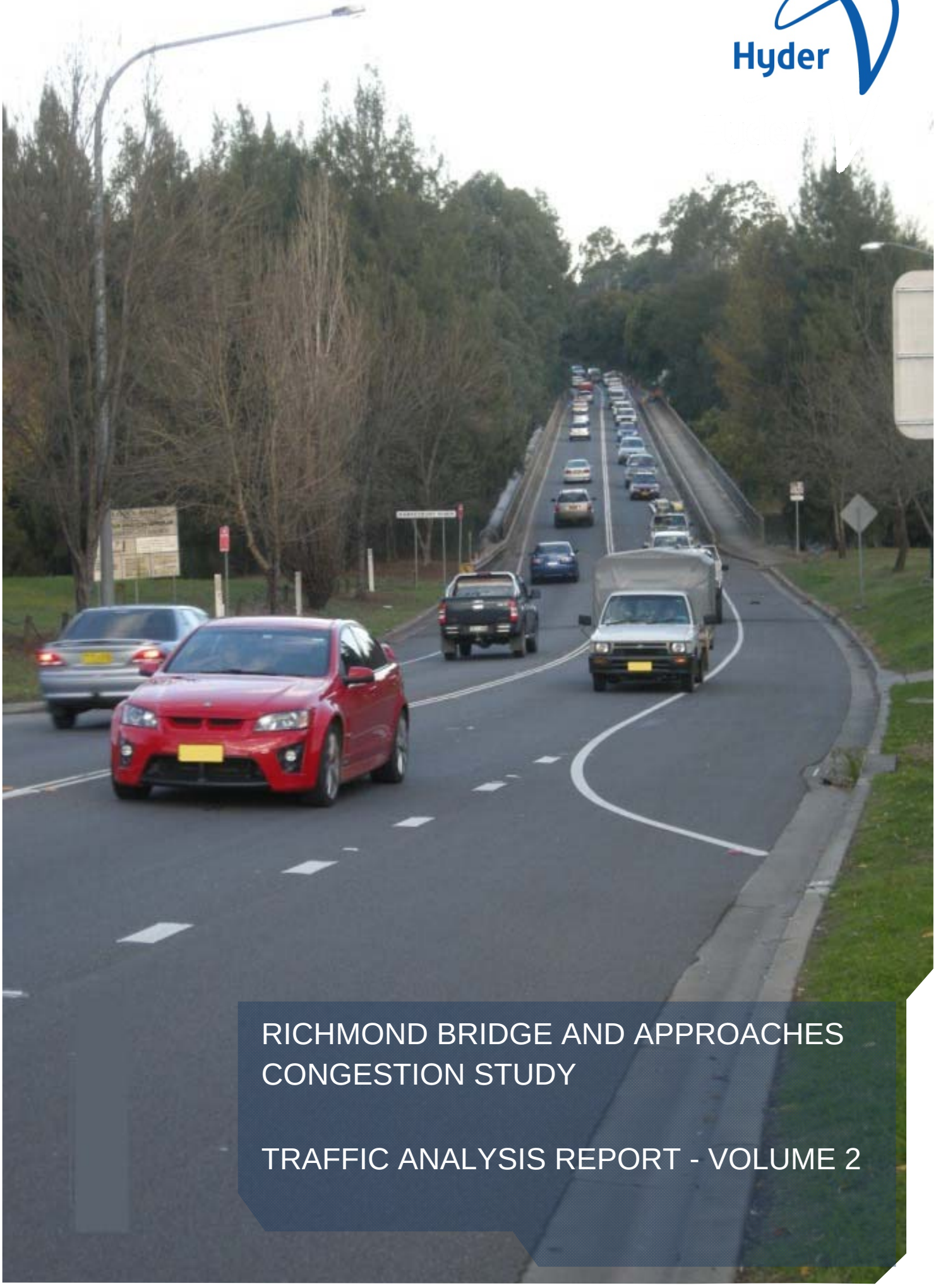
APPENDIX 4

TRAFFIC ANALYSIS REPORT VOLUME 2



RICHMOND BRIDGE AND APPROACHES CONGESTION STUDY

TRAFFIC ANALYSIS REPORT - VOLUME 2

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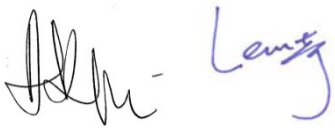
ROADS AND TRAFFIC AUTHORITY

RICHMOND BRIDGE AND APPROACHES CONGESTION STUDY

TRAFFIC ANALYSIS REPORT - VOLUME 2- APPENDICES

Author	Mukit Rahman, Alen Krljic, Jacky Leung	
Checker	Mukit Rahman	
Approver	Mukit Rahman	

Report No F0001-AA004249-AAR01

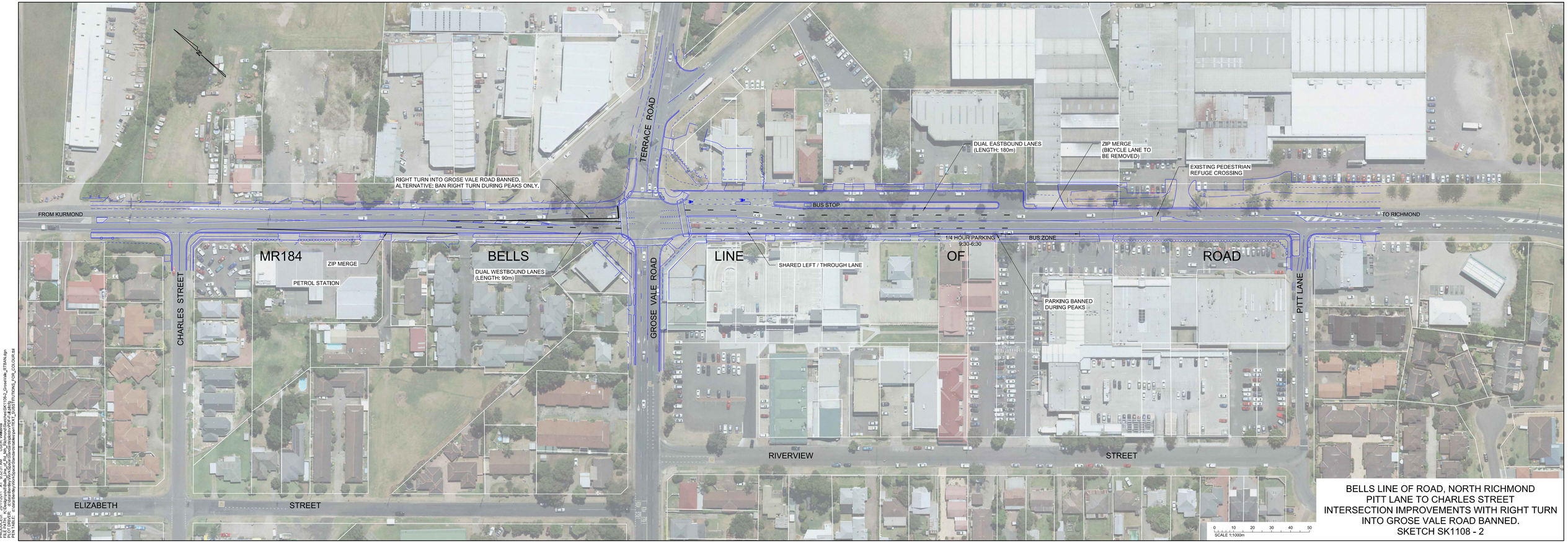
Date November 2011

CONTENTS

APPENDIX A

STRATEGIC CONCEPT SKETCHES PREPARED BY RMS FOR THE PROPOSED INTERSECTION IMPROVEMENTS

BELLS LINE OF ROAD, NORTH RICHMOND
PITT LANE TO CHARLES STREET
INTERSECTION IMPROVEMENTS WITH RIGHT TURN
INTO GROSE VALE ROAD
SKETCH SK1108 - 1



BELLS LINE OF ROAD, NORTH RICHMOND
PITT LANE TO CHARLES STREET
INTERSECTION IMPROVEMENTS WITH RIGHT TURN
INTO GROSE VALE ROAD BANNED.
SKETCH SK1108 - 2

PARKING TO BE BANNED FROM CHAPEL STREET TO BOSWORTH STREET (27 CARPARK SPACES TO BE REMOVED)

RIGHT TURN BAY (LENGTH: 145m)

BOSWORTH STREET

PARKING TO BE BANNED FROM BOSWORTH STREET TO 120m EAST. (6 CARPARK SPACES TO BE REMOVED)

FROM NORTH RICHMOND

TO WINDSOR

MARCH STREET

MR184 KURRAJONG ROAD

PARKING TO BE BANNED FROM BOSWORTH STREET TO 190m WEST. (21 CARPARK SPACES TO BE REMOVED)

PARKING TO BE BANNED FROM BOSWORTH STREET TO 100m EAST. (5 CARPARK SPACES TO BE REMOVED)

MR155 BOSWORTH STREET

LEGEND

LAND TO BE ACQUIRED

LAND ALREADY ACQUIRED

0 10 20 30 40 50

SCALE 1:1000m

MR 184 KURRAJONG ROAD
INTERSECTION WITH MR155 BOSWORTH STREET
TURN BAY FOR RIGHT TURN INTO BOSWORTH STREET
SKETCH SK1108 - 4

PRODUCED: 10/11/2011 AT 2:32:32 PM untitled
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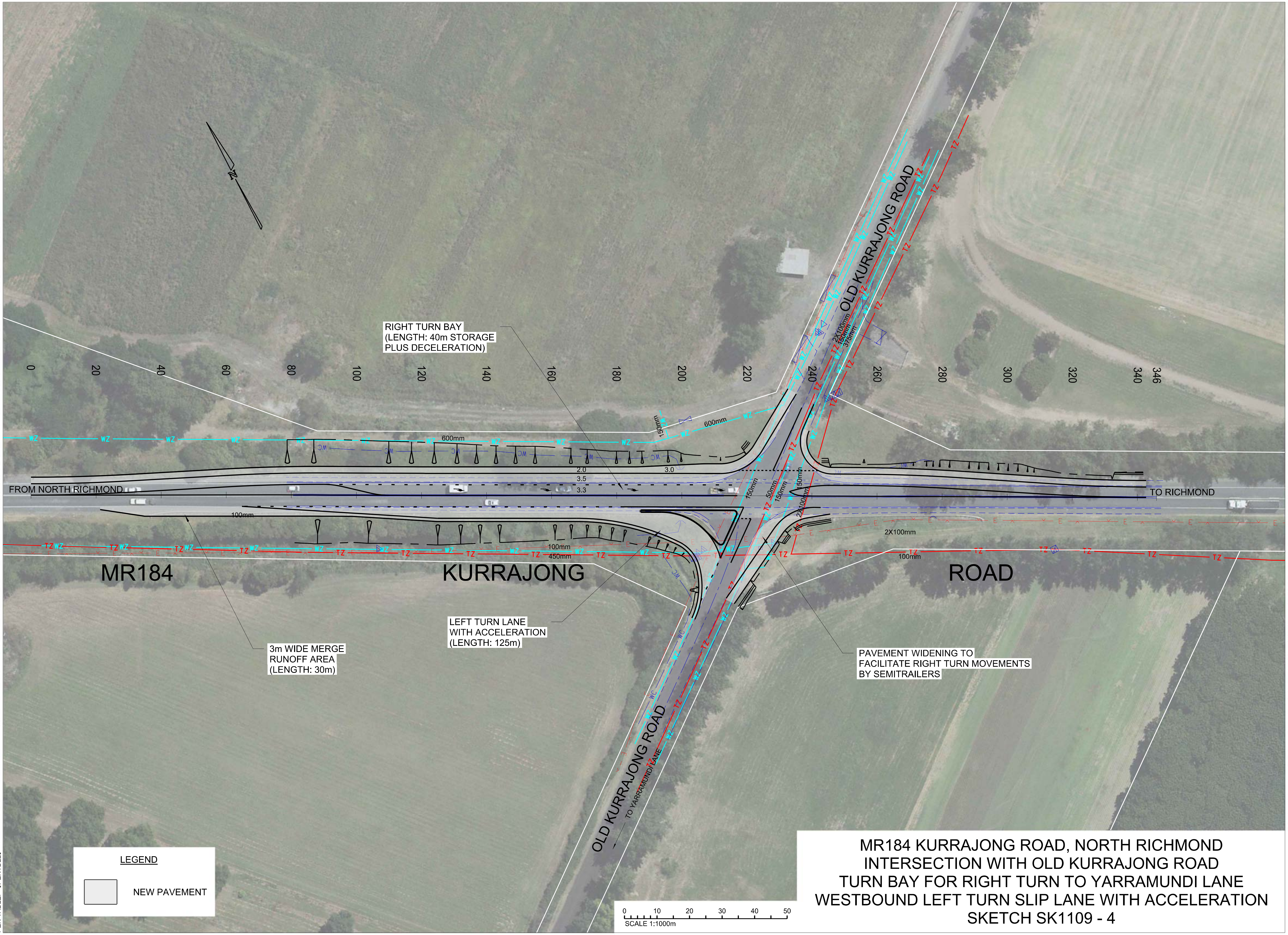
PEN TABLE: $PENTBL$



MR184 KURRAJONG ROAD, NORTH RICHMOND
INTERSECTION WITH OLD KURRAJONG ROAD
TURN BAY FOR RIGHT TURN TO YARRAMUNDI LANE
WESTBOUND LEFT TURN SLIP LANE WITH ACCELERATION
SKETCH SK1109 - 4

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APPENDIX B

EXISTING TRAFFIC DATA, SIDRA ANALYSIS

B1 Existing Level of Service (LoS), *SIDRA* analysis

At signalised intersections, Level of Service (LoS) criteria are related to average intersection delay measured in seconds per vehicle. The RTA's guideline (Guide to Traffic Generating Developments, Issue 2.2, RTA, October 2002) has recommended that with roundabouts, 'Stop' and 'Give Way' sign control intersections, the LoS value is determined by the critical movement with the highest delays.

Table B-1 below summarises intersection LoS criteria used to assess the intersection performance.

Table B-1 LoS Criteria for intersection capacity analysis

Level of Service	Average Delay per Vehicle (sec/veh)	Traffic Signals, Roundabout	Give Way & Stop Signs
A	<14	Good operation	Good operation
B	15 to 28	Good with acceptable delays & spare capacity	Acceptable delays & spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity & accident study required
E	57 to 70	At capacity; at signals, incidents will cause excessive delays Roundabouts require other control mode	At capacity, requires other control mode
F	>70	Unsatisfactory with excessive queuing	Unsatisfactory with excessive queuing

Source: RTA Guide to Traffic Generating Developments

In general, SIDRA predicts intersection performance for the following key parameters:

- Degree of saturation (DoS),
- Average delays to intersection
- Level of service (LoS) determined from LoS criteria from the table above
- Queue length.

Inappropriate interpretation of these parameters can create confusion, particularly for sign controlled intersections. For example, for a sign controlled intersection, LoS is determined by the highest delay for minor traffic movements and LoS could be lower such as "F", but with a small amount traffic delayed. In that situation, the intersection should not have significant capacity issues, except for one minor movement.

In SIDRA, signalised intersections are modelled with fixed time signals. Signal timing data (Intersection Diagnostic Monitor, IDM) for this study was sourced from the RMS. In general, the SIDRA model has assumed average phase time values based on RMS's IDM data. The modelling results are also validated against queue length data. The queue length from the model followed the same trend within the survey data range. The result confirmed that the SIDRA model was validated for queue length at key intersections.

SIDRA has limitations with regard to modelling the blockage of entry into the short lane by a queue in the adjacent lane. Therefore, the actual queue length of through traffic could be longer

because it also contains the turning traffic queue. The average delays and degree of saturation will also be higher than the model results.

The effect of blockage by downstream queues cannot be modelled by SIDRA accurately. Such delays and queue length should be modelled in micro-simulation software.

With priority intersections, SIDRA cannot effectively model the traffic behaviour of left turning traffic from minor roads when the speed of congested traffic on the major road is low. In reality, traffic from minor roads has more opportunity to merge with the main road.

Tables B-2 and B-3 below present the summary of level of service LoS of modelled intersections in the study area for the AM and PM peaks respectively.

Table B-2 Level of Service Summary AM Peak

Model :2011 AM						
Site ID	**Intersection**	**Approach**	**Average Delay (Sec)**	**LoS (Delay)**	**Overall Average Delay (Sec)**	**Intersection LoS**
A-1	Bells Line of Rd / Grose Vale Rd / Terrace Rd	North-Terrace Rd	46	D	38	**C**
		East-Bells Line of Rd	21	B		
		South-Grose Vale Rd	73	F		
		West-Bells Line of Rd	24	B		
A-2	Kurrajong Rd / Old Kurrajong Rd / Yarramundi La	North-Old Kurrajong Rd	70	E	70	**E**
		East-Kurrajong Rd	8	A		
		South Yarramundi Ln	11	A		
		West-Kurrajong Rd	12	A		
A-3	Kurrajong Rd / March St / Bosworth St	North-Bosworth St	41	C	34	**C**
		East-Kurrajong Rd	40	C		
		South-Bosworth St	67	E		
		West-March St	18	B		
A-4	Castlereagh Rd / Bosworth St / Lennox St	North-Bosworth St	5	A	13	**A**
		East-Lennox St	13	A		
		South-Bosworth St	7	A		
A-5	Castlereagh Rd / Inalls La / Southee Rd	North-Castlereagh Rd	9	A	15	**B**
		East-Southee Rd	15	B		
		South-Castlereagh Rd	11	A		
		West-Inalls La	13	A		
A-6	Lennox St / East Market St	North-East Market St	29	C	18	**B**
		East-Lennox St	11	A		
		South-East Market St	31	C		

Model :2011 AM						
		West-Lennox St	16	B		
A-7	March St / East Market St	North-East Market St	15	B	22	**B**
		East-March St	26	B		
		South-East Market St	24	B		
		West-March St	22	B		
A-8	Windsor St / East Market St	North-East Market St	31	C	24	**B**
		East-Windsor St	18	B		
		South-East Market St	25	B		
		West-Windsor St	28	B		
B-2	Lennox St / Paget St	North-Paget St	20	B	13	**A**
		East-Lennox St	10	A		
		South-Paget St	23	B		
		West-Lennox St	9	A		
B-3	Windsor St / Bosworth St	North-Bosworth St	10	A	10	**A**
		East-Windsor St	10	A		
		South-Bosworth St	9	A		
		West-Windsor St	10	A		
B-5	Bells Line of Rd / Charles St	East-Bells Line of Rd	8	A	27	**B**
		South-Charles St	27	B		
		West-Bells Line of Rd	10	A		
B-6	Lennox St / Bourke St / Blacktown Rd	North-Bourke St	44	D	21	**B**
		East-Blacktown Rd	16	B		
		South-Bourke St	46	D		
		West-Lennox St	7	A		
B-7	Windsor St / Bourke St	North-Bourke St	16	B	16	**B**
		East-Windsor St	15	B		
		South-Bourke St	23	B		
		West-Windsor St	13	A		

Table B-3 Level of Service Summary PM Peak

Model :2011 PM						
Site ID	**Intersection**	**Approach**	**Average Delay (Sec)**	**LoS (Delay)**	**Overall Average Delay (Sec)**	**Intersection LoS**
A-1	Bells Line of Rd / Grose Vale Rd / Terrace Rd	North-Terrace Rd	40	C	39	**C**
		East-Bells Line of Rd	43	D		
		South-Grose Vale Rd	47	D		
		West-Bells Line of Rd	27	B		
A-2	Kurrajong Rd / Old Kurrajong Rd / Yarramundi La	North-Old Kurrajong Rd	>100	F	>100	**F**
		East-Kurrajong Rd	18	B		
		South Yarramundi La	44	D		
		West-Kurrajong Rd	15	B		
A-3	Kurrajong Rd / March St / Bosworth St	North-Bosworth St	47	D	45	**D**
		East-Kurrajong Rd	47	D		
		South-Bosworth St	56	D		
		West-March St	35	C		
A-4	Castlereagh Rd / Bosworth St / Lennox St	North-Bosworth St	5	A	19	**B**
		East-Lennox St	19	B		
		South-Bosworth St	6	A		
A-5	Castlereagh Rd / Inalls La / Southee Rd	North-Castlereagh Rd	9	A	17	**B**
		East-Southee Rd	17	B		
		South-Castlereagh Rd	11	A		
		West-Inalls La	13	A		
A-6	Lennox St / East Market St	North-East Market St	29	C	21	**B**
		East-Lennox St	12	A		
		South-East Market St	29	C		
		West-Lennox St	22	B		
A-7	March St / East Market St	North-East Market St	20	B	28	**B**
		East-March St	33	C		
		South-East Market St	30	C		
		West-March St	31	C		
A-8	Windsor St / East Market St	North-East Market St	44	D	29	**C**
		East-Windsor St	21	B		

Model :2011 PM						
		South-East Market St	27	B		
		West-Windsor St	37	C		
B-2	Lennox St / Paget St	North-Paget St	24	B	15	**B**
		East-Lennox St	11	A		
		South-Paget St	24	B		
		West-Lennox St	10	A		
B-3	Windsor St / Bosworth St	North-Bosworth St	10	A	11	**A**
		East-Windsor St	11	A		
		South-Bosworth St	9	A		
		West-Windsor St	10	A		
B-5	Bells Line of Rd / Charles St	East-Bells Line of Rd	8	A	13	**A**
		South-Charles St	13	A		
		West-Bells Line of Rd	11	A		
B-6	Lennox St / Bourke St / Blacktown Rd	North-Bourke St	32	C	23	**B**
		East-Blacktown Rd	28	B		
		South-Bourke St	28	B		
		West-Lennox St	9	A		
B-7	Windsor St / Bourke St	North-Bourke St	17	B	19	**B**
		East-Windsor St	17	B		
		South-Bourke St	28	B		
		West-Windsor St	16	B		

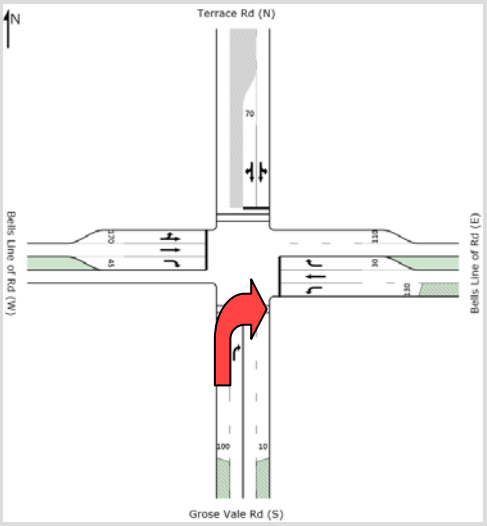
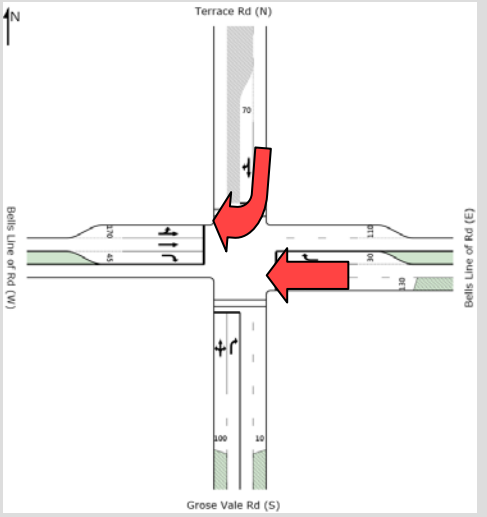
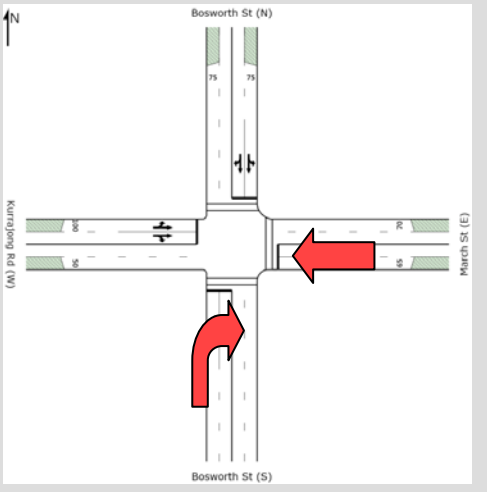
In general, the model forecasts low LoS for critical movements at the following three intersections:

- Bells Line of Road/Grose Vale Road/Terrace Road (A-1);
- Kurrajong Road/Old Kurrajong Road/Yarramundi Lane (A-2); and
- Kurrajong Road/Bosworth Street/March Street (A-3).

While some of these issues do not necessarily reflect an overcapacity situation for the entire intersection, any further increase in demand is likely to affect the network performance.

Table B-4, below, summarises the key network operational issues identified in the study area network based on the SIDRA modelling outcome.

Table B-4 Network Operational Issues (based on SIDRA modelling outcome)

Intersection	Network operational issue	SIDRA layout
A-1 Bells Line of Rd / Grose Vale Rd / Terrace Rd	Northbound right turn (463 vehicles) from Grose Vale Road shows high delays during AM Peak (Avg Delays = 78s, LoS = F)	
A-1 Bells Line of Rd / Grose Vale Rd / Terrace Rd	Westbound through traffic (532 vehicles) from Bells Line of Road experience high delays during PM Peak (Avg Delays = 47s, LoS = D) Southbound right turn (52 vehicles) from Terrace Road experience high delays during PM Peak (Avg Delays = 57s, LoS = E)	
A-3 Kurrajong Road / Bosworth Street / March Street	Westbound through traffic (479 vehicles) from Bells Line of Road experience high delays during PM Peak (Avg Delays = 47s, LoS = D) The actual delays and queue length can be longer due to SIDRA model limitations. North bound right turn (50 vehicles) from Castlereagh Road experience high delays during PM Peak (Avg Delays = 75s, LoS = F)	

APPENDIX C

PARAMICS MODEL DEVELOPMENT, CALIBRATION AND VALIDATION

C1 BASE MODEL DEVELOPMENT

C1.1 OVERVIEW

A *Paramics* model was developed to facilitate a more in depth analysis of the operational impacts of the Richmond Bridge and adjoining intersections. The Paramics models were calibrated and validated according to the RMS's Paramics modelling guidelines. The models represented 2011 traffic conditions for both morning (AM) peak and afternoon (PM) peak periods, i.e.;

- The AM peak period between 7:00 and 9:00, and
- The PM peak period between 15:00 and 18:00.

C1.2 DATA SOURCES

Hyder reviewed various sources of historical traffic data prior to conducting actual traffic surveys.

The following data sources were used for the Paramics model development and calibration and validation purposes:

- Geo-referenced aerial photography provided by the RMS.
- Classified tube counts (ATC).
- Intersection turning counts.
- Intersection queue lengths survey data at 5 minute intervals.
- Video surveys of traffic operations along the main corridor (Bells Line of Road and Kurrajong Road between Grose Vale Road and Bosworth Street).
- Existing signal timings (IDM data) provided by the RMS.
- Travel time data provided by the RMS.
- Journey to Work (JWT) data for Census year 2006.
- Hyder's own Sydney Strategic Model, SSTM (TransCAD).
- RMS's Strategic Model, (Emme/2).
- Public transport data.
- Data collected during the site visit.

C1.3 SOFTWARE AND PLUG-IN USED

Paramics (Version 6.7.2) was used. Azalient Plug-in software (Version 6.7.1.G.05) was used to provide additional functionality in the developed models.

C1.4. ROAD NETWORK CODING

Aerial photography was primarily utilised to code the road network for the existing model. The geo-referenced aerial photography provided adequate information for network coding including road length, lane width, number of lanes, lane discipline and intersection configurations. The model network was coded in the Lamberts 94 coordinate system as per the RMS's recommendations.

In Paramics, roads are classified into major and minor roads, corresponding to the main roads and local roads in the RMS's road classifications. All link-types and categories were coded based on RTA Paramics manual *(Paramics Microsimulation Modelling, RTA Manual, Version 1.0, May 2009).*

Figure C-1 shows Paramics model road network and travel zone system.

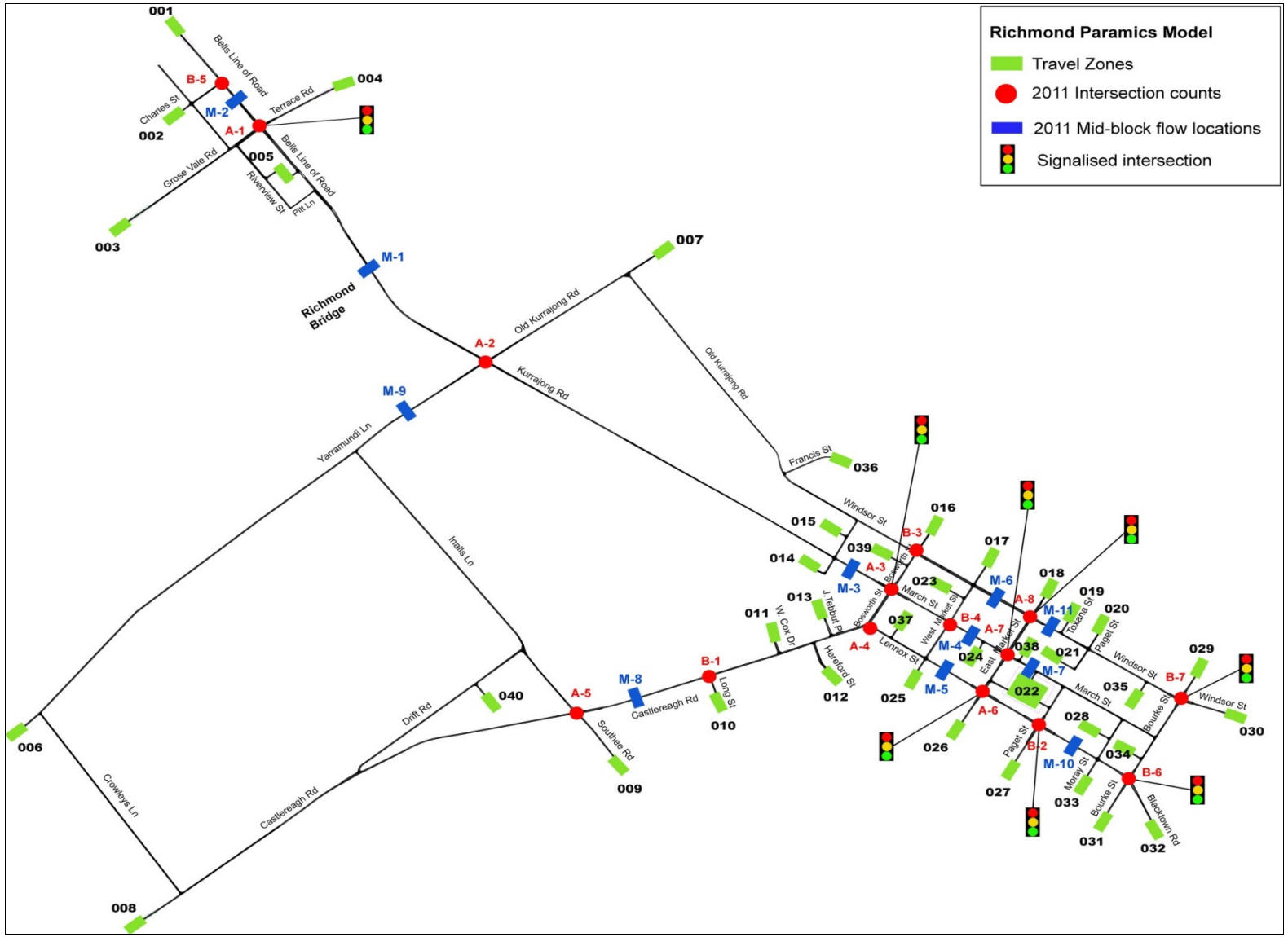


Figure C-1 Paramics model network and travel zone system

C1.5 RTA STANDARDS FILE INCORPORATED IN THE MODEL

The Following RTA's standard Paramics files were incorporated in the models:

- Configuration
- Vehicles
- Categories
- Acceleration
- Behaviour.

C1.6 TRAFFIC ASSIGNMENT METHOD

In general, the scope of micro-simulation modelling is to examine options that improve traffic flows on Bells Line of Road between North Richmond and Richmond. The east west traffic flows on Bells Line of Road dominate the traffic characteristics in the study area. Between North Richmond and Richmond, Bells Line of Road/Kurrajong Road is the east-west traffic route that carries the majority of traffic volumes. The study area network has dominantly linear characteristics. In general, an 'all-or-nothing' (AON) traffic assignment technique was adopted, supported by local route choices where relevant. The local alternative trafficable routes in the study area (including Old Kurrajong Road, Windsor Road, Yarramundi Lane and Inalls Lane) are modelled reflecting local route choices. The route choice behaviours of local roads in the Richmond township are applied based on traffic data collected for this study. During the model development stage, Hyder's modelling team tested a Dynamic Feedback (DF) assignment technique. It was found that DF assignment resulted in unrealistic route choices of local traffic, particularly in Richmond township.

C1.7 ADDITIONAL TECHNIQUES

Additional Paramics techniques were used to adjust model parameters to replicate the existing traffic conditions. They are defined as follows:

- *Next Lanes* – Forcing vehicles into the correct lanes and avoiding the attractive but incorrect lanes which the vehicles should not move into.
- *Cost factor*: The effect of this is to adjust the attractiveness of major links to vehicles.
- *Sign Posting* – Adjusting signposting distance, which is often subject to the link length, to improve lane change behaviour and reduce unrealistic congestion.
- *Node Blocking* – Avoiding vehicles queuing at intersections when congestion occurs.
- *Force Merge / Across* – Forcing -turning vehicles to cross the oncoming traffic after they have been delayed for some time when oncoming traffic leaves a gap at non-signalised intersections. This function was mainly activated when minor traffic tries to merge or turn into a heavily congested/queued major stream.
- *Reaction factor*: the Mean Driver Reaction Time for all vehicles on the link can be modified using this factor. This factor is mainly applied on links to the model 'shockwave' effect where drivers are aware or not aware of the surrounding conditions.
- *Headway factor*: the Mean Target Headway for all vehicles on the link can be modelled using this factor. This factor is applied on high volume/low speed links where appropriate.
- *Approach visibility*: specifies the length from an intersection that a vehicle will be able to visibly see conflicts and judge if it will have to yield.

- *Restrictions*: Restrictions were applied on some local roads and streets in the network to prevent access of articulated and B-double trucks to use these roads.

C1.8 PARAMICS DEMAND MATRIX

C1.8.1 DEMAND DATA

The initial demand matrix was estimated using Hyder's own Sydney Strategic Transport Model, (SSTM operates in TransCAD) using a sub-area technique. The demand was further refined using data obtained from RMS's Sydney Strategic Model (operates in Emme/2). Further travel zone and network refinements were undertaken for the study area. The demand matrix was calibrated to the RMS's standards using the 2011 traffic counts data.

The demand matrix was estimated separately for two vehicle types:

- Cars/light vehicles.
- Rigid and articulated heavy vehicles.

The proportion of heavy vehicles has been taken directly from classified traffic surveys.

C1.2.2 TRAVEL ZONES

The Paramics model has a total of 40 travel zones covering the study area which includes North Richmond village from Charles Street on the west and the entire Richmond town to Bourke Street on the east.

C1.2.3 DEMAND PROFILE

In order to ensure that the correct numbers of vehicles are released into the network as per defined time slices, a demand profile was constructed. Temporal traffic profiles were developed for 15 minute periods across the modelled two hours. The temporal traffic profiles are based on traffic count data. The demand profiling for the AM peak is shown in Figure C-2. In addition, a pre-loading 'warm up' period for 30 minutes from 6:30 to 7:00 and post peak 'cool down' period for 30 minutes from 9:00 to 9:30 were applied in the AM peak model.

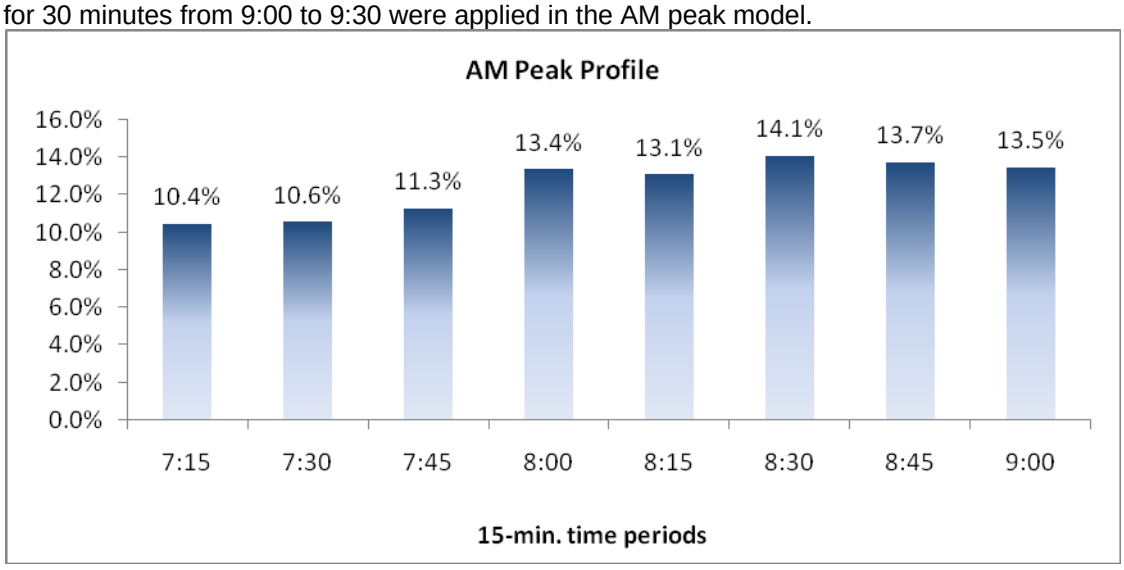


Figure C-2 AM peak demand profiling

The demand profiling for the PM peak is shown in Figure C-3. In addition, a pre-loading 'warm up' period for 30 minutes from 14:30 to 15:00 and post peak 'cool down' period for 30 minutes from 17:00 to 17:30 were applied in the PM peak model.

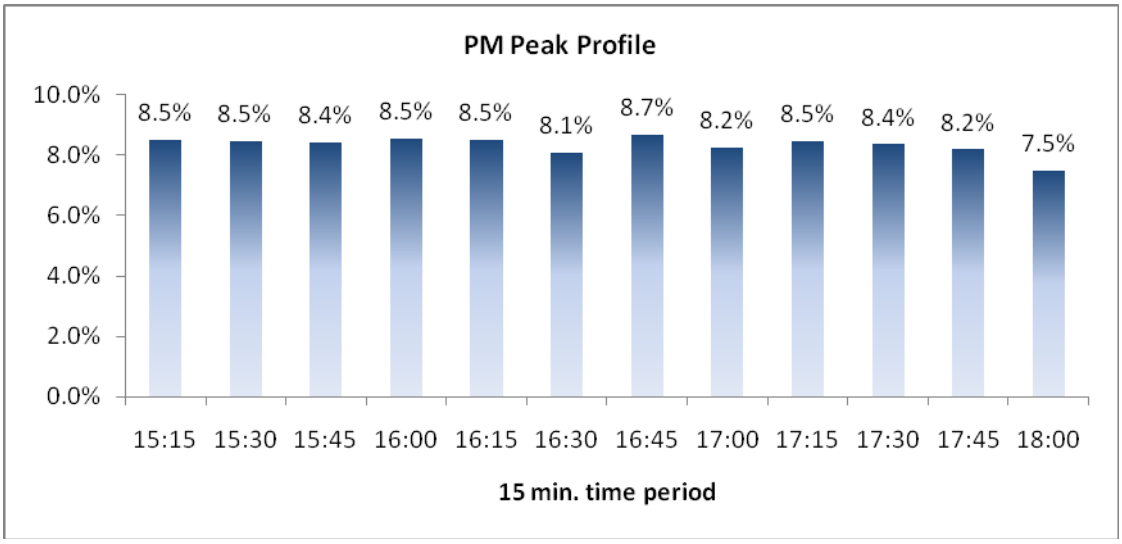


Figure C-3 PM peak demand profiling

C1.9 MODEL CALIBRATION AND VALIDATION

The calibration and validation criteria were based on the following sources:

- RTA manual – *Paramics Microsimulation Modelling* Version 1.0 issued in May 2009;
- UK Design Manual for Roads and Bridges (DMRB) issued by the Highways Agency, UK and last amended in November 2009.

Model calibration is the process that develops and adjusts model parameters to adequately reflect the observed traffic behaviour.

The model validation provides an independent check of the calibrated model to assess its accuracy and confirm its 'fit for purpose'. For this study the following data were used for the model validation purpose:

- Queue lengths, and
- Travel time data.

The following sections provide a summary of calibration and validation results.

C1.9.1 CALIBRATION CRITERIA

Intersection turning volumes/ individual link flows were assessed based on the modelling criteria detailed in Table C-1.

Table C-1 Calibration criteria for link flows and intersection turning volumes

Calibration Criteria	Target
Difference in flow within 100 vph for flows less than 700 vph	85%
Difference in flow within 15% for flows between 700 and 2700 vph	85%
Difference in flow within 400 vph for flows more than 2700 vph	85%
GEH statistic less than 5	85%

C1.9.2 CALIBRATION RESULT FOR THE AM PEAK

Individual link flows and intersection turning volumes have been assessed based on the calibration criteria. Tables C-2 and C-3 summarise the calibration results for the AM peak model, Hyder can provide a copy of turn flow comparison at individual intersections and link flow comparison on request.

Table C-2 AM Peak calibration results (intersection counts)

Model Calibration (intersection turning volumes)			
Total number of turn flows:	159 (15 intersections)		
Number of flows less than 700 vph	156		
Number of flows between 700 and 2700 vph	3		
Number of flows more than 2,700 vph	0		
Meet the assessment criteria:	**Target**	**Achieved**	**Status**
Difference in link flow within 100 for flows <700 vph	85%	100%	Pass
Difference in link flow within 15% for flows 700-2,700 vph	85%	100%	Pass
Difference in link flow within 400 for flows >2,700 vph	n/a	n/a	n/a
GEH Statistic less than 5 of all individual modelled flow	85%	91%	Pass

The results from Table C-2 showed that AM peak model was calibrated as per RTA's guidelines while compared for intersection turning movements.

The link flow comparisons between observed and modelled traffic flows were undertaken for 22 links.

The summary of the link calibration results are shown in Table C-3.

Table C-3 2010 AM Peak Model Link Calibration

Link Calibration			
Number of individual link flows (by direction):			22
Number of flows less than 700 vph			*19*
Number of flows between 700 and 2700 vph			*3*
Number of flows more than 2,700 vph			*0*
Average link flow			660 vph
Meet the assessment criteria:	**Target**	**Achieved**	**Status**
Difference in link flow within 100 for flows <700 vph	85%	100%	Pass
Difference in link flow within 15% for flows 700-2,700 vph	85%	100%	Pass
GEH Statistic less than 5 of all individual modelled flow	85%	100%	Pass

The results from Table C-3 suggested that AM peak model was calibrated for individual link flows to the RTA Paramics standards.

Model stability

Figures C-4 and C-5 below show the AM Peak variation of modelled traffic flows at eleven mid-block locations (See Figure C-1) for five different seeds. The model was run for five 'seed' values as per RTA guideline. The five seeds values were 560, 28, 7771, 86524, and 2849. The results showed minor traffic variations for all seed values. This confirmed that model is stable.

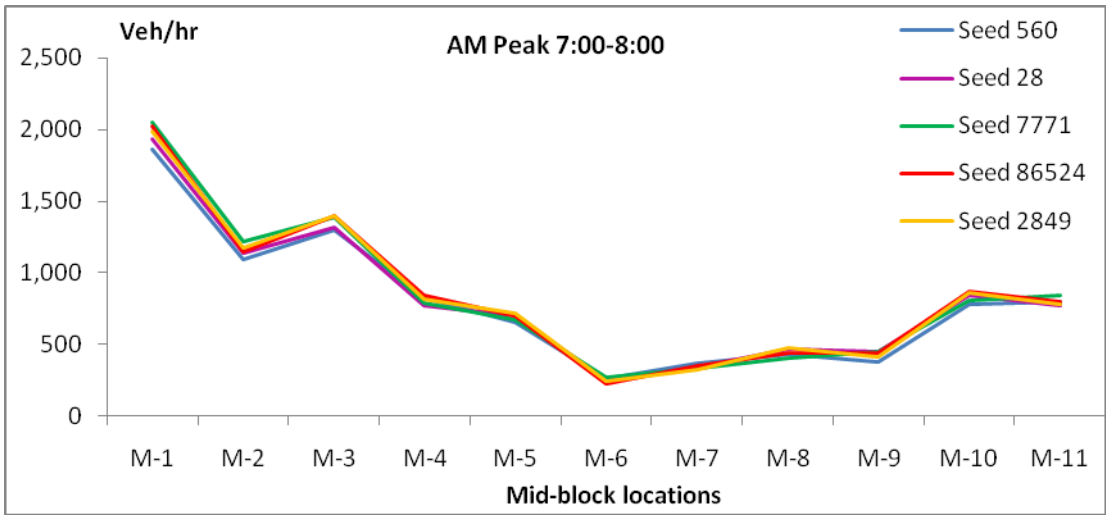


Figure C-4 Model stability check-AM peak 7:00-8:00

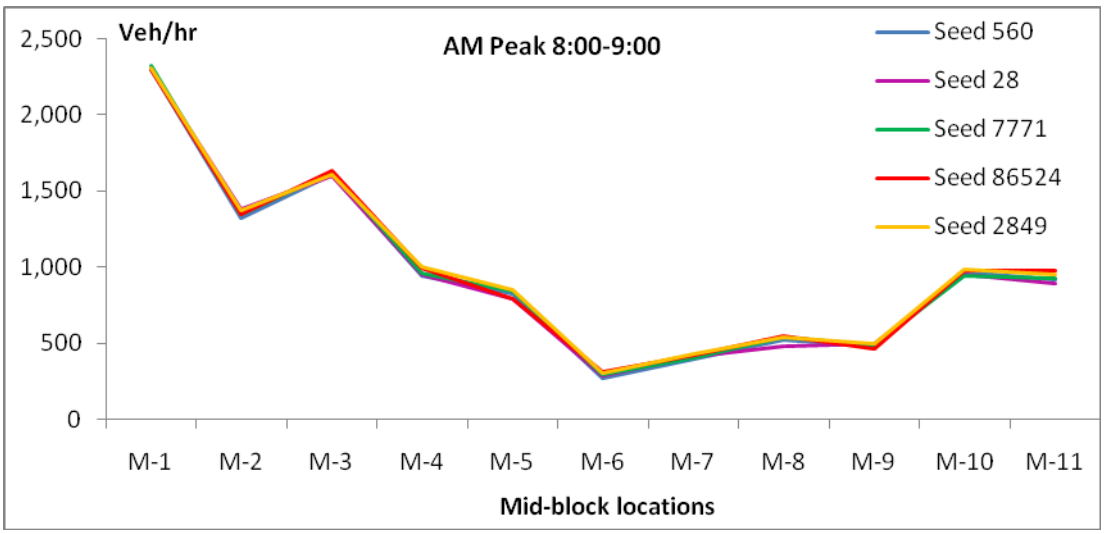


Figure C-5 Model stability check-AM peak 8:00-9:00

Demand release

For the AM peak 100 per cent of the demand was released during the two hour period modelled.

Model validation-travel time and speed

The model was validated for both travel time and queue lengths. AM Peak observed and modelled travel times, as cumulative values, were compared at three main road sections between Grose Vale Road and East Market Street in eastbound direction as follows;

- Section 1: Grose Vale Road-Richmond Bridge;
- Section 2: Richmond Bridge-Bosworth Street; and
- Section 3: Bosworth Street-East Market Street.

Figure C-6 shows AM peak travel time comparison between Base Case model and average survey travel time data (March 2011). The model travel time (yellow line) followed the same trend with the average survey travel time data.

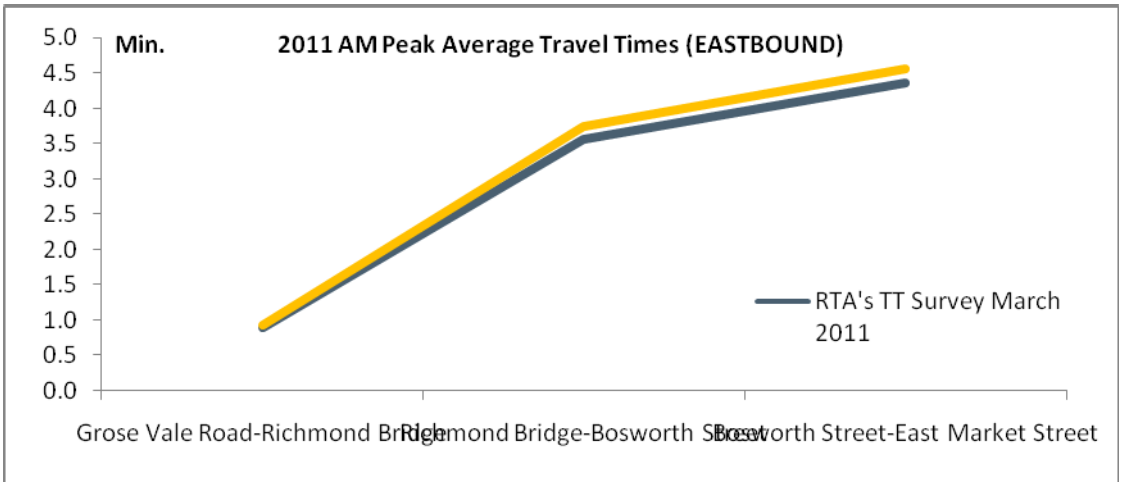


Figure C-6 AM peak model validation-average travel times

In conjunction with the travel time comparison, model speed data along main roads were compared with the average observed speeds. Observed and modelled speeds were compared section by section, and for entire route between Grose Vale Road and East Market Street in eastbound direction. Figure C-7 shows comparison of the model speeds with the average survey speeds. The survey data showed that the average speed during the AM Peak period from Grose Vale Road to East Market Street is approximately 50 km/h. In general, model speeds were in line with average survey speeds.

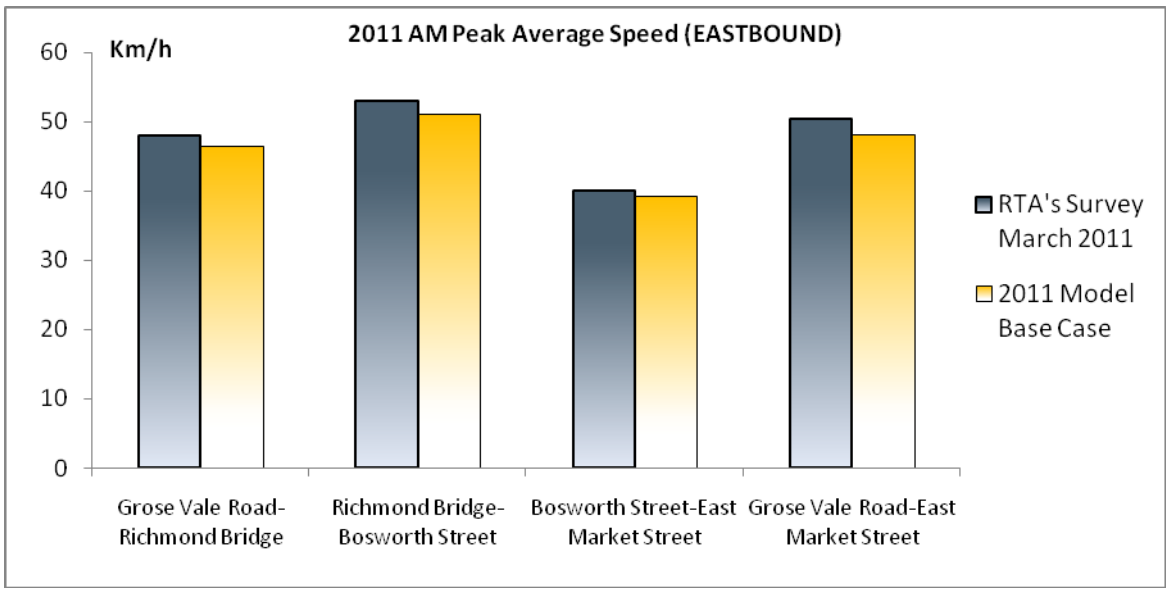


Figure C-7 AM peak model validation- average travel speed

Queue lengths

Queue lengths were recorded at 5 minute intervals on all of the approaches at 11 intersections. Observed and modelled average queue length data were compared. During the validation period, queue length data from the video survey was also observed. The queue length from the model followed a similar trend within the survey data range. The result confirmed that the model was validated for the queue lengths at key intersections. Hyder can provide, on request, to RMS a copy of the queue length comparison between observed and modelled condition at modelled intersections for the purposes of model auditing.

Summary of AM Peak model calibration and validation

The modelling results documented in this section suggests that the AM peak period model was adequately calibrated and validated for 2011 traffic conditions.

C1.9.3 CALIBRATION RESULT FOR THE PM PEAK

Individual link flows and intersection turning volumes have been assessed based on the calibration criteria. Tables C-5 and C-6 summarise the calibration results for the PM peak model. Hyder can provide, on request,to RMS a copy of the queue length comparison between observed and modelled condition at modelled intersections for the purposes of model auditing.

Table C-5 PM Peak calibration results (intersection counts)

Model Calibration (intersection turning volumes)			
Total number of turn flows:			159 (15 intersections)
Number of flows less than 700 vph			158
Number of flows between 700 and 2700 vph			1
Number of flows more than 2,700 vph			0
Meet the assessment criteria:	**Target**	**Achieved**	**Status**
Difference in link flow within 100 for flows <700 vph	85%	100%	Pass
Difference in link flow within 15% for flows 700-2,700 vph	85%	100%	Pass
Difference in link flow within 400 for flows >2,700 vph	n/a	n/a	n/a
GEH Statistic less than 5 of all individual modelled flow	85%	88%	Pass

The results from Table C-5 showed that the AM peak model was calibrated as per the RTA's guidelines while compared for intersection turning movements.

The link flow comparisons between observed and modelled traffic flows were undertaken for 22 links.

The summary of the link calibration results are shown in Table C-6.

Table C-6 2010 PM Peak Model Link Calibration

Link Calibration			
Number of individual link flows (by direction):			22
Number of flows less than 700 vph			*18*
Number of flows between 700 and 2700 vph			*4*
Number of flows more than 2,700 vph			*0*
Average link flow			700 vph
Meet the assessment criteria:	**Target**	**Achieved**	**Status**
Difference in link flow within 100 for flows <700 vph	85%	100%	Pass
Difference in link flow within 15% for flows 700-2,700 vph	85%	100%	Pass
GEH Statistic less than 5 of all individual modelled flow	85%	95%	Pass

The results from Table C-6 suggested that the PM peak model was calibrated for individual link flows to the RTA Paramics standards.

Model stability

Figures C-8 to C-10 below show the PM Peak variation of modelled traffic flows at eleven mid-block locations (See Figure C-1) for five different seeds. The model was run for five seed values as per the RTA's guideline. The five seeds values were 560, 28, 7771, 86524, and 2849. The results showed minor traffic variations for all seed values. This confirmed that the model is stable.

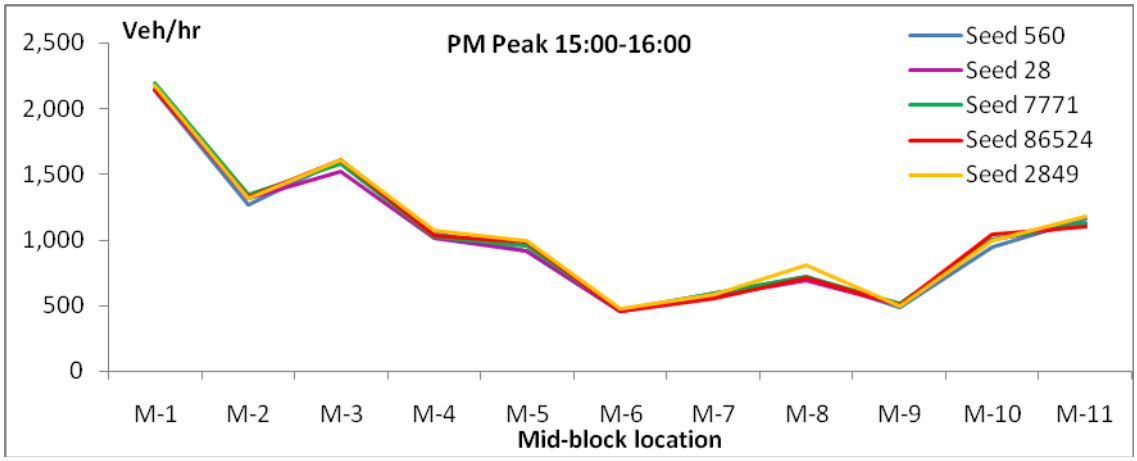


Figure C-8 Model stability check-AM peak 15:00-16:00

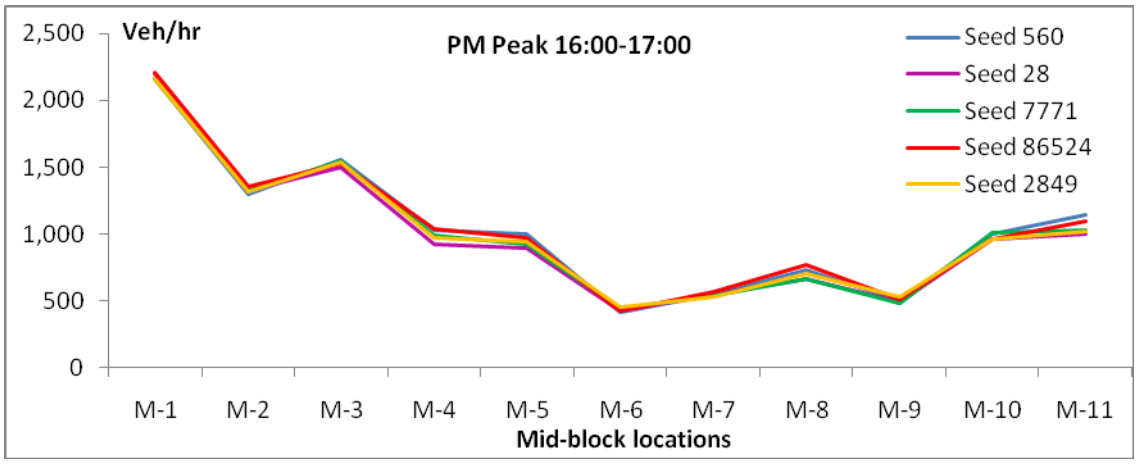


Figure C-9 Model stability check-AM peak 16:00-17:00

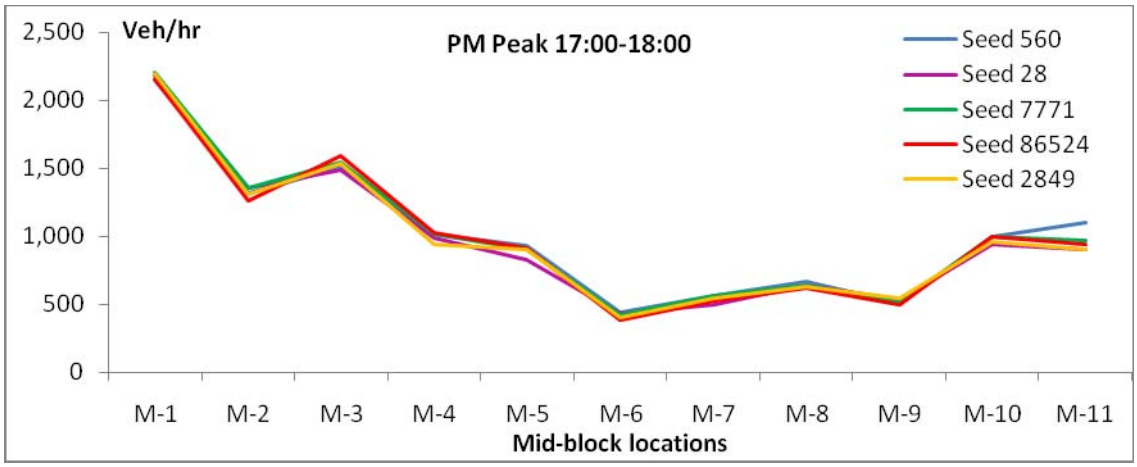


Figure C-10 Model stability check-AM peak 17:00-18:00

Demand release

For the PM peak 100 per cent of the demand was released during the three hour period modelled.

Model validation-travel time

The model was validated for both travel time and queue lengths. PM Peak observed and modelled travel times, as cumulative values, were compared at three main road sections between East Market Street and Grose Vale Road in westbound direction as follows:

- Section 1: East Market Street-Bosworth Street;
- Section 2: Bosworth Street-Richmond Bridge; and
- Section 3: Richmond Bridge-Grose Vale Road;

Figure C-11 shows the PM peak travel time comparison between Base Case model and average survey travel time data (March 2011). The modelled travel time (yellow line) followed the same trend as the average survey travel time data.

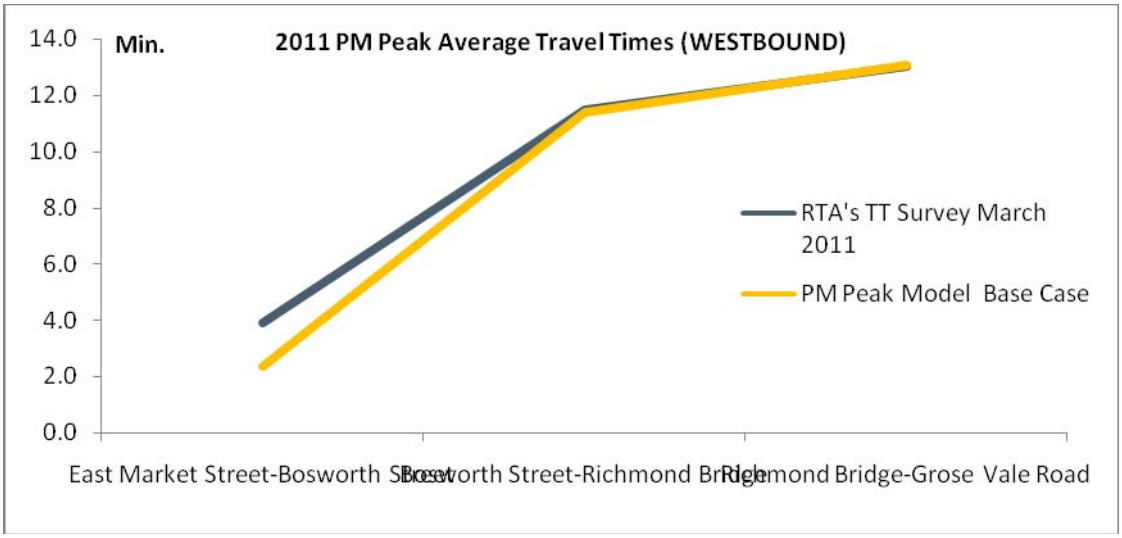


Figure C-11 Model stability check-PM peak 17:00-18:00

In conjunction with travel time comparison, model speed data along main roads were compared with the average observed speeds. Observed and modelled speeds were compared, section by section, and for entire route between East Market Street and Grose Vale Road in the westbound direction. Figure C-12 shows a comparison of the model speeds with the average survey speeds. The survey data showed that the average speed during the PM Peak period from East Market Street to Grose Vale Road is approximately 17 km/h. In general, the modelled speed was in line with the average survey speed.

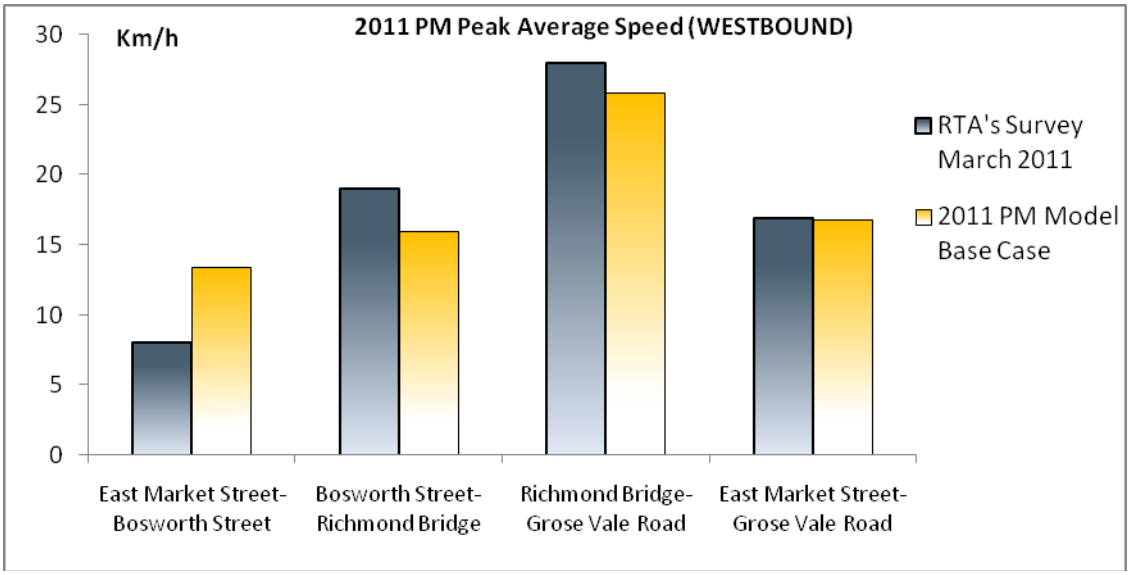


Figure C-12 PM peak model validation- average travel speed

Queue lengths

Queue lengths were recorded at 5 minute intervals on all of the approaches at 11 intersections. Observed and modelled average queue length data were compared. During the validation period, queue length data from the video survey was also observed. The queue length from the model followed a similar trend within the survey data range. The result confirmed that the model was validated for the queue lengths at key intersections. Hyder can provide, on request, to RMS a copy of the queue length comparison between observed and modelled condition at modelled intersections for the purposes of model auditing.

Summary of PM Peak

The modelling results documented in this section suggests that the PM peak period model was adequately calibrated and validated for 2011 traffic conditions.