3.1 SCATS data

Roads and Maritime provided traffic signal data to inform the configuration of the traffic signals within the model. The following traffic signal data was sourced and supplied by Roads and Maritime:

- SCATS traffic volumes.
- Intersection Diagnostic Monitor (IDM).
- LX data.
- EPROM personality data.
- Traffic signal layouts.
- SCATS time settings.

The SCATS traffic volume data was provided for each intersection along the Prospect Highway / Blacktown Road corridor. This data was used to validate the origin-destination matrices generated by the strategic modelling exercise as well as gain a general understanding of where the traffic is travelling along the network.

The IDM data is used to record traffic signal operation statistics at each site on a cycle by cycle basis. The IDM data is then filtered and reported at 15-minute intervals. The IDM records what split plan and link plan is selected during each 15-minute interval. The IDM also records which traffic signal phases run, their duration, the average cycle time and which pedestrian movements operated each 15-minute interval. Overall, the IDM provides a comprehensive snapshot of how the traffic signals operate at each site.

The LX file and the EPROM personality file (SFT file) were provided. These files provide intricate operating details of each signalised intersection. These files were deciphered and all relevant traffic signal information was then coded into the model.

The traffic signal layouts were supplied for each site, with the exception of Blacktown Road / Leabons Lane / Bungarribee Road (site number 2566). The signal plans were used to confirm the signal hardware on-site, which can be then used to confirm the traffic signal phasing inputs in the model.

The SCATS time settings were used to provide accurate information regarding the duration of the intergreen periods, late start intervals and duration of various signal groups (for example, signalised slip lanes and bus signal groups). This information was incorporated into the signal plan for each intersection within the model.

3.3.2 Cycle time and phase splits

Each of the signalised intersections has been coded as fixed time. All of the signalised intersections along the Prospect Highway / Blacktown Road corridor (six in total) are configured in the same sub system. As such, these intersections all share a common cycle time. All of the signals operate with a 130 second cycle time in the peak periods, with the exception of Leabons Lane/ Seven Hills Road South/ Bowen Place and Prospect Highway/ M4 Western Motorway Westbound Ramps which adopt a shorter 90 cycle time to minimise delays. The cycle times were derived from the IDM data.

All the signal phase operations and phase times have been manually configured based on the IDM data. The IDM data indicates what signals phases ran during the peak periods and the average duration that each phase ran for. This information was then used as the basis for creating the signal plan in AIMSUN and is a true reflection of the existing operating conditions of the route.

3.3.3 Signal coordination

Signal offsets have been adopted from SCATS data to coordinate the signals. As all of the intersections (bar Leabons Lane/ Seven Hills Road South/ Bowen Place and Prospect Highway/ Western Motorway (M4) Westbound Ramps are configured in the same sub system, they are all linked via internal signal offsets. These offsets values are provide in the LX file for each site.

During the AM peak the signals are coordinated in the northbound direction which relates to the Blacktown bound traffic flow, while the PM peak signals are coordinated in the southbound direction which relates to the Prospect bound traffic flow.

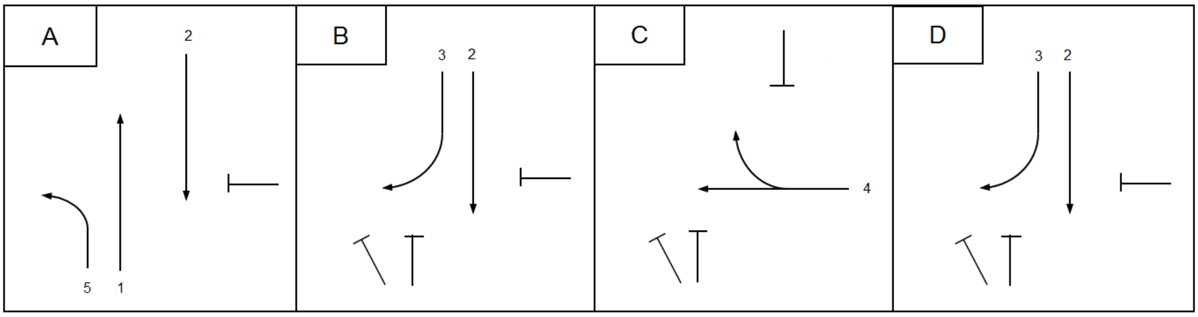
3.3.4 Assumptions

To best represent the existing traffic conditions, it was decided to use the IDM data from Wednesday 30 October for all intersections as SMEC was provided with a complete set of IDMs for that day. Although there are daily variations in the traffic, it can be assumed that the traffic signal operation on Wednesday 30 October 2013 is a true reflection of how the signals generally operate at these locations.

For a number of the signalised intersections, the 'Z-' special facility is used to permit vehicles to perform a filter right turn during the through phase for a number of the sites within our model. The LX file indicates if the 'Z-' flag is set in the split plan data, however it is unknown whether this flag is set via Variation Routine 29 – Set Special Facility, or via an action list during either the AM or PM peak. Based on this, SMEC assumes that some intersections are allowed to perform filter turns in the peak periods.

3.3.5 Prospect Highway/ M4 Western Motorway westbound entry and exit ramps, site number 4523

This site is a four-phase site that operates with a phase sequence A-B-C-D. A summary of the phasing sequence and phase times is provided in Figure 3.9.



Green	20 seconds (AM)	**Green**	10 seconds (AM)	**Green**	26 seconds (AM)	**Green**	10 seconds (AM)
	13 seconds (PM)		10 seconds (PM)		33 seconds (PM)		10 seconds (PM)
Yellow	4.0 seconds	**Yellow**	4.0 seconds	**Yellow**	4.0 seconds	**Yellow**	4.0 seconds
Red	2.0 seconds	**Red**	2.0 seconds	**Red**	2.0 seconds	**Red**	2.0 seconds

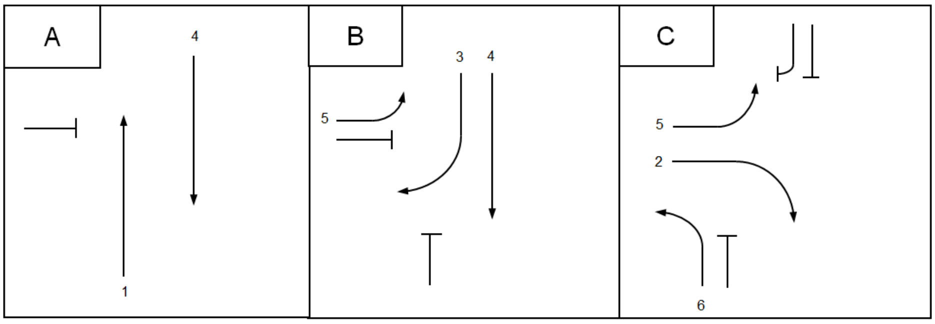
Figure 3.2: Site number 4523 phase sequence

The following signal operation details were included in the model:

- Signal Group 3 is a partially controlled right turn, it is permitted to filter in A-phase.
- Signal Group 5 is a signalised slip lane that operates concurrently with Signal Group 1.
- D-phase is the repeat right turn phase that operates based on 'Z+' flag being set in the split plan data.

3.3.6 Prospect Highway/ Harrod Street, site number 3327

This site is a three-phase site that operates with a phase sequence A-B-C. A summary of the phasing sequence and phase times is provided in Figure 3.7.



Green	90 seconds (AM)	**Green**	8 seconds (AM)	**Green**	14 seconds (AM)
	95 seconds (PM)		8 seconds (PM)		9 seconds (PM)
Yellow	4.0 seconds	**Yellow**	4.0 seconds	**Yellow**	4.0 seconds
Red	2.0 seconds	**Red**	2.0 seconds	**Red**	2.0 seconds

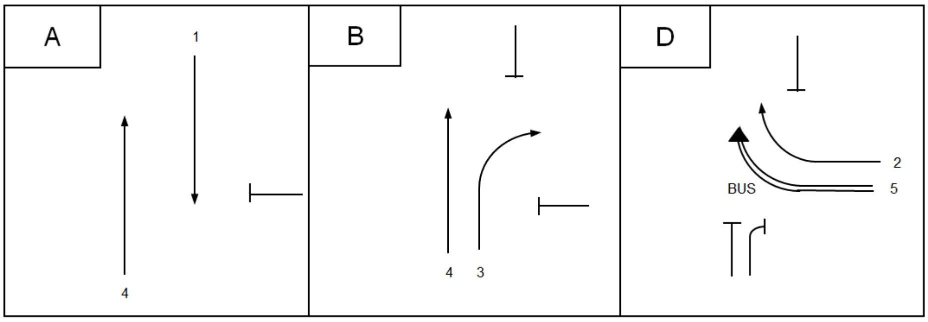
Figure 3.3: Site number 3327 phase sequence

The following signal operation details were included in the model:

- Signal Group 3 is a partially controlled right turn, it is permitted to filter in A-phase after a five-second late start interval.
- Signal Group 5 overlaps from B-phase to C-phase as there are no pedestrian demands.
- Signal Group 6 is a bonus left turn that operates in C-phase.

3.3.7 Prospect Highway/ Blacktown Road, site number 3022

This site is a three-phase site that operates with a phase sequence A-B-D. A summary of the phasing sequence and phase times is provided in Figure 3.6.



Green	84 seconds (AM)	**Green**	10 seconds (AM)	**Green**	18 seconds (AM)
	85 seconds (PM)		18 seconds (PM)		19 seconds (PM)
Yellow	4.0 seconds	**Yellow**	4.0 seconds	**Yellow**	4.0 seconds
Red	2.0 seconds	**Red**	2.0 seconds	**Red**	2.0 seconds

Figure 3.4: Site number 3022 phase sequence

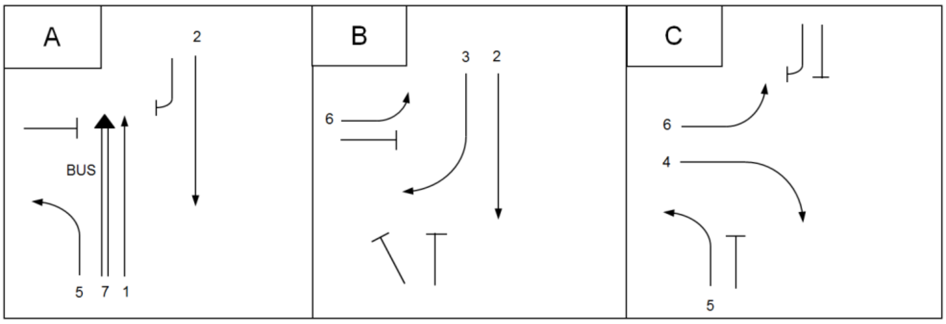
The following signal operation details were included in the model:

- Signal Group 3 is a partially controlled right turn, it is permitted to filter in A-phase after a five-second late start interval.
- C-phase is a bus only phase. For the purpose of this model, C-phase has been omitted from the phase sequence as it runs fewer than five times in both the AM and PM peak periods. The bus phase (C-phase) would typically be allocated five seconds of green time.

In order to provide bus priority at this site, SMEC has modified the operation of D-phase accordingly. In D-phase, the bus signal group (Signal Group 5) receives a two-second early start, after which Signal Group 2 commences. This means that the introduction of Signal Groups 2 is delayed by two seconds in D-phase every cycle. This approach has been adopted to best replicate the bus priority operation at this site.

3.3.8 Blacktown Road/ Lancelot Street, site number 4131

This site is a three-phase site that operates with a phase sequence A-B-C. A summary of the phasing sequence and phase times is provided in Figure 3.5.



Green	80 seconds (AM)	**Green**	8 seconds (AM)	**Green**	24 seconds (AM)
	82 seconds (PM)		16 seconds (PM)		14 seconds (PM)
Yellow	4.0 seconds	**Yellow**	4.0 seconds	**Yellow**	4.0 seconds
Red	2.0 seconds	**Red**	2.0 seconds	**Red**	2.0 seconds

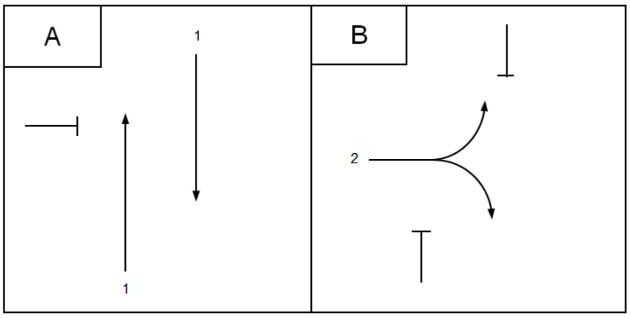
Figure 3.5: Site number 4131 phase sequence

The following signal operation details were included in the model:

- Signal Group 3 is a fully controlled right turn, it is not permitted to filter in A-phase.
- Signal Group 7 is a bus signal group. In A-phase, Signal Group 7 receives a two-second early start, after which Signal Group 1 commences. The bus early start is typically eight seconds, however as this bus movement does not operate every cycle, we have adopted a two-second bus movement early start in every cycle. This means that the introduction of Signal Groups 1 is delayed by two seconds in A-phase every cycle. This approach has been adopted to best replicate the bus priority operation at this site.
- Signal Group 5 is a signalised slip lane signal group that operates in A-phase and C-phase.
- Signal Group 6 overlaps from B-phase to C-phase as there are no pedestrian demands.

3.3.9 Blacktown Road/ Keyworth Drive, site number 2439

This site is a two-phase site that operates with a phase sequence A-B. A summary of the phasing sequence and phase times is provided in Figure 3.4.



Green	99 seconds (AM)	**Green**	17 seconds (AM)
	105 seconds (PM)		11 seconds (PM)
Yellow	4.0 seconds	**Yellow**	4.0 seconds
Red	4.0 seconds	**Red**	2.0 seconds

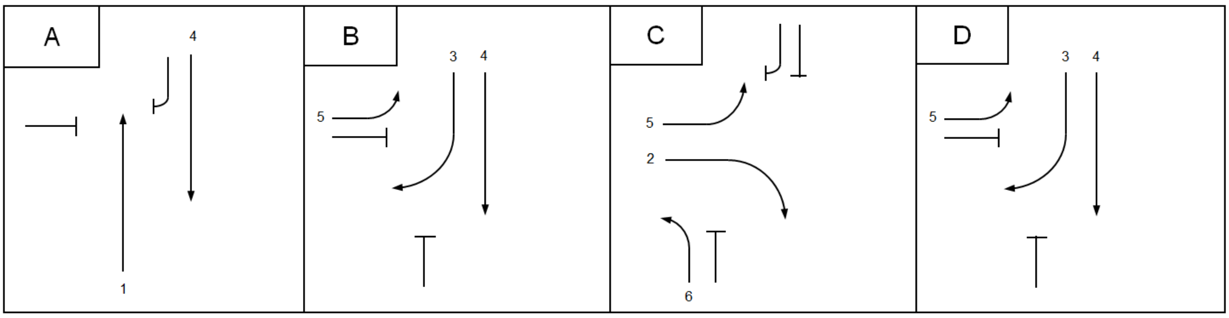
Figure 3.6: Site number 2439 phase sequence

The following signal operation details were included in the model:

- The right turn from north to west is permitted to filter in A-phase.

3.3.10 Blacktown Road / St Martins Crescent, site number 2375

This site is a four-phase site that operates with a phase sequence A-B-C-D. A summary of the phasing sequence and phase times is provided in Figure 3.3.



Green	58 seconds (AM)	**Green**	11 seconds (AM)	**Green**	22 seconds (AM)	**Green**	15 seconds (AM)
	60 seconds (PM)		8 seconds (PM)		21 seconds (PM)		17 seconds (PM)
Yellow	4.0 seconds	**Yellow**	4.0 seconds	**Yellow**	4.0 seconds	**Yellow**	4.0 seconds
Red	2.0 seconds	**Red**	2.0 seconds	**Red**	2.0 seconds	**Red**	2.0 seconds

Figure 3.7: Site number 2375 phase sequence

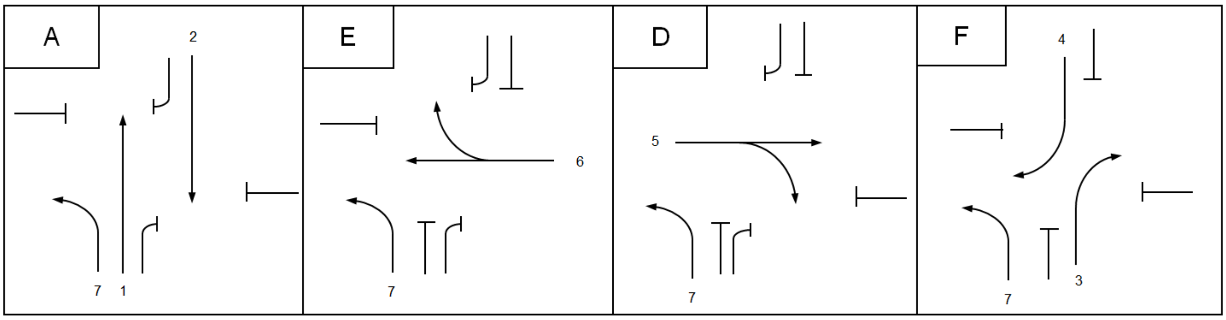
The following signal operation details were included in the model:

- Signal Group 3 is a fully controlled right turn, it is not permitted to filter in A-phase.

- Signal Group 5 overlaps from B-phase to C-phase to D-phase as there are no pedestrian demands.
- Signal Group 6 is a bonus left turn that operates in C-phase.
- D-phase is the repeat right turn phase that operates based on 'Z+' flag being set in the split plan data.

3.3.11 Blacktown Road / Leabons Lane / Bungarribee Road, site number 2556

This site is a four-phase site that operates with a phase sequence A-E-D-F. A summary of the phasing sequence and phase times is provided in Figure 3.2.



Green	48 seconds (AM)	**Green**	18 seconds (AM)	**Green**	20 seconds (AM)	**Green**	16 seconds (AM)
	49 seconds (PM)		15 seconds (PM)		19 seconds (PM)		19 seconds (PM)
Yellow	4.0 seconds	**Yellow**	4.0 seconds	**Yellow**	4.0 seconds	**Yellow**	4.0 seconds
Red	3.0 seconds	**Red**	3.0 seconds	**Red**	3.0 seconds	**Red**	3.0 seconds

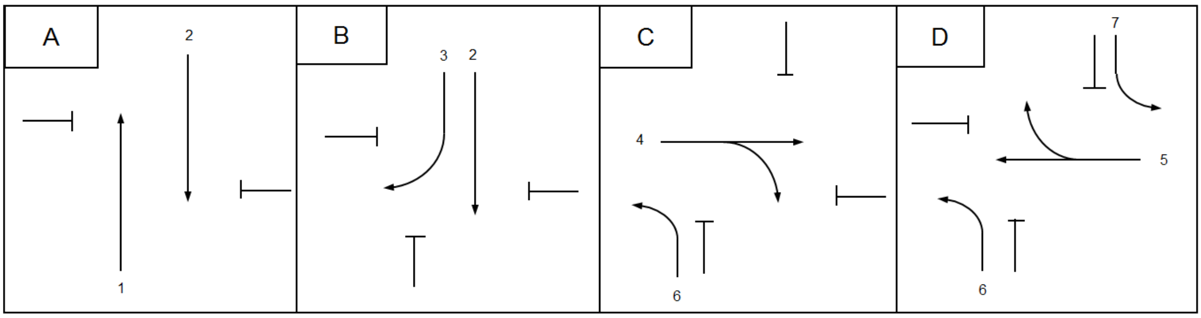
Figure 3.8: Site number 2556 phase sequence

The following signal operation details were included in the model:

- Signal Group 3 and Signal Group 4 are fully controlled right turns, they are not permitted to filter in A-phase.
- D-phase and E-phase are split-phases.
- F-phase is a diamond overlap phase.
- Signal Group 7 runs continuously in every phase as there are no pedestrian demands for the south-west slip lane.

3.3.12 Leabons Lane/ Seven Hills Road South/ Bowen Place, site number 4167

This site is a four-phase site that operates with a phase sequence A-B-C-D. A summary of the phasing sequence and phase times is provided in Figure 3.8.



Green	23 seconds (AM)	**Green**	9 seconds (AM)	**Green**	18 seconds (AM)	**Green**	16 seconds (AM)
	24 seconds (PM)		13 seconds (PM)		14 seconds (PM)		15 seconds (PM)
Yellow	4.0 seconds	**Yellow**	4.0 seconds	**Yellow**	4.0 seconds	**Yellow**	4.0 seconds
Red	2.0 seconds	**Red**	2.0 seconds	**Red**	2.0 seconds	**Red**	2.0 seconds

Figure 3.9: Site number 4167 phase sequence

The following signal operation details were included in the model:

- Signal group 3 is a partially controlled right turn, it is permitted to filter in A phase after a 5.0 seconds late start period.
- C-phase and D-phase are split-phases.
- Signal Group 6 is a bonus left turn that operates in C-phase.
- Signal Group 7 is a bonus left turn that operates in D-phase.

3.4 Public transport

3.4.1 Bus routes and frequency

The AIMSUN model includes the existing bus routes that service the corridor and surrounding area. There are three bus routes that traverse roads within the model:

- Route 700 – Parramatta to Blacktown.
- Route 702 – Seven Hills to Blacktown.
- Route 812 – Fairfield to Blacktown.

The AM and PM peak timetables have been reviewed for each route. The bus timetables have been coded into the model so that each individual bus arrives at the edge of the model at the timetabled time.

3.4.2 Bus stops and dwell times

Every bus stop has been coded into the model. It has been assumed that every bus will stop at every bus stop. While in reality certain buses might miss stops if there are no passengers to pick-up or set-down, it is the most appropriate assumption available without conducting an extensive survey.

A dwell time survey at a number of stops along the Prospect Highway / Blacktown Road corridor was conducted during a site visit on 11 November 2013, during the AM peak period. The survey found that the average dwell time was 19 seconds, with a standard deviation of eight seconds. As such, to replicate on-site conditions, the model dwell time has been set to 19 seconds, with eight seconds standard deviation.

4. DEMAND DEVELOPMENT

The traffic demand on the network is driven by the trip matrices, which are an input into the AIMSUN model. This section describes the development of the base year matrices for calibration of the network assignment model.

4.1 Background

The model's network has a foundation of 22 zones, of which five are internal to the model area and 17 are external. Figure 4.1 shows the road network, the positions of the zone centroids and their connections into the network. The external zones (or gates) are numbered from 100 to 116, while the internal zones are numbered from 200 to 204.

Zones 200 and 204 do not exist in the Sydney Greater Metropolitan Area (GMA) model. SMEC added these zones to allow for more refined options for growth in future scenarios.

The zones are listed and named in Table 4.1.

Table 4.1: Zones in the microsimulation model

Zone Number	Zone Type	Description
100	Gate	Reconciliation Road
101	Gate	Reservoir Road (west)
102	Gate	Great Western Freeway (west)
103	Gate	Great Western Highway (west)
104	Gate	Harrod Street
105	Gate	Lancelot Street
106	Gate	Keyworth Avenue
107	Gate	Bungarribee Road
108	Gate	Blacktown Road (north)
109	Gate	Vienna Street
110	Gate	Seven Hills Road
111	Gate	Lucretia Road
112	Gate	Elam Drive
113	Gate	Blacktown Road (south)
114	Gate	Stoddard Road

Zone Number	Zone Type	Description
115	Gate	Great Western Highway (east)
116	Gate	Great Western Freeway (east)
200	Internal	Reservoir Road (east)
201	Internal	St Martin's Crescent
202	Internal	Residential area around El Alamein Park
203	Internal	Residential area around Maureen Caird and Topaz Parks
204	Internal	Residential area around Himalaya Park

4.1.1 Source data

The data we have used to develop the demand matrices are from three sources:

- Demand matrices from the strategic model.
- Classified traffic counts.
- Turning movement counts from SCATS.

Initial trip matrices were extracted from the Bureau of Transport Statistics (BTS) model of the Sydney GMA model. These matrices represent the number of vehicles travelling into, out of and through the corridor cordon shown in Figure 4.1 as modelled in the EMME/3 strategic models of the wider Sydney network. The matrices represent the morning and afternoon peak periods for a typical weekday in 2006.

The classified counts were carried out for one week and provide a daily profile of the traffic demand on the roads in the area as well as the vehicular classification composition of the traffic demand on the roads.

4.1.2 Vehicle types

SCATS data provide turning movements for all vehicles only. As a consequence, SMEC's estimates of vehicular composition are based entirely on the classification counts carried out at the eight sites on the road network in October 2013.

The counts were classified into the following vehicle types:

- Motor and pedal cycles.
- Cars.
- Light goods vehicles.
- Other goods vehicles 1 and public service vehicles.
- Other goods vehicles 2.

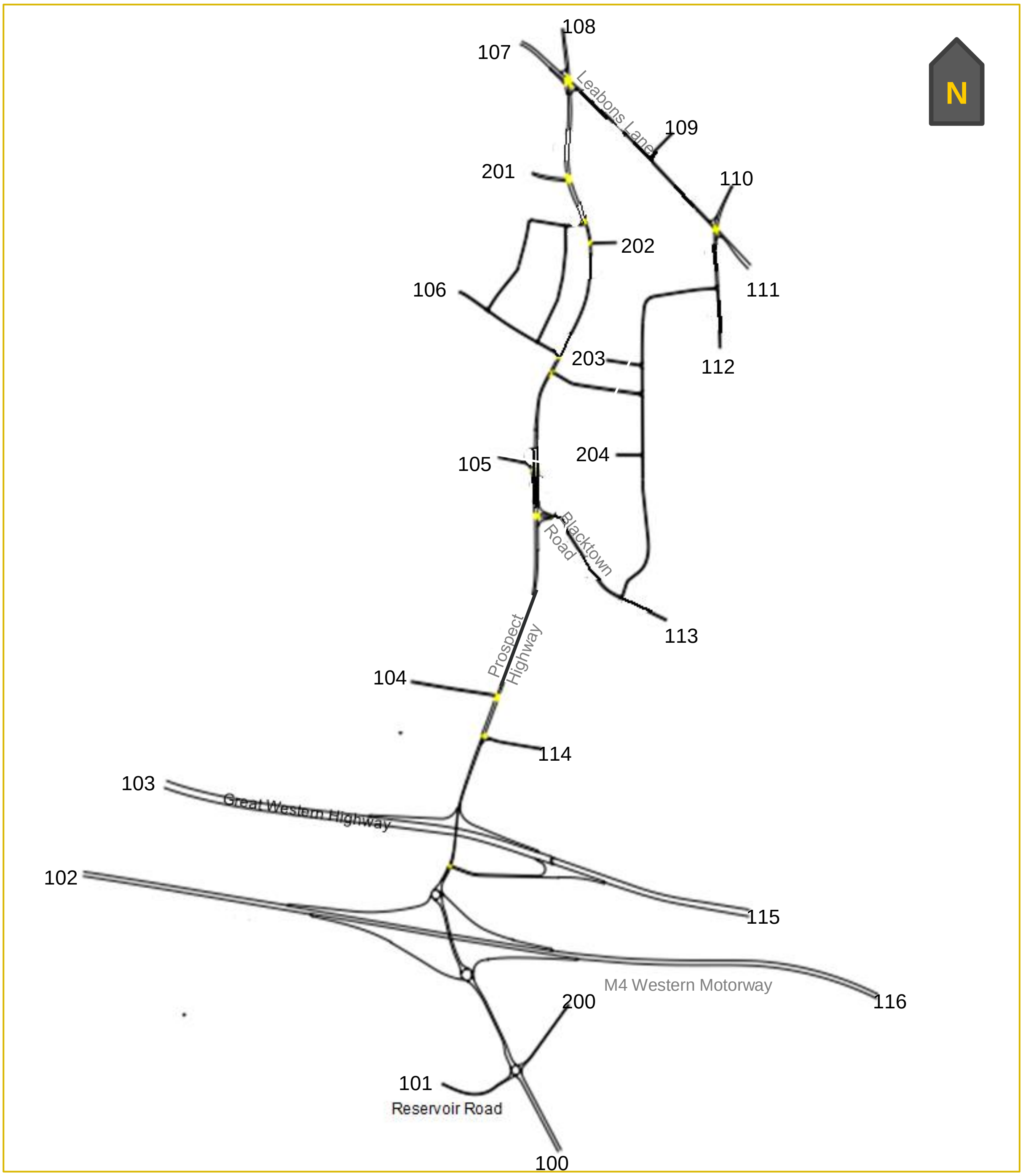
For the purposes of this study, SMEC used two vehicle classes, light vehicles and heavy vehicles. Light vehicles comprise cycles and cars, while all goods vehicles and public service vehicles make up the heavy vehicles class.

Based on the heavy vehicles content of the counts, SMEC developed a matrix of heavy vehicle content for the two model periods. These are shown in Tables 4.2 and 4.3.

4.1.3 Demand profiles

Traffic demand was counted throughout seven days. The average weekday demand profile has peaks hours between 7am and 8am in the morning and 5pm and 6pm in the afternoon.

Figures 4.2 and 4.3 illustrate the profiles of the average weekday for the Prospect Highway, travelling northbound and southbound respectively. Figures 4.4 and 4.5 illustrate the profiles of the average weekday for Blacktown Road, travelling northbound and southbound respectively.



(Source –EMME Network – 2006TZ Sydney GMA Strategic Traffic Forecasting Model)

Figure 4.1: Diagram of model's road network showing location of zones

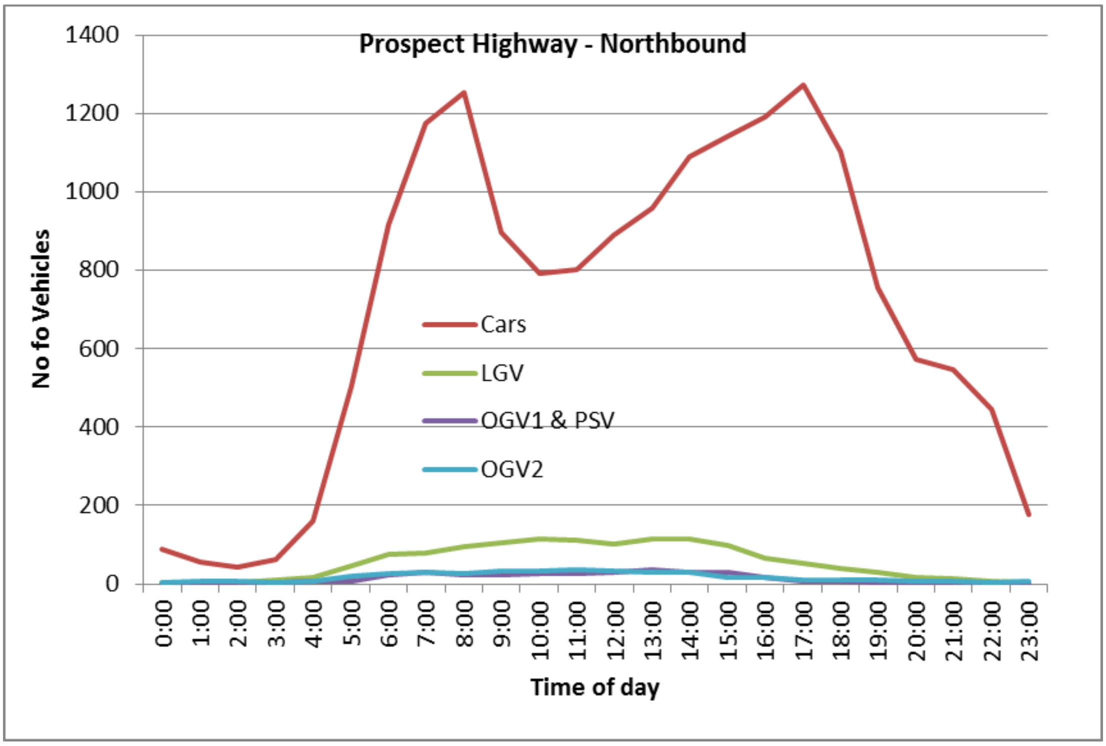


Figure 4.2: Daily traffic demand profile for the Prospect Highway, northbound

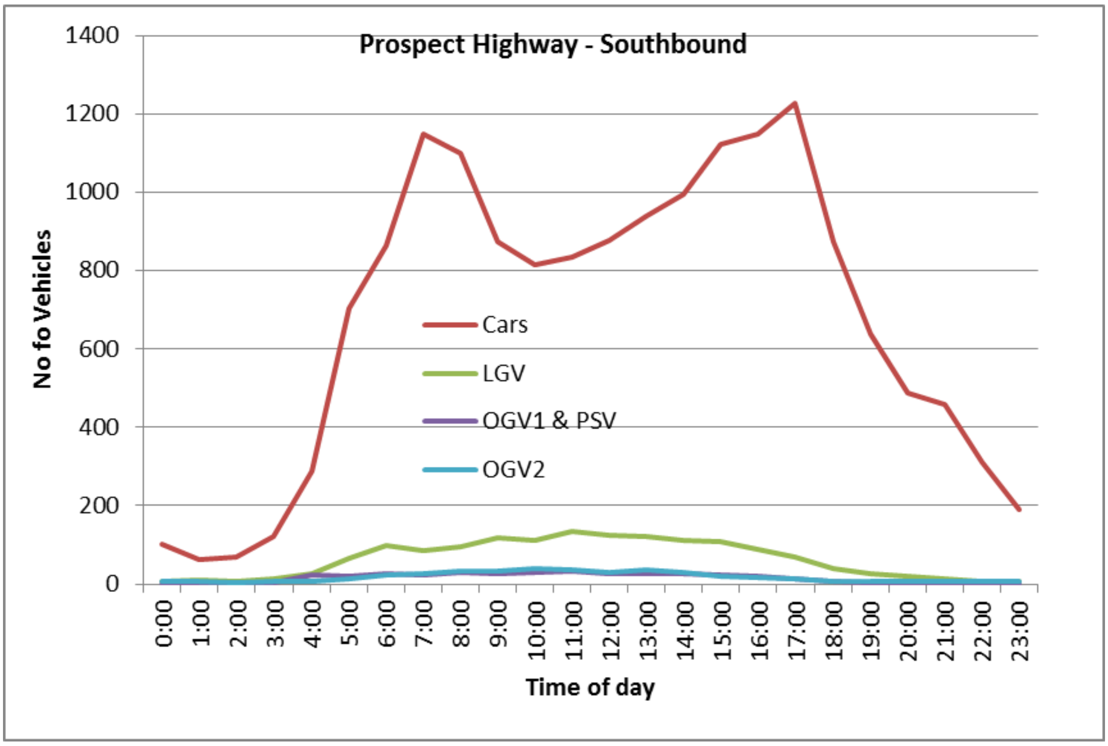


Figure 4.3: Daily traffic demand profile for the Prospect Highway, southbound

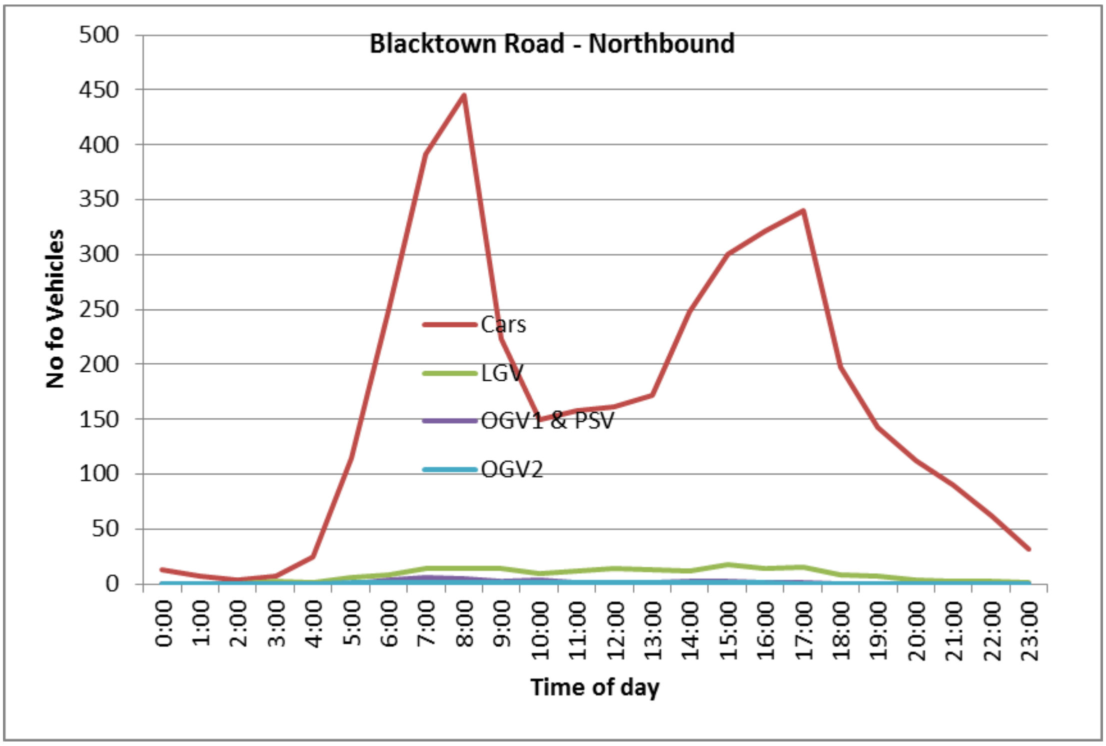


Figure 4.4: Daily traffic demand profile for Blacktown Road, northbound

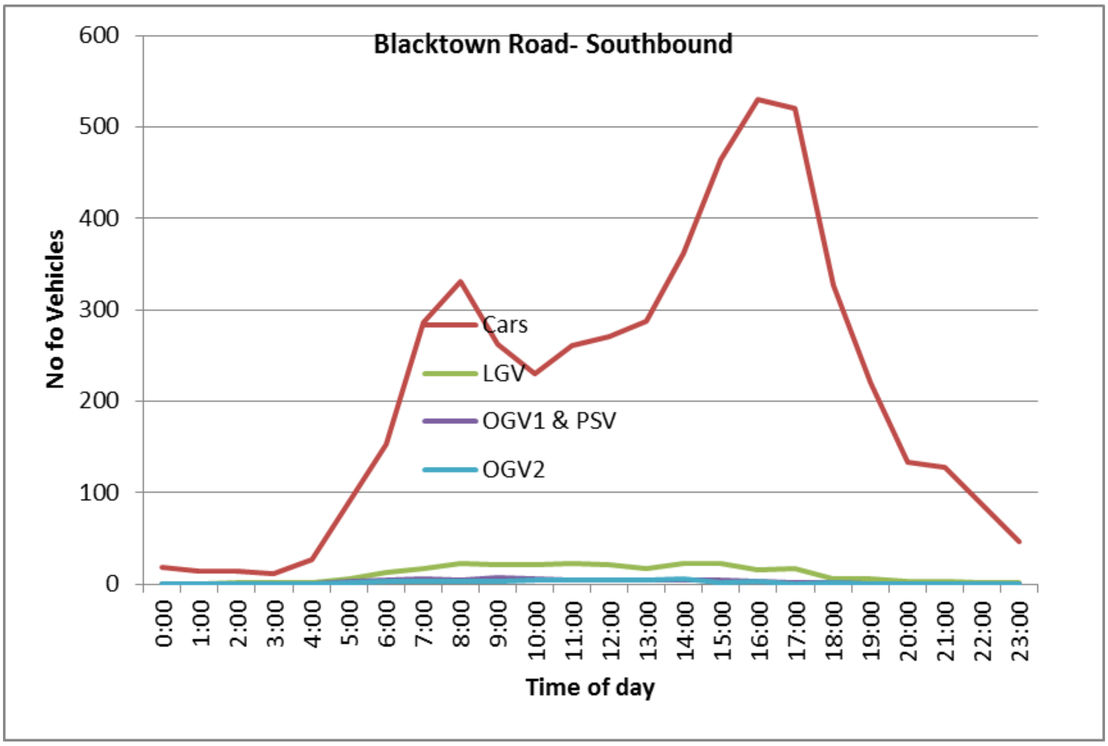


Figure 4.5: Daily traffic demand profile for Blacktown road, southbound

Table 4.2: Estimated heavy vehicle content of volumes in the morning peak hour

	Destination Zone																					
Origin Zone	**100**	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**	**112**	**113**	**114**	**115**	**116**	**200**	**201**	**202**	**203**	**204**
100		8%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	4%	10%	10%	10%	10%
101	8%	8%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	4%	10%	10%	10%	10%
102	12%	12%		10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	8%	8%	4%	10%	10%	10%	10%
103	12%	12%	8%	8%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	8%	8%	4%	10%	10%	10%	10%
104	12%	12%	8%	8%		10%	10%	10%	10%	10%	10%	10%	10%	10%	4%	8%	8%	12%	10%	10%	10%	10%
105	12%	12%	8%	8%	12%		10%	10%	10%	10%	10%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
106	12%	12%	8%	8%	12%	12%	10%	10%	10%	10%	10%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
107	12%	12%	12%	12%	12%	12%	12%		10%	4%	4%	4%	12%	12%	12%	4%	4%	12%	4%	4%	4%	4%
108	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%
109	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%
110	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%
111	12%	12%	12%	12%	12%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	4%	4%	12%	4%	4%	4%	4%
112	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
113	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%

		Destination Zone																					
		100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	200	201	202	203	204
	114	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
	115	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
	116	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
	200	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
	201	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
	202	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
	203	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
	204	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%

Table 4.3: Estimated heavy vehicle content of volumes in the afternoon peak hour

		Destination Zone																					
		100	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**	**112**	**113**	**114**	**115**	**116**	**200**	**201**	**202**	**203**	**204**
Origin Zone	**100**	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
	101	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
	102	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
	103	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
	104	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
	105	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
	106	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
	107	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
	108	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
	109	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
	110	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
	111	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
	112	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
	113	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%

		Destination Zone																				
		100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	200	201	202	203	204
	114	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
	115	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
	116	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
	200	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
	201	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
	202	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
	203	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
	204	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%

4.2 Traffic demand development

The traffic demand for the road network was estimated as a zone to zone trip matrix for each of the peak hours. The development of these matrices is described in the following subsections.

4.2.1 Overall methodology

For each of the peak hours, a prior matrix was used as a foundation for the traffic demand matrix. The prior matrices were then modified using traffic counts as the basis for the modifications. To do this the following tasks were conducted:

- Identified, for each count, the origin-destination pairs whose traffic would pass through the count location.
- Expressed an estimate of the count as the sum of the volumes in the identified origin-destination pairs.
- Compared the estimated volumes with the counted volumes and total the square of the differences.
- Adjusted the values of the prior matrices to minimise the total of the square of the differences.
- Separated the resultant matrix into cars and heavy vehicle matrices using estimates from traffic counts.

The resultant matrices were then assigned to the network using the AIMSUN model and the GEH statistics at each counted location were calculated. To bring these statistics into the required level of accuracy, a few cells in the matrices were manually adjusted.

In the development of the demand matrices, a primary focus was to minimise the changes to the prior matrix.

4.2.2 Prior matrix

The prior matrix for each peak hour was obtained from BTS's strategic transport model of the Sydney GMA. It was provided by BTS as the matrix of demand across a cordon around the study corridor. The matrices are for peak two-hour periods. The morning matrix represents trips made in the period 7am to 9am and the afternoon matrix represents trips in the period 4pm to 6pm.

The cordon intersects several connectors to zones outside the cordon. Connectors are hypothetical connections that do not represent specific roads, with arbitrary connections to road sections that aim to characterise the local road connection to the modelled road network. These include zones 2104, 2108 and 2118. For the purposes of this model, these zones were disregarded in the road network and their trips in the demand matrices were allocated to gates on roads into which they connected. Gates are the points where the cordon cuts model road links and function as zones in the model. For this exercise:

- Trips to and from zone 2104 were shared between gates 109 and 110 and the trips were proportioned between them on the basis of the number of trips crossing the cordon at those gates.

- Trips to and from zone 2108 were allocated to gate 111.
- Trips to and from zone 2118 were allocated to gates 113 and 114, in proportion to the number of trips crossing the cordon at those gates.

The BTS model also did not include road links that represent St Martins Crescent or Reservoir Road east of Reconciliation Road. A road link was added for each of these. St Martins Crescent crosses the model cordon at point 201 for which estimates of trips crossing the cordon were obtained from SCATS turning movement volumes at the signals at the intersection of Blacktown Road and St Martins Crescent.

The end of Reservoir Road east represents zone 200, which currently accommodates some industrial development.

Only zone 2113 is wholly internal to the cordon but it represents all of the residential area within the cordon. To help with the calibration of the model, this zone was split into three separate internal zones:

- Zone 202 connects into Blacktown Road at about the location of Roger Place and represents the residential area around El Alamein Park.
- Zone 203 connects into Columbia Road at about the location of the southern intersection of Topaz Crescent and Columbia Road. It represents the residential area around Topaz Park and Maureen Caird Reserve.
- Zone 204 connects into Columbia Road at about the location of Cascade Street and represents the residential area around Himalaya Park.

Initial trips were assigned to these based on an estimate of the number of properties with each area.

4.3 Outcome demand estimation

After the final trip matrices were derived, they were compared to the prior matrix using a scatterplot of trips in the output matrix compared to those in the prior matrix. The results of these comparisons are shown in Figures 4.6a and b and 4.7a and b.

With the comparison of the output and prior matrices, there are some important provisos to take into account. The prior matrices are from a strategic model of the entire Sydney metropolitan area and aims to describe the overall operation of transport networks across the whole area. The model networks, for example, are necessarily broad and are missing details, such as the smaller, more local roads and services. Strategic transport models seldom account for intersection delay and the result is that there are usually many more right turn movements in the models than in reality; this is generally the case for the Prospect highway. Using the strategic model to focus on a small area is akin to using a map of mainland Australia to navigate from Parramatta to Blacktown. At the detailed level, small errors at the large scale may become highly magnified at the small scale. In addition, the Sydney Transport Model works with peak 2-hour periods while our micro-simulation model works with the peak hour.

The afternoon peak period prior matrix contains more trips than the morning peak hour prior matrix and appears to be close to a transport of the morning peak matrix. This relationship of morning and evening peak matrices is typical of strategic models, where matrices are built as productions and attractions from land use and demographic information. On the other hand, traffic counts on the Prospect Highway suggest that the afternoon traffic is not a transpose of the morning traffic. Also, the afternoon trip matrix contains more trips than the morning trips matric. By contrast, the traffic counts indicate that the morning peak hour contains more demand than the afternoon peak.

The slope of the regression line for the afternoon peak is consistent with the disconnect between the PM prior matrix and the traffic counts. With a slope of 2.5, it suggests that there are too many trips in the prior matrix and, with the output matrix reflecting traffic counts more closely, the indication is that a relatively large number of trips have been removed from the afternoon prior matrix.

Given that the prior matrix is for a two-hour peak period, the slope of the straight line regression in figures 4.6 and 4.7 should be about 2.0 and, because we were aiming to minimise the differences between the prior and the output matrices, the R^2 value should be close to 1. For the morning peak hour, the slope of the regression line is 1.99 and the R^2 is 0.99. For the afternoon peak hour, the slope is 2.5 and the R^2 is 0.95.

For the larger hourly demand, the output and prior matrices match well. For cells with smaller numbers of trips, the match is more complex. We examined the output for all cells where the prior and output matrices differ by more than 30% and sought to explain the reason for the difference. In general, there are four sources of the differences, which are:

1. **The trips in the prior trip matrix are inconsistent with traffic counts**. We have turning movements at all signalised intersections along the Prospect Highway/Blacktown Road south of Bungarribee Road from SCATS. We also have turning movement counts at the interchange of the Great Western Freeway and Prospect Highway. Finally, we have numerous traffic counts along the length of the Prospect Highway and Blacktown Road. From these counts the turning movements at intersections can be directly estimated or can be deduced. Comparison of these with turning movements that would result from the assignment of the prior matrix can be assessed.

   This factor accounts for most of the differences between the output and prior matrices. Two of the most prominent examples of this are at the Blacktown Road/Bungarribee intersection and the interchange of the Great Western Freeway and the Prospect Highway.

   SCATS turning movements show that during the morning peak hour, 160 vehicles turned left from Bungarribee Road into Blacktown Road and 240 vehicles turned right from Blacktown Road into Bungarribee Road. These two movements represent the trips from zones 107 to 108 and 108 to 107 respectively. The number of trips in the morning peak prior matrix for these cells are 735 vehicles and 653 vehicles respectively. Allowing for the fact that the prior trip matrix is for 2 hours, they are significantly higher than the number of counted trips.

   Similarly in the south, at the interchange of the Great Western Freeway and the Prospect Highway, turning movement counts show that the left turn onto the westbound ramp from Reconciliation Road (south) is around 70 vehicles in the morning and evening peak hours. This movement approximates travel from zone 100 to 102, which in the 2-hour prior matrices contain 80 vehicles and 260 vehicles.

   Aggregations of zones can also be compared to turning movements on the Prospect Highway. For example at Harrod Street, the left turn is represented by trips to zone

104 from more southern zones, including 100 to 103 and 114 to 200. The morning 2-hour peak prior matrix contains 180 vehicles and the afternoon 2-hour peak contains 550 trips in these cells. SCATS counts for the left turn movement are 40 for the morning peak hour and 100 for the afternoon peak hour.

2. **Trips in the prior matrix are based upon unlikely routes**. The strategic model produces a cut-out matrix of movements into, out of and through the study cordon based on the way it assigns trips to the cordon. Many local roads are omitted from the model road network and consequently, routes that trips use may not be totally representative.

   In this road network there are many such instances. The prior matrices contain a large number of trips between zones 103 and 113 and 114. The route would require a turn onto the Prospect Highway and a right turn into either Stoddard Road (zone 114) or Blacktown Road (zone 113). In reality, these movements are more likely to be via the Great Western Highway with a left turn at its intersection with Blacktown Road. Another example is the movement between zone 105 (Lancelot Street) to zone 107 (Bungarribee Road). The road network outside of the study cordon provides better routes fort his movement, so that few, if any, of these trips would occur in reality.

3. **Trips that do not impact on the study results.** These are cells in prior and output matrices that contain few trips, even though they may differ, or the movement is on the fringe of the network. This category includes trips between neighbouring zone pairs 111 and 112, 110 and 112, 110 and 111, 103 and 115, 102 and 116.

4. **Cells that contain inadequate land use and demographic data or do not exist.** There are only two instances of this factor: zone 200 (Reservoir Road east) and zone 201 (St Martin’s Crescent) neither of which is included in the prior matrix. However, the only internal zone in the strategic model (zone 2113) was split into three separate zones for this study (zones 202 to 204).

All of the larger differences between prior and output matrices have been account for on the basis of the four sources of differences. In general, there are more differences in the afternoon peak matrices, but the reason for this is that the strategic model’s afternoon peak matrix was representative of a transposed morning matrix rather than a true afternoon peak matrix.

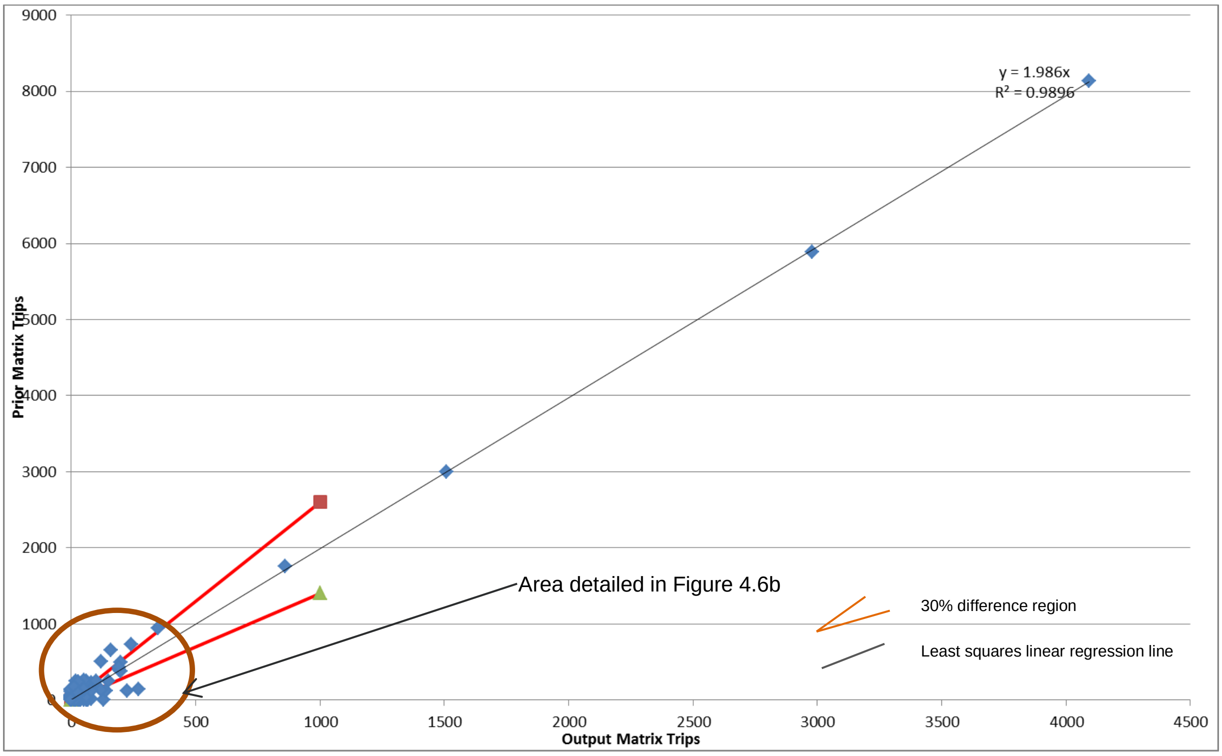


Figure 4.6a: Comparison of the morning peak hour prior matrix and output matrix

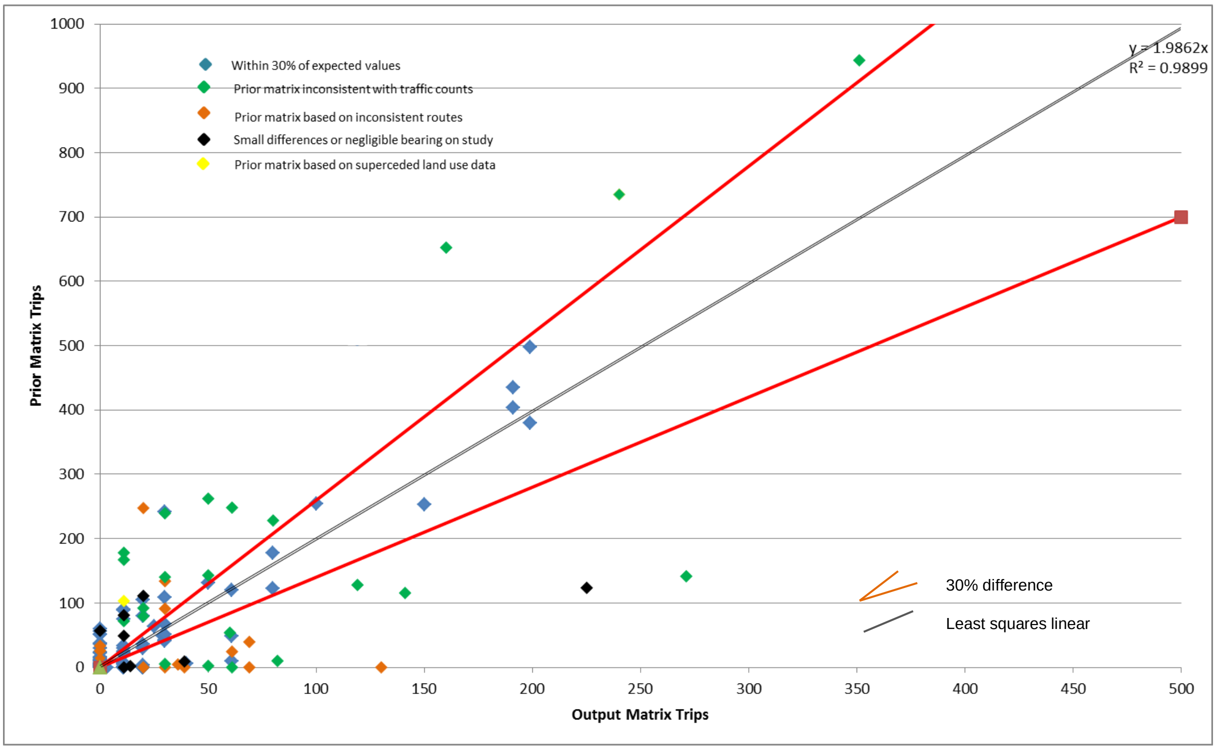


Figure 4.7b: Detail comparison of the morning peak hour prior matrix and output matrix

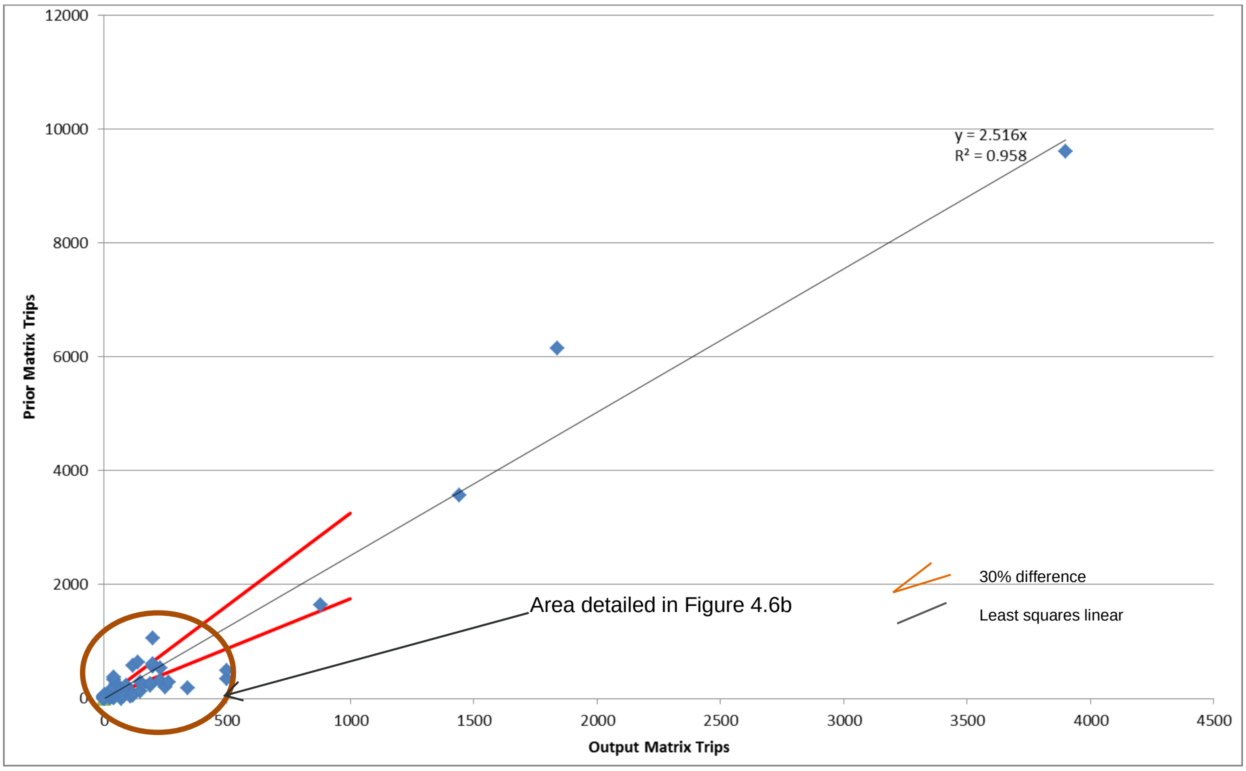


Figure 4.8a: Comparison of the evening peak hour prior matrix and output matrix

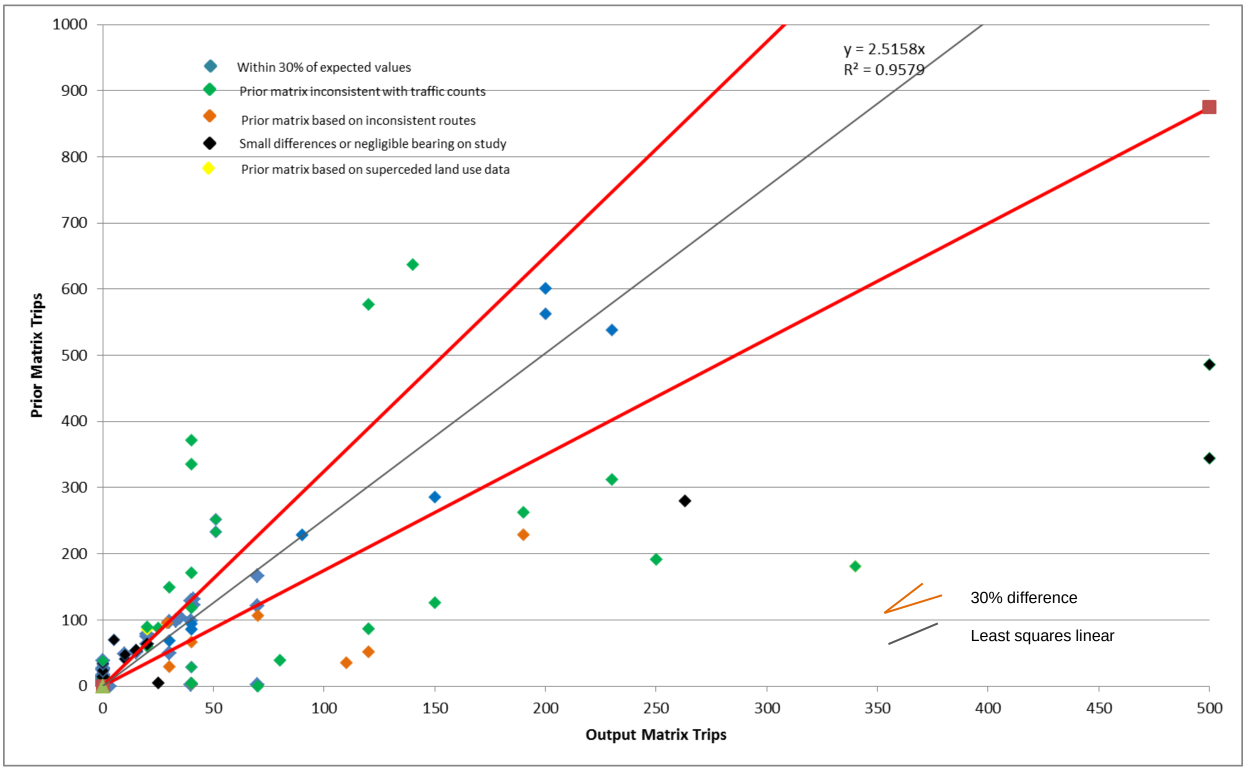


Figure 4.9b: Detail comparison of the evening peak hour prior matrix and output matrix

5. MODEL CALIBRATION

5.1 Overview

The Roads and Maritime Traffic Modelling Guidelines (2013) specify five statistical criteria that can be used to assess whether a micro-simulation model is performing adequately:

- Traffic volumes.
- Signal timings.
- Saturation flows.
- Journey time routes.
- Queue lengths.

The mid-block classification surveys conducted in October 2013, supported by the SCATS traffic count recordings supplied by Roads and Maritime form the basis of the traffic volume calibration.

The calibration of the signal timings has been discussed in detail in Section 3.3 , and showed that the model signal timings have been coded adequately reflect the on-site conditions.

The saturation flows will not be calibrated since that statistic is not an output generated by AIMSUN.

The calibration of the journey time along the Prospect Highway / Blacktown Road corridor model will be reviewed. The modelled journey times will be compared to the surveys conducted in October 2013.

The queue lengths will be qualitatively validated but not calibrated. Queue survey data is very difficult to collect accurately due to the subjective nature of the back of a queue, this makes calibrating to queue lengths very difficult. The site visits undertaken will be used as a reference to validate the results of the calibrated base model.

5.2 Calibration criteria

5.2.1 Traffic volumes

The traffic volumes are calibrated on a network wide basis using the GEH statistic. Detectors have been placed in the model at the location all of the available surveyed turning movements and mid-block counts. The GEH statistic is then calculated at each location to compare the model and survey traffic volumes. To achieve calibration, Roads and Maritime stipulates that:

- 85% of count sites must be GEH less than five.
- Sites with GEH greater than 10 are undesirable and require explanation if the exist.
- R^2 value of the regression analysis greater than 0.9.

5.2.2 Journey times

The journey times along the Prospect Highway / Blacktown Road are calibrated by comparing modelled and surveyed journey times. Three criteria are specified by Roads and Maritime to achieve journey time calibration:

- Journey time average: Average modelled journey time to be within 15 per cent or one minute (whichever is greater) of average observed journey time for full length of route.
- Average modelled journey time to be within 15 per cent of average observed journey time for individual sections.
- Average and 95 per cent confidence intervals to be plotted for observed and modelled travel times for each journey time route. Comparison to be to modeller and Roads and Maritime satisfaction.

The requirement to assess the variability of both the observed and modelled journey times is not possible in this case due to the method of measurement of the modelled journey time. The average travel time on sub paths is being measured in AIMSUN. This statistic does not provide results for individual vehicles and therefore a spread of journey times cannot be calculated.

5.3 Calibration data source

Three data sources have been used to represent the surveyed traffic data for calibration purposes:

- Mid-block classification counts conducted from 8 to 14 October 2013 at eight locations:
  + Reconciliation Road, south of Reservoir Road.
  + Prospect Highway, 200 metres north of the Great Western Highway.
  + Blacktown Road, south of Roger Place.
  + Blacktown Road, east of Mitumba Road.
  + Cavendish Avenue, north of Ridley Place.
  + Columbia Road, north of Jade Place.
  + Elam Drive, north of Myuna Crescent.
  + Columbia Road, north of Sierra Place.
- SCATS volumes from detector data recorded from 7 to 13 October 2013 at six locations:
  + Prospect Highway / Harrod Street.
  + Blacktown Road / Prospect Highway.
  + Blacktown Road / Lancelot Street.
  + Blacktown Road / Keyworth Drive.

+ Blacktown Road / St Martins Crescent.
+ Blacktown Road / Bungarribee Road / Leabons Lane.

- Journey time surveys on the Prospect Highway / Blacktown Road corridor, recorded between 6am and 9am and 3pm and 7pm on 10 October 2013, which included the eight timing points:

+ Reservoir Road.
+ M4 Western Motorway westbound exit / entry ramps.
+ M4 Western Motorway eastbound exit / entry ramps.
+ Great Western Highway eastbound exit / entry ramps.
+ Blacktown Road.
+ Keyworth Drive.
+ St Martins Crescent
+ Bungarribee Road.

The data used for the traffic volume calibration represents an average weekday one hour peak (AM and PM). Since the SCATS data does not provide classification information, all of the volume data represents all vehicles combined.

There were 11 travel time runs in each direction made in the three-hour AM peak, of which four could be expected to reflect the one hour peak between 8am and 9am. These four runs will be used for calibration purposes in the AM peak.

There were 13 travel time runs in each direction made in the four-hour PM peak, of which four could be expected to reflect the one hour peak between 5pm and 6pm. These four runs will be used for calibration purposes in the PM peak.

5.4 Performance against criteria

5.4.1 Median random seed

The assessment of the models' performance against the observed data is based on the median random seed model run. The median model run has been determined by comparing the total travel time in the model, and finding the median result. Since there were 10 random seed model runs, the median falls between the fifth and sixth runs. The model run that has its total travel time closer to the average total travel time of all runs has been used.

5.4.2 Traffic volumes

The modelled traffic volumes have been compared to the observed volumes at the locations described in Section 5.3 . The GEH statistic has been calculated for each data point. The full set of modelled versus observed data and GEH statistics is contained in Appendix A.

Figure 5.1 and Figure 5.2 show plots of observed versus modelled traffic volumes for the AM and PM peak hour models respectively.

Table 5.1 shows the summary data for the GEH calculation for the AM and PM peak models. The results indicate that more than 85% of locations have GEH of less than five and no locations have GEH greater than 10. Also, the R^2 value is less than 0.9. Therefore both the AM and PM peak models are considered calibrated to the observed traffic volumes.

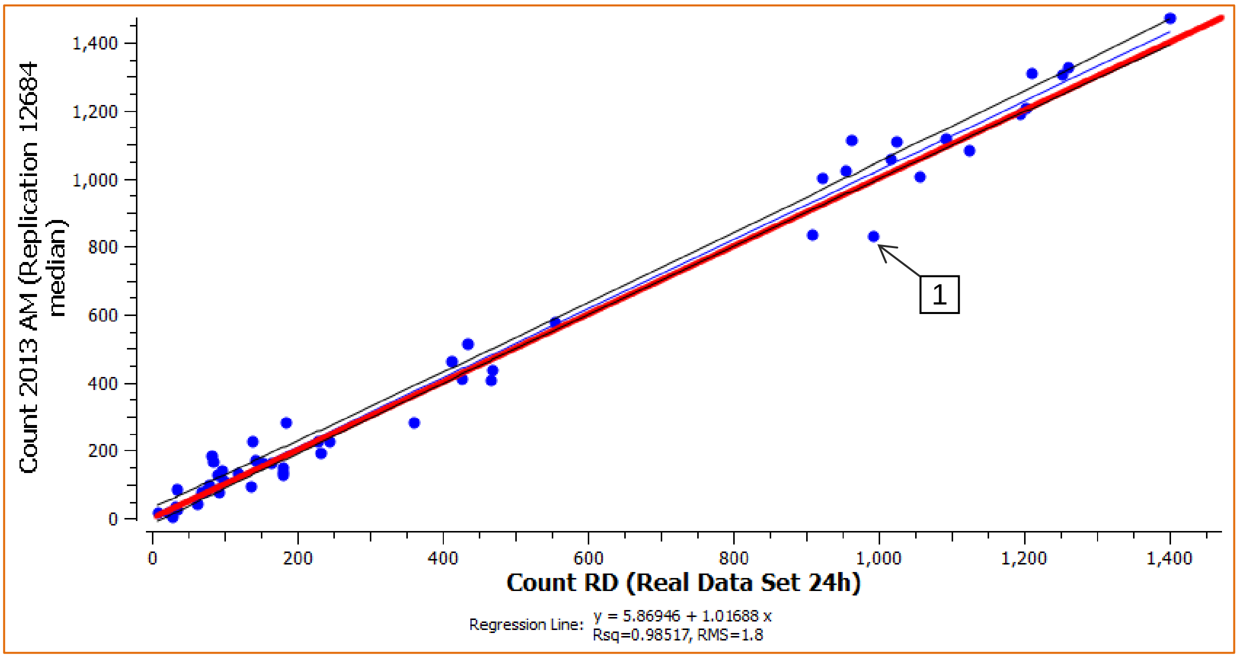


Figure 5.1: AM peak observed versus modelled traffic volumes

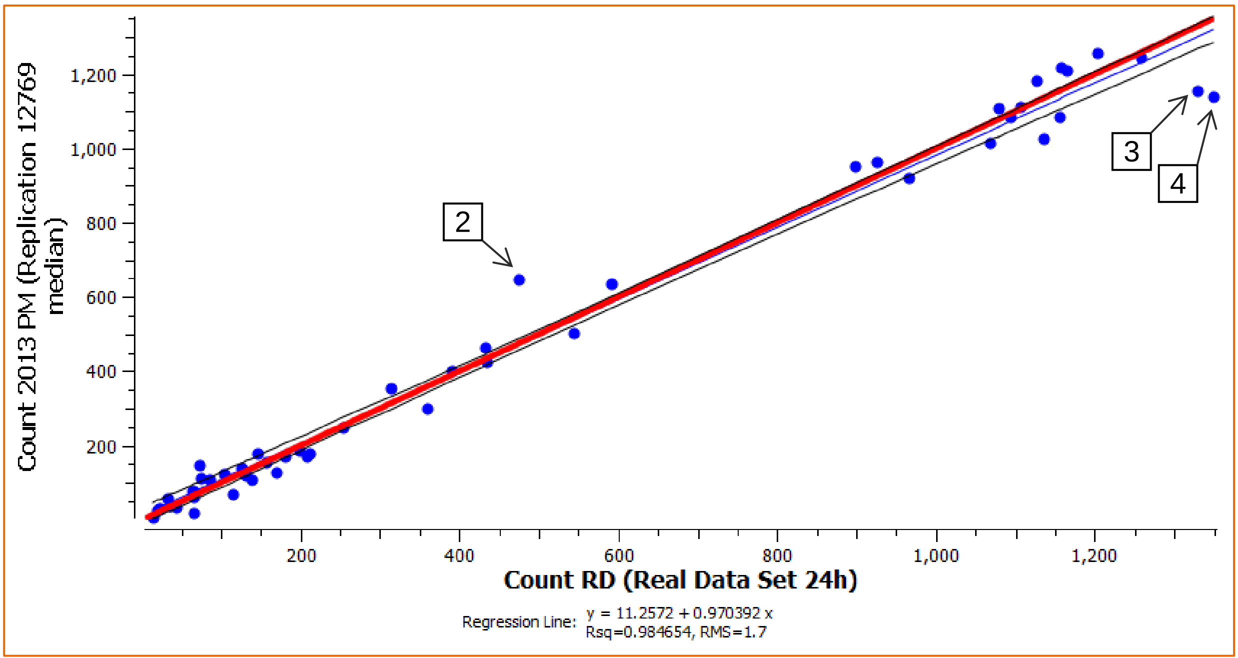


Figure 5.2: PM peak observed versus modelled traffic volumes

There are a few outliers in the AM and PM models as indicated by the numbers 1 - 4 in Figure 5.1 and Figure 5.2. These outliers are explained as follows:

1. AM Peak, Intersection of Blacktown Road and Bungarribee Road, south approach, through movement. Observed volume = 993 vehicles. Modelled volume = 830 vehicles.

GEH = 5.4. The difference between the observed and modelled volumes at this location is not a big issue for the calibration of the model, firstly because it is only a small outlier with GEH 5.4 and secondly the location is beyond the end of the project study area at the periphery of the model. Small errors here will not have a major impact on the number of vehicles using the proposed upgraded highway, especially since the upstream intersection is calibrated entirely to GEH < 5 and there are no intermediate entry/exit points.

2. PM Peak, Ellam Drive, south of Emerald Road, northbound mid-block. Observed volume = 474 vehicles. Modelled volume = 648 vehicles. GEH = 7.3. The difference between the observed and modelled volumes at this location is not a big issue for the calibration of the model, primarily because the location is outside the main corridor of the proposed upgrade project. The roads in the model to the east of the corridor, including this location are only in the model to provide re-routing alternatives to vehicles who can no longer make a right turn on the duplicated Prospect Highway due to the median. Therefore small inaccuracies in this location will not substantially affect the route choice behaviour or travel delays of vehicles using the proposed upgraded highway.

3 and 4. PM peak, Prospect Highway, north of Great Western Highway, southbound (3) and northbound (4) mid-block. Southbound observed volume = 1,329 vehicles. Modelled volume = 1,179 vehicles. GEH = 4.2. Northbound observed volume = 1,349 vehicles. Modelled volume = 1,155 vehicles. GEH = 5.5. The difference between the observed and modelled volumes at this location is due to an underestimation of trips using Stoddart Street in the EMME model. One of the goals of the matrix manipulation process was to minimise the required changes to achieve calibration. Given that the adjacent signalised site at Harrod Street is suitably calibrated for all approaches and the calibration at these sites is close to the target (even better than the target for northbound) a view was taken to not adjust the matrix any further. In any case the errors at this site are less than 10% and daily fluctuations on highways in general can be in the order of 10%. These sites are considered to be ok for the purposes of this model.

Table 5.1: Traffic volume calibration summary

Peak hour model	Number of calibration count sites	Number of GEH <5	Number of GEH >10	R^2
AM Peak	52	45 (87%)	0	0.99
PM Peak	52	46 (88%)	0	0.98

5.4.3 Journey time

The modelled journey time along the Prospect Highway / Blacktown Road corridor has been compared to the average observed journey time. Figure 5.3 to Figure 5.6 show plots of the observed versus modelled journey times, including a +/- 15 per cent margin that is part of the calibration criteria. The figures show that all of the journey times in the AM and PM peak are within the +/- 15 per cent margin for the entire route. Therefore the AM and PM models are considered calibrated to journey times.

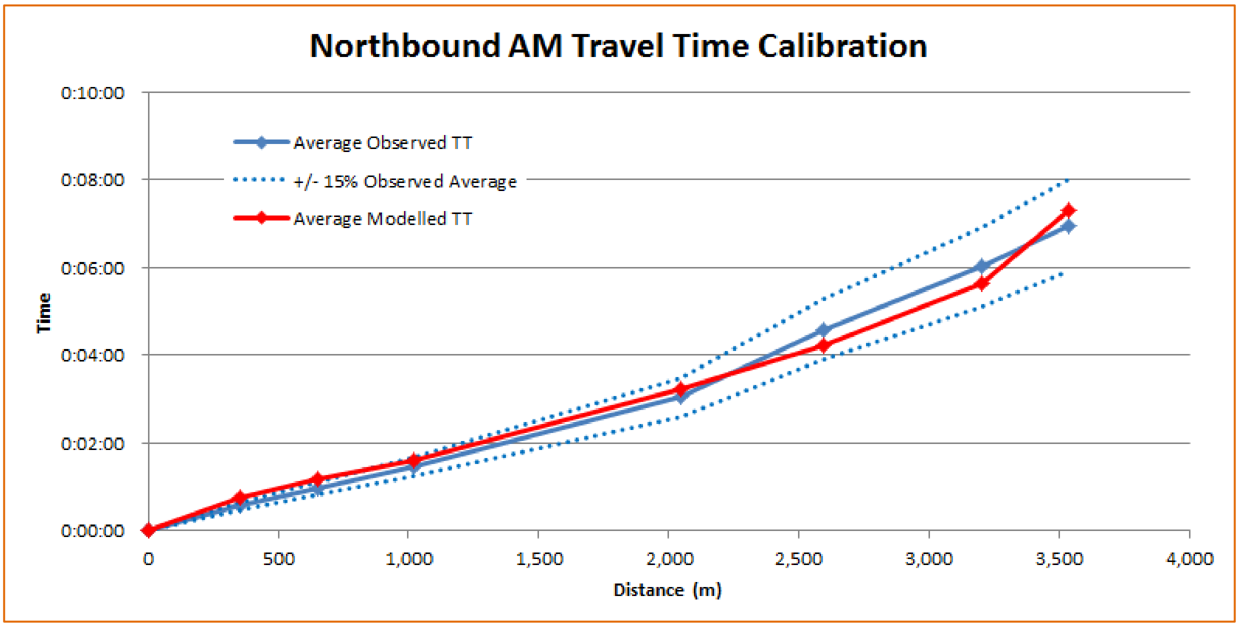


Figure 5.3: AM peak travel time comparison, northbound

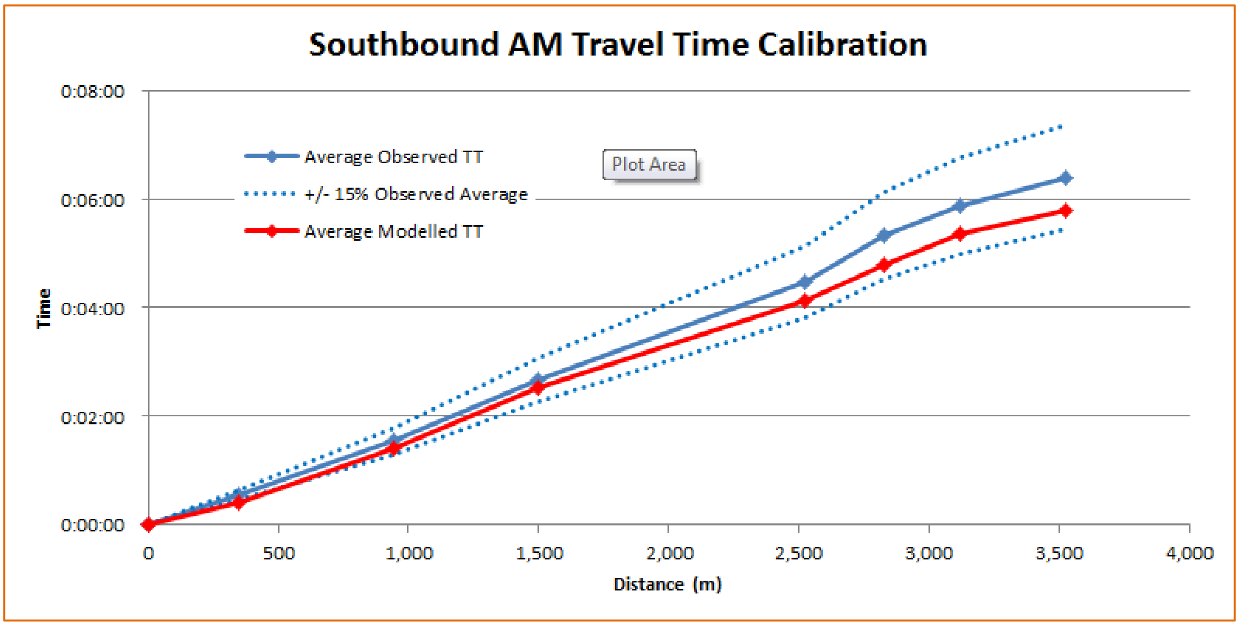


Figure 5.4: AM peak travel time comparison, southbound

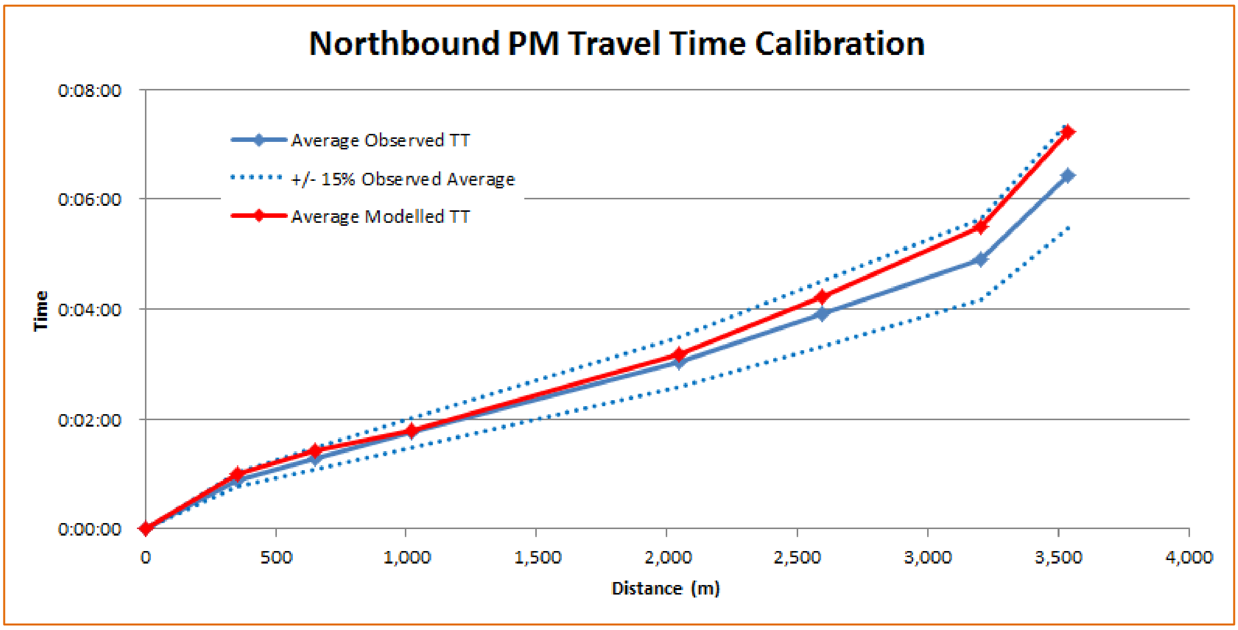


Figure 5.5: PM peak travel time comparison, northbound

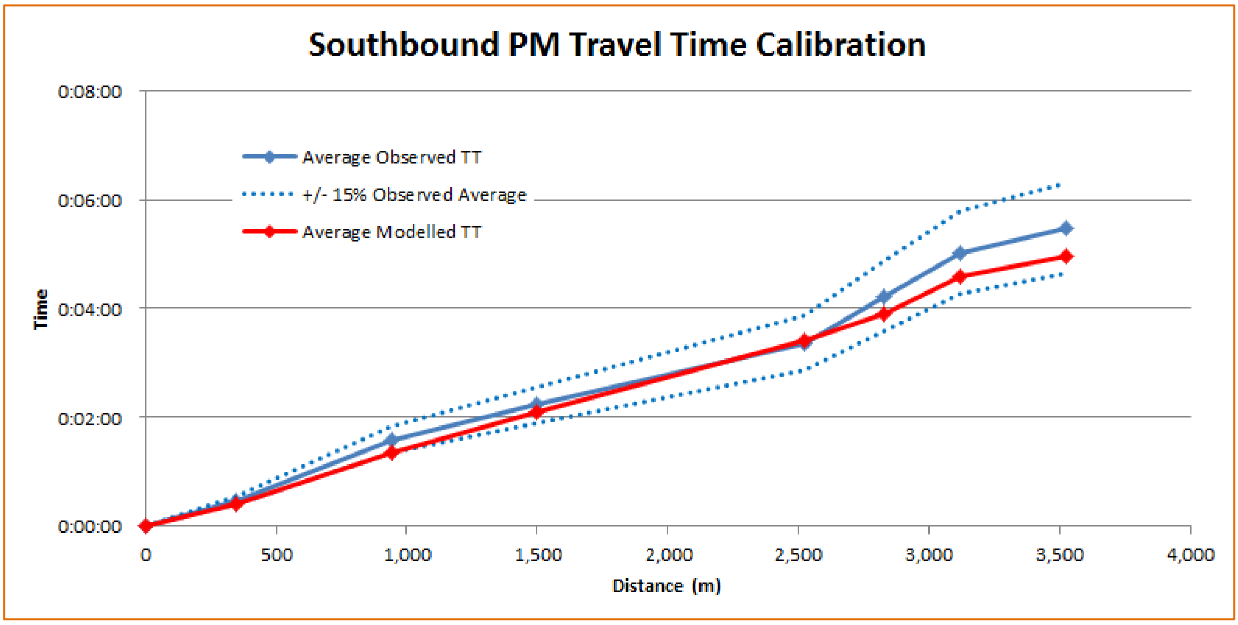


Figure 5.6: PM peak travel time comparison, southbound

6. MODEL VALIDATION

The calibrated base year models (AM and PM peak) have been validated by qualitatively comparing the model operation to onsite operating conditions. The operation of the model was thoroughly inspected and the locations of key queues were noted. Following the model inspection, a site visit was carried out in which the actual operating conditions were compared to the model. The site visit was carried out on 26 November between 7am and 5pm.

The locations of the key queues that were checked on site were:

- AM northbound queue right turn into Stoddart Road, extending the length of the right turn bay.
- AM peak southbound queue, between Keyworth Drive and Tudor Avenue.
- AM peak northbound queue, between Blacktown Road and Lancelot Street.
- AM peak northbound queue, on the approach to the merge north of Lancelot Street.
- AM peak northbound queue, south of Roger Place.
- AM northbound queue from St Martins Crescent to Tudor Avenue from the signalised intersection of Blacktown Road and St Martins Crescent.
- PM northbound and southbound, some congestion between Keyworth Drive and Roger Place.
- PM northbound queue from St Martins Crescent to Tudor Avenue from the signalised intersection of Blacktown Road and St Martins Crescent.
- PM Leabons Lane / Bungarribee Road intersection, queuing on all approaches.

Site observations showed that the model appropriately reflected the location and average length of the queues at the key locations mentioned above. The base year models are therefore considered validated.

7. SUMMARY

This report has detailed the four main components of model calibration:

- Network verification.
- Demand calibration.
- Route choice calibration.
- Model validation.

SMEC has described how the network has been coded according to the on-site conditions, including an accurate representation of the signal operation and posted speed limits.

The traffic volume calibration has shown that the demand matrices have been calibrated to suitably represent the observed conditions. Table 7.1 reiterates that summary of the GEH statistics, which show that both the AM and PM peak hour models have greater than 85% of locations with GEH less than five, and a R^2 value of greater than 0.9.

Table 7.1: Traffic volume calibration summary

Peak Hour Model	Number of calibration count sites	Number of GEH <5	Number of GEH >10	R^2
AM Peak	52	45 (87%)	0	0.99
PM Peak	52	46 (88%)	0	0.98

The travel time calibration showed that the journey times and speeds along the primary corridor Prospect Highway / Blacktown Road reflect the observed conditions to +/- 15 per cent.

Site inspections confirmed that the model was accurately representing the queues at key locations.

Therefore, the AM and PM peak models developed for this Transport Impact Assessment are deemed to be calibrated to existing conditions and fit for purpose.

8. GLOSSARY

EPROM

See *erasable programmable read only memory*

Erasable programmable read only memory

A type of memory chip that retains its data when its power supply is switched off. It houses the unique program that configures the traffic signal controller to a specific operational design of the intersection its controlling. This includes specifications of which signal groups run in each phase, the sequence of phases, detector functions, detector alarm conditions, conflict points and default time settings.

GEH

The GEH statistic is a self-scaling empirical statistic with similarities to a chi-squared test. The desired target for model calibration is to achieve a GEH value less than 5.0 at more than 85% of sites.

IDM

See *intersection diagnostic monitor*

Intersection diagnostic monitor

A software feature of SCATS that records (on demand) all of the key operating characteristics of a signalised site for a given time period. Data recorded includes individual and average cycle times, individual and average phase times, number of times a phase runs.

LX File

The data file that feeds into the region computer for each signalised intersection. It contains the data necessary for communications, signal timings, intergreen intervals, pedestrian walk and clearance timings, coordination values, flexilink data and variation routines.

R^2

R-squared is a statistical measure of how close the data are to the fitted regression line. It is the percentage of the response variable variation that is explained by a linear model.

SCATS

See *Sydney coordinated adaptive traffic system*

Sydney coordinated adaptive traffic system

An intelligent transportation system developed in Sydney, Australia by former constituents of the Roads and Maritime Services in the 1970. SCATS primarily manages the dynamic (on-line, real-time) timing of signal phases at traffic signals, meaning that it tries to find the best phasing (i.e. cycle times, phase splits and offsets) for the current traffic situation (for individual intersections as well as for the whole network). This is based on the automatic plan selection from a library in response to the data derived from loop detectors or other road traffic sensors.

APPENDIX A:
GEH TRAFFIC VOLUME CALIBRATION

AM PEAK

Observed	Modelled	Absolute Difference	Relative Difference (%)	GEH
1401	1473	72	5	1.9
1260	1329	69	5	1.9
1195	1192	-3	0	0.1
962	1113	151	16	4.7
361	284	-77	-21	4.3
468	438	-30	-6	1.4
34	87	53	156	6.8
22	16	-6	-27	1.4
139	226	87	63	6.4
91	128	37	41	3.5
427	410	-17	-4	0.8
467	406	-61	-13	2.9
84	166	82	98	7.3
83	184	101	122	8.7
181	136	-45	-25	3.6
554	580	26	5	1.1
909	837	-72	-8	2.4
164	162	-2	-1	0.2
412	465	53	13	2.5
96	140	44	46	4.1
228	227	-1	0	0.1
993	830	-163	-16	5.4
136	96	-40	-29	3.7
434	515	81	19	3.7
244	229	-15	-6	1.0
1253	1304	51	4	1.4
955	1022	67	7	2.1
119	132	13	11	1.2
78	99	21	27	2.2
63	44	-19	-30	2.6
1203	1209	6	0	0.2
1025	1111	86	8	2.6
28	7	-21	-75	5.0
75	82	7	9	0.8
153	162	9	6	0.7
1124	1083	-41	-4	1.2
1057	1006	-51	-5	1.6
69	77	8	12	0.9
93	78	-15	-16	1.6
181	149	-32	-18	2.5
1016	1057	41	4	1.3
184	284	100	54	6.5

Observed	Modelled	Absolute Difference	Relative Difference (%)	GEH
181	129	-52	-29	4.2
232	194	-38	-16	2.6
143	170	27	19	2.2
923	1002	79	9	2.5
35	26	-9	-26	1.6
1210	1312	102	8	2.9
1092	1116	24	2	0.7
9	17	8	89	2.2
33	34	1	3	0.2
99	113	14	14	1.4

PM Peak

Observed	Modelled	Absolute Difference	Relative Difference (%)	GEH
1349	1155	-194	-14	5.5
1329	1179	-150	-11	4.2
1127	1147	20	2	0.6
1203	1289	86	7	2.4
544	505	-39	-7	1.7
359	319	-40	-11	2.2
23	35	12	52	2.2
20	29	9	45	1.8
65	137	72	111	7.2
65	16	-49	-75	7.7
474	648	174	37	7.3
592	667	75	13	3.0
75	131	56	75	5.5
72	137	65	90	6.4
434	426	-8	-2	0.4
64	80	16	25	1.9
1093	1086	-7	-1	0.2
211	207	-4	-2	0.3
432	503	71	16	3.3
129	126	-3	-2	0.3
254	238	-16	-6	1.0
965	896	-69	-7	2.3
131	101	-30	-23	2.8
390	409	19	5	1.0
207	196	-11	-5	0.8
1165	1171	6	1	0.2
1156	1098	-58	-5	1.7
169	140	-29	-17	2.3
157	140	-17	-11	1.4

Observed	Modelled	Absolute Difference	Relative Difference (%)	GEH
126	157	31	25	2.6
1157	1179	22	2	0.6
1257	1289	32	3	0.9
15	5	-10	-67	3.2
33	53	20	61	3.0
198	197	-1	-1	0.1
1079	1068	-11	-1	0.3
1135	1045	-90	-8	2.7
115	71	-44	-38	4.6
65	65	0	0	0.0
85	109	24	28	2.4
898	947	49	5	1.6
138	126	-12	-9	1.0
181	178	-3	-2	0.2
313	321	8	3	0.4
146	181	35	24	2.7
926	981	55	6	1.8
103	131	28	27	2.6
1068	1028	-40	-4	1.2
1107	1137	30	3	0.9
36	36	0	0	0.0
21	30	9	43	1.8
43	34	-9	-21	1.5