



Australian Government  
Nation Building Program



Transport  
Roads & Maritime  
Services



# Richmond Bridge and Approaches Congestion Study

Stage 1 summary report | Volume 1

JULY 2012



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# REPORT STRUCTURE

The Richmond Bridge and Approaches Congestion Study consists of this Summary Report and five Appendices outlined below.

## SUMMARY REPORT

This Summary Report contains the following eight sections providing an assessment of the network performance of the Richmond Bridge and adjoining roads.

Section 1 provides an overview of the project, background information, study objectives, and a description of the study area.

Section 2 provides a description of the road hierarchy for the study area.

Section 3 provides the regional and local transport context within which the assessment has taken place. This section provides an overview of key transport indicators including historical traffic growth, mode share analysis, crash data and also provides an overview of existing travel patterns in the study area.

Section 4 describes the existing transport network performance in the study area. Results from traffic surveys are summarised in this section. An assessment of the existing network capacity has been undertaken, summarising network deficiency at key roads and intersections.

Section 5 provides a summary of the key network conditions in the study area.

Section 6 provides an overview of the traffic models. It describes the modelling purpose and network assumptions, and analysis is included.

Section 7 describes the eight options and key traffic criteria used to compare the performance for each option. Of the eight modelled options; the best performing option (H) is identified from a current and future traffic perspective.

Section 8 summarises the key study findings and recommendations.

## APPENDICES

Details of bridge investigations, traffic analyses and strategic concept sketches of proposed short term improvements are included in Appendices to this Report. The appendices are as follows:

- Appendix 1 – Concept Proposal for the widening of Richmond Bridge (RMS).
- Appendix 2 - Bridge Inspection and Structural Assessment (RMS).
- Appendix 3 - Richmond Bridge and Approaches Congestion Study – Traffic Analysis Report, Volume 1, (Hyder).
- Appendix 4 - Richmond Bridge and Approaches Congestion Study – Traffic Analysis Report, Volume 2 (Hyder).
- Appendix 5 – Strategic Concept Sketches of Proposed Short-Term Improvements (RMS).

# EXECUTIVE SUMMARY

## This Study

In August 2010 the Federal Minister for Infrastructure and Transport, the Hon Anthony Albanese MP, announced that the Federal Government would initiate planning work to deal with congestion at Richmond Bridge.

This report details the outcomes of the first of two stages involved in the planning process. This first stage combines:

- An appraisal by New South Wales Roads and Maritime Services (RMS) of the condition of the existing Richmond Bridge, together with reporting of its analysis of two options for future development of the bridge, i.e. the three lane augmentation announced by Minister Albanese and an alternative four lane option.
- A detailed assessment by Hyder Consulting Pty Ltd (Hyder) of current traffic conditions in the area of the bridge and options for addressing congestion. It provides a recommended short and medium-term solution to relieve traffic congestion both on the bridge and in the local area.

Whilst the work undertaken by Hyder underlines the necessity of undertaking intersection improvements to relieve traffic congestion, it is also apparent that planning for ultimate bridge expansion is required.

Stage 2 of this study therefore will:

- Assess, in detail, Hyder's options and the proposal contained within this document, including costings; and
- Develop strategic concept plans for upgrading the bridge and approaches to provide a medium to long term solution, again including costings.

This Stage 1 report is an amalgamation of individual reports undertaken by RMS and Hyder. The original reports form appendices to this document:

- Appendix 1 - Concept Proposal for the widening of Richmond Bridge (RMS),
- Appendix 2 - Bridge Inspection and Structural Assessment (RMS),
- Appendix 3 - Richmond Bridge and Approaches Congestion Study – Traffic Analysis Report, Volume 1, (Hyder)
- Appendix 4 - Richmond Bridge and Approaches Congestion Study – Traffic Analysis Report, Volume 2 (Hyder), and
- Appendix 5 – Strategic Concept Sketches of Proposed Short-Term Improvements (RMS).

## The Bridge in its regional context

The Bells Line of Road provides a supplementary link to the Great Western Highway between the Sydney Basin and the Central West Region of New South Wales. It is one of the few escarpment crossings supporting the Great Western Highway and acts as an alternative route. It also has high tourism significance with botanical gardens, bushwalking trails, lookout points and is one of the most picturesque routes crossing the Blue Mountains.



The eastern end of the Bells Line of Road corridor provides access to Richmond and the rapidly growing North-West Growth Sector of Sydney, forming a commuter route for settlements west of the Hawkesbury River to Richmond and the Sydney urban area. This section of the route includes the Richmond Bridge which is the only Hawkesbury River crossing serving the entire residential catchment of North Richmond, Kurrajong, Bilpin, Bell and beyond. During the morning and afternoon peak hours this section of Bells Line of Road experiences significant levels of traffic congestion. Congestion is experienced on the two lane Richmond Bridge (one lane in each direction) and adjoining approach roads between North Richmond and Richmond. Proposed additional residential developments are likely to add to this pressure.

### Options for Richmond Bridge

The existing bridge was built in 1905 and widened downstream in 1927.



Figure E-1 Richmond Bridge

The carriageway between kerbs is 8.53m and carries two traffic lanes and a footway.

In 2011, Richmond Bridge carried about 27,000 vehicles per day, with about 1,400 to 1,500 vehicles per direction (either eastbound or westbound) in the morning and afternoon peak one hour periods respectively. This is a typical 'tidal flow' pattern, with heavy eastbound flow in the morning (about 1,500 vehicles in one hour). A significantly low volume is observed in the westbound direction (about 700 vehicles in one hour) in the morning peak. The reverse is true in the evening. The modelling undertaken by Hyder as part of the traffic study suggests 2021 demand volumes in the order of 1800 vehicles in the morning peak one hour, well above capacity for a single lane. This suggests the ultimate need for two through traffic lanes in the peak direction, hence a tidal flow scheme could be considered.

Hyder have concluded that the possible tidal flow system on Richmond Bridge may provide some complexities and challenges for traffic management, particularly regarding right and left turn movements and turn bays on sections of Bells Line of Road between Grose Vale Road and the Bridge. The tidal flow option may not be effective in improving traffic flows if future increased traffic on the bridge in both directions leads to a balanced flow due to unexpected land use changes in Richmond and North Richmond areas.

Given the above, RMS have also undertaken a strategic concept design of a four lane option in addition to the three lane option, which, when the costs of a tidal flow system are incorporated, may be an ultimately cheaper option than a three lane structure. Both widening options involve the construction of separate structures to the current bridge.

The bridge was inspected in August and October 2011 by personnel from RMS. RMS concluded that, overall, the bridge is in “fair to good” condition for its age and that the bridge is suitable for widening on the downstream side as an independent structure to the existing structure. Either a three or four lane ultimate structure is feasible.

### Hyder’s Traffic Study

Richmond Bridge does not operate in isolation from the surrounding road network. Given this, RMS commissioned Hyder to develop a road-based traffic model to identify network capacity issues that affect the performance of the Richmond Bridge and adjoining approach roads.

The purpose of Hyder’s study is to assess the performance of Richmond Bridge and section of Bells Line of Road/Kurrajong Road between Grose Vale Road and East Market Street (the study area). A road based micro-simulation traffic model was developed for the study area. For this micro-simulation model, Hyder used *Paramics* software. For assessing individual intersection capacities, Hyder used *SIDRA* software.

Both *Paramics* and *SIDRA* models provided an assessment tool to identify:

- Key network issues that affect the performance of Richmond Bridge and adjoining approach roads.
- Short term options for improvements to traffic flow. Each option was assessed in terms of key traffic factors which are most likely to influence the decisions on the best performing option.

A consultation process engaging RMS and key stakeholders constituted an important element of this Stage 1 study. Three stakeholder workshops were undertaken over the course of this project. The stakeholder group comprised representatives from RMS, Transport for NSW and Hawkesbury City Council.

As indicated above, the traffic analysis suggests that Richmond Bridge is close to ‘saturation’ traffic levels. During morning and afternoon peak periods, some turning movements at adjoining key intersections with Bells Line of Road/Kurrajong Road also adversely impact the operation of the Richmond Bridge performance. The traffic modelling has identified network operational issues at the following three key intersections:

1. Bells Line of Road/Grose Vale Road (traffic light controlled);
2. Kurrajong Road / Yarramundi Lane / Old Kurrajong Road (sign control); and
3. Kurrajong Road/ Bosworth Street (traffic light controlled).

Figure E-2 shows the location of these key intersections.

Based on modelling investigations, Hyder identified ten preliminary short term improvement options. In consultation with key stakeholders, eight options were shortlisted for detailed assessment. These are referred to in this report as Options A to H. Each option was assessed in terms of key traffic factors which are most likely to influence decisions on the best performing option.



The short term options involve improvements to road and intersections to achieve an acceptable level of traffic operation. These improvements involve some intersection widening, prohibiting parking during peak periods and banning some turn movements. The identified improvement options at the three key intersections (see Figure E-3) are aimed at improving major east-west movement of traffic on this section of Bells Line of Road and Kurrajong Road.

The traffic simulation undertaken has enabled an assessment of the eight options (A to H) for this section of Bells Line of Road/Kurrajong Road between Grose Vale Road and East Market Street. Each option was developed to test alternative approaches aimed at improving network efficiency and level of service. The magnitude of this benefit varied between options.

### **The Recommended Option**

Of all options considered, Option H, comprising improvements at Grose Vale Road and Yarramundi Lane intersections, along with prohibiting on-street parking during peak periods on both sides of Kurrajong Road between Chapel Street and Bosworth Street, would provide a relatively better outcome than other competing options. Option H was further assessed for future traffic conditions in 2016 and 2021. The future year analysis suggested the need for additional improvements at the Bosworth Street intersection after 2016.

The proposed improvements as outlined below and graphically shown in Figure E-3 can be delivered in two stages.

### **Short Term Recommendation**

Over the next five years (to 2016) the following improvements (Option 'H' in this study) are recommended:

*Bells Line of Road/Grose Vale Road intersection:*

- Provision of a westbound shared through/left turn lane on Bells Line of Road, east of Grose Vale Road replacing the existing left turn lane.
- Prohibiting on-street parking during peak periods on southern side of Bells Line of Road between Pitt Lane and Grose Vale Road.
- Banning of eastbound right turns from Bells Line of Road into Grose Vale Road.
- Conversion of the existing eastbound right-turn bay to a second westbound short through lane on Bells Line of Road, west of Grose Vale Road.
- Extension of the eastbound merge (east of Grose Vale Road intersection).

*Kurrajong Road / Yarramundi Lane / Old Kurrajong Road intersection:*

- Provision of an eastbound exclusive right turn bay from Kurrajong Road to Yarramundi Lane.
- Provision of a left turn slip lane out of Yarramundi Lane with an acceleration lane on Kurrajong Road (in the westbound direction).

*Kurrajong Road:*

- Prohibiting on-street parking on both sides of Kurrajong Road from Chapel Street to Bosworth Street during peak periods.

## Medium Term Recommendation

Over the following five years (2016- 2021) additional improvements at the Kurrajong Road/Bosworth Street intersection are recommended:

- Provision of an eastbound exclusive right turn bay from Kurrajong Road to Bosworth Street.
- A right turn ban from March Street to Bosworth Street (north) subject to further investigation at that time.

## Longer Term Recommendation (Stage 2 planning)

Following 2021, there will be a need to augment Richmond Bridge and approaches to either a three lane configuration (including 'tidal flow') or to four lanes.

In conclusion, the traffic analysis found that the proposed improvements to 2021 would achieve an acceptable level of service to key intersections including the Richmond Bridge over the short time period (up to 10 years). The future traffic volumes (in 2021) on Richmond Bridge and this section of Bells Line of Road/Kurrajong Road suggests the need for two through traffic lanes in the peak direction between Grose Vale road and Yarramundi Lane, with either a 3 lane 'tidal flow' arrangement on the bridge and approaches or a four lane bridge and approaches.

## What will the Stage 2 Planning Process Involve?

This Stage 1 study has provided an indication of the traffic benefits to be gained from intersection and other improvements to traffic flows in the area of Richmond Bridge. It has produced a recommended option for works to 2021. The study also included preliminary investigations regarding the structural suitability of the existing bridge and has also considered preliminary concept proposals for the upgrading of Richmond Bridge, likely to be required from 2021 onwards.

Stage 2 of this work will develop strategic concept design options for upgrading the bridge and approaches between Richmond and North Richmond to meet future demands beyond 2021. The objective of this work will be to reserve a suitable road corridor between Richmond and North Richmond.





Figure E-2 Study Area and Key Intersections



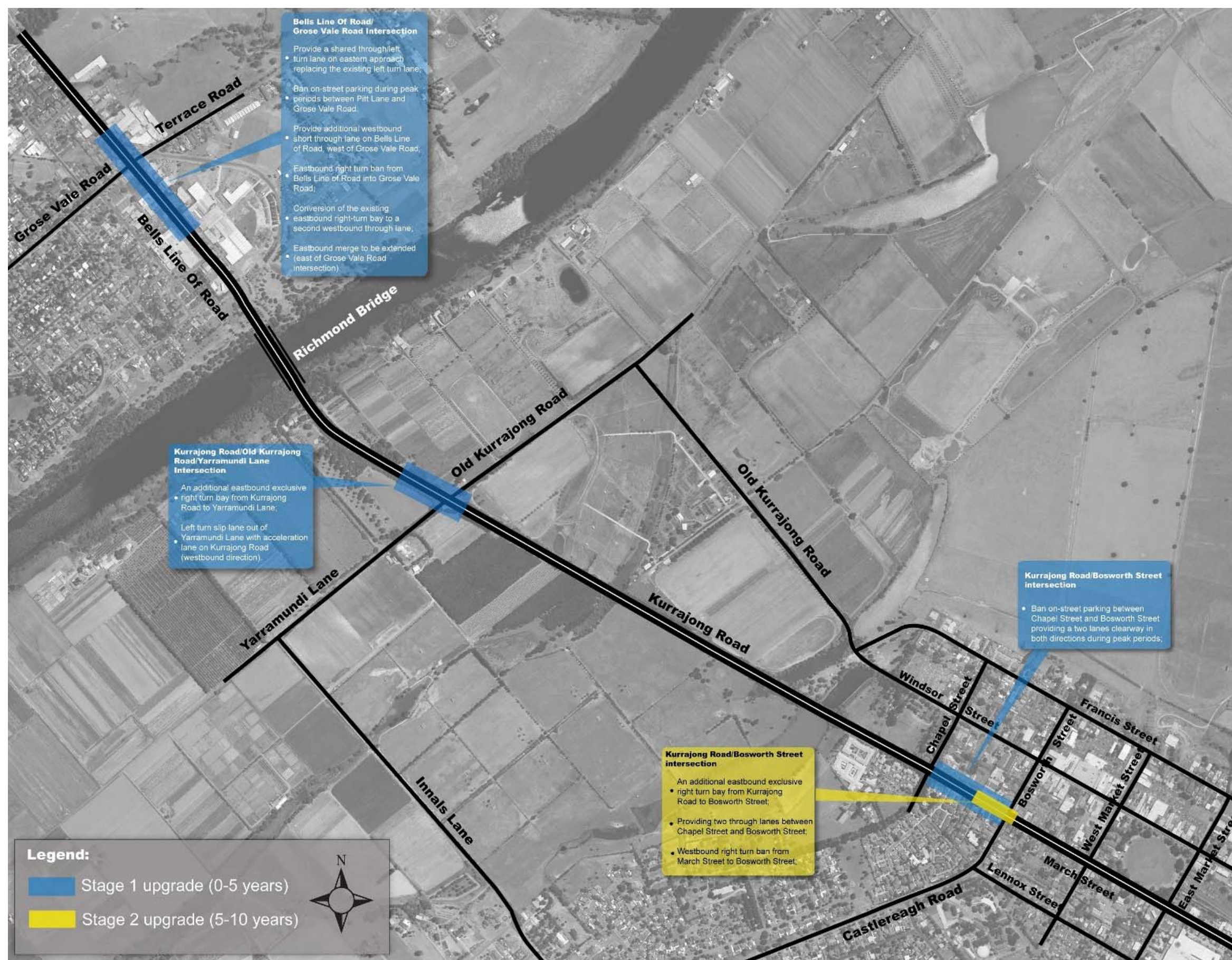


Figure E-3 Proposed Short term Improvements



## GLOSSARY

AADT	Average Annual Daily Traffic
AM	Morning Peak
BTS	Bureau of Transport Statistics (Now part of Transport for NSW)
EMME/2	Strategic Transport Modelling Software used by RMS
GMA	Greater Sydney Metropolitan Area
JTW	Journey to Work
LoS	Level of Service
RTA	NSW Roads and Traffic Authority (Now NSW Roads and Maritime Services)
RMS	NSW Roads and Maritime Services
SSTM	Hyder's Sydney Strategic Traffic Model
TZ	Travel Zone
VKT	Vehicle Kilometres Travelled;
VHT	Vehicle Hours Travelled
Veh/h	Vehicles per Hour
SIDRA	Intersection Analytical Modelling Software
PARAMICS	Traffic Micro-simulation Modelling Software
PM	Afternoon Peak
TransCAD	Strategic Transport Modelling Software used by Hyder





# 1 INTRODUCTION

## 1.1 BACKGROUND

In August 2010 the Federal Minister for Infrastructure and Transport, the Hon Anthony Albanese MP, announced that the Federal Government would initiate planning work to deal with congestion at Richmond Bridge.

This report details the outcomes of the first of two stages involved in the planning process. Stage 1 combines:

- An appraisal by RMS of the condition of the existing Richmond Bridge, together with reporting of its analyses of two options for future development of the bridge, i.e. the three lane augmentation announced by Minister Albanese and an alternative four lane option.
- A detailed assessment by Hyder Consulting Pty Ltd (Hyder) of current traffic conditions in the area of the bridge and proposed options for addressing congestion. It provides recommended short and medium-term solutions that will reduce congestion both on the bridge and in the local area.

Whilst the work undertaken by Hyder underlines the necessity of undertaking intersection improvements to relieve traffic congestion, it is also apparent that planning for ultimate bridge expansion is required.

Stage 2 of this study will therefore:

- Assess, in detail, Hyder's options and the proposal contained within this document, including costings; and
- Develop strategic concept plans for upgrading the bridge and approaches including costings.

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## 1.2 THE ROAD NETWORK

The Bells Line of Road provides a supplementary link to the Great Western Highway between the Sydney Basin and the Central West Region of New South Wales. It is one of the few escarpment crossings supporting the Great Western Highway and acts as an alternative route. It also has high tourism significance with botanical gardens, bushwalking trails, lookout points and is one of the most picturesque routes crossing the Blue Mountains.

The eastern end of the Bells Line of Road corridor provides access to Richmond and the rapidly growing North-West Growth Sector of Sydney, forming a commuter route for settlements west of the Hawkesbury River to Richmond and the Sydney urban area. This section of the route includes the Richmond Bridge which is the only Hawkesbury River crossing serving the entire residential catchment of North Richmond, Kurrajong, Bilpin, Bell and beyond. During the morning and afternoon peak hours this section of Bells Line of Road experiences significant levels of traffic congestion. Congestion is experienced on the two lane Richmond Bridge (one lane in each direction) and adjoining approach roads between North Richmond and Richmond. Planned additional residential developments are likely to add to this pressure.

The Australian and NSW Governments are jointly funding the Long Term Strategic Corridor Plan of the Bells Line of Road. When completed this Plan would guide long term strategic planning along the Bells Line of Road corridor.

Figure 1-1 shows the study area network as well as the geographical scope of the Long Term Strategic Corridor Plan. Figure 1-2 shows the Richmond to North Richmond corridor location map (the current study area) prepared by RMS.

## 1.3 STAGE 1 STUDY OBJECTIVES

The purpose of the traffic modelling investigation was to assess the performance of Richmond Bridge and the section of Bells Line of Road/ Kurrajong Road between Grose Vale Road and East Market Street. A road based micro-simulation traffic model was developed for the study area. For the micro-simulation model, Hyder used *Paramics* software. For assessing individual intersection capacity, Hyder used *SIDRA* software.

Both *Paramics* and *SIDRA* models provided an assessment tool to identify:

- 1 Key network issues that affect the performance of Richmond Bridge and adjoining approach roads.
- 2 Short term options for improvements to traffic flow. Each option was assessed in terms of key traffic factors which are most likely to influence the decisions on the best performing short term option.

In addition to Hyder's traffic modelling, an assessment of the structural capacity of Richmond Bridge and widening options was undertaken by RMS.

## 1.4 THE STUDY AREA

Richmond is located approximately 65 km to the northwest of Sydney. The study area is geographically subdivided into two by the Hawkesbury River and both parts are connected via Richmond Bridge. To the west of the Bridge is North Richmond which is predominantly a residential precinct. To the east is East Richmond which is a mixture of residential, commercial and retail precincts. The RAAF base located to the east of Richmond is a major employer. In addition, there are a number of retail units in the main activity area.

The Richmond rail line connects Richmond with Sydney and its north-western suburbs via train. The Bells Line of Road/Kurrajong Road that goes through Richmond connects the area to the north-western suburbs of Sydney. Access to the western suburbs of Sydney is via Castlereagh Road, Blacktown Road/ Richmond Road or Londonderry Road/The Northern Road. Bells Line of Road also connects Richmond with Kurrajong, located further to the north west of Richmond, via Richmond Bridge. Figure 1-3 shows study area network, illustrating through traffic lanes that are available on the section of Bells Line of Road/Kurrajong Road between Grose Vale Road and East Market Street.

Over the years, the steady residential growth in North Richmond and Kurrajong has put additional traffic pressure on the study area. During critical peak periods, intersections on both sides of the Bridge experience major congestion. The two-lane Bells Line of Road on the bridge is also close to capacity.

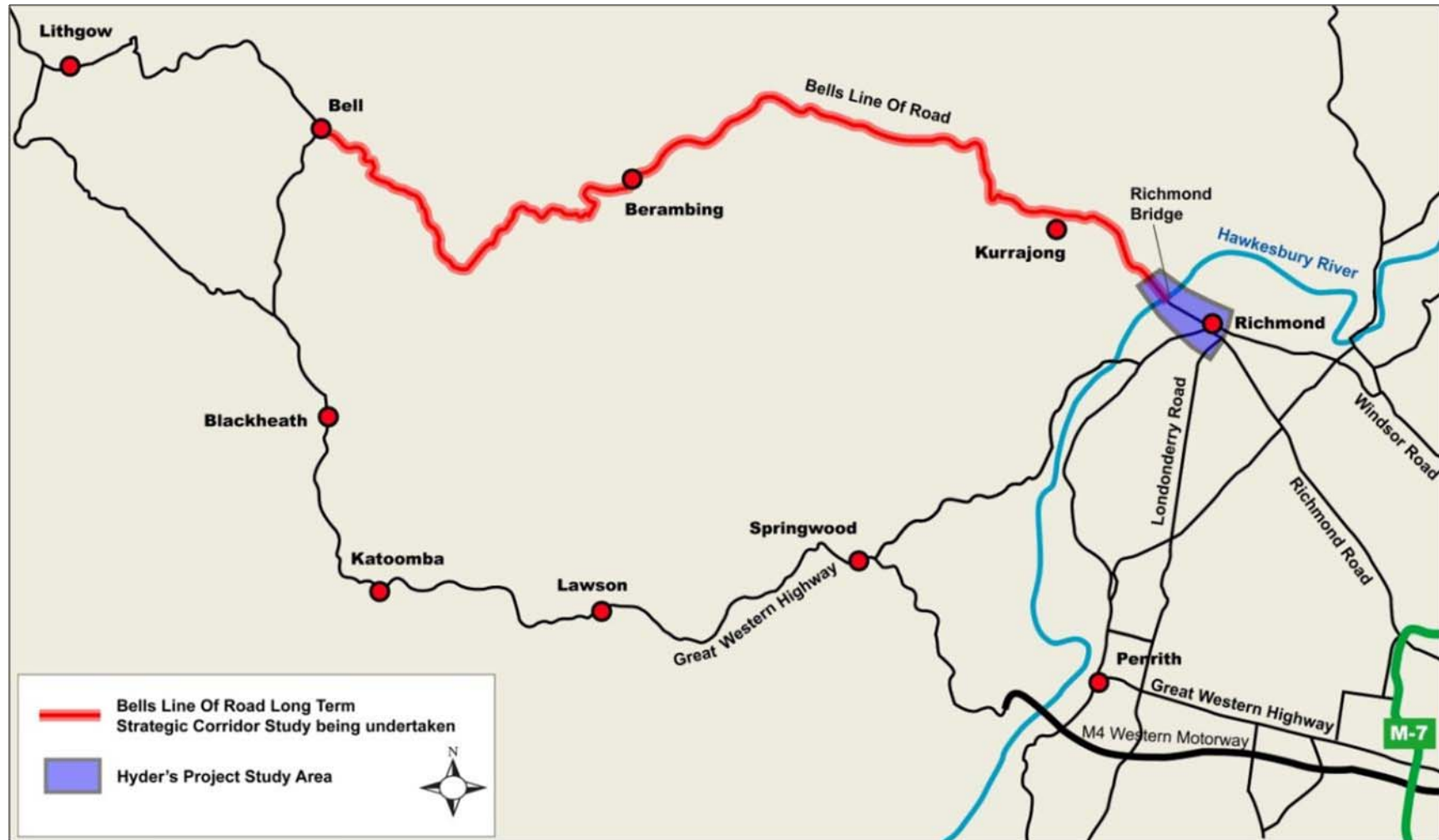
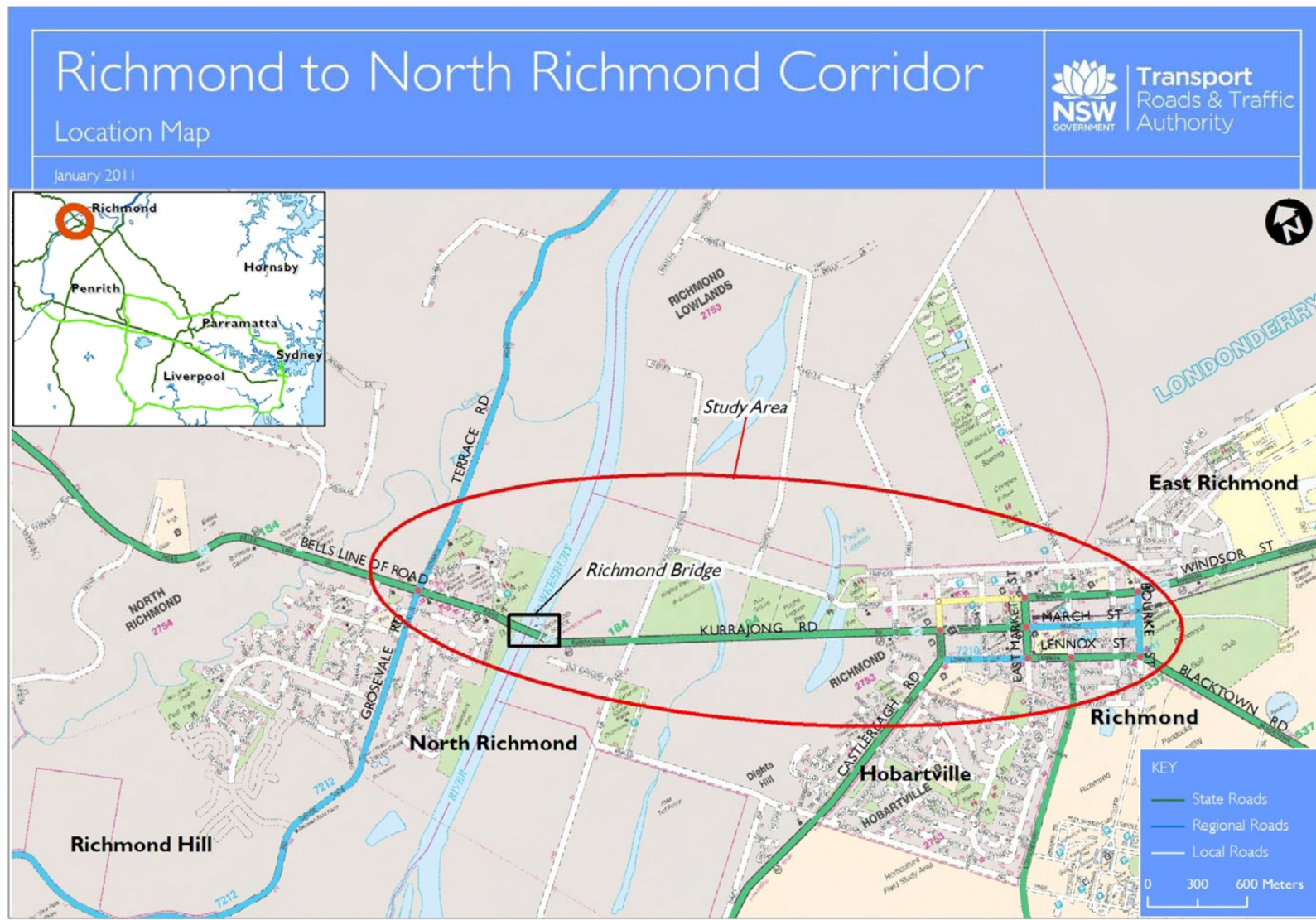


Figure 1-1 Richmond Bridge and Approaches Congestion Study Area in context of the Bells Line of Road Long Term Strategic Corridor Plan





**Figure 1-2** Richmond to North Richmond Corridor-Location Map

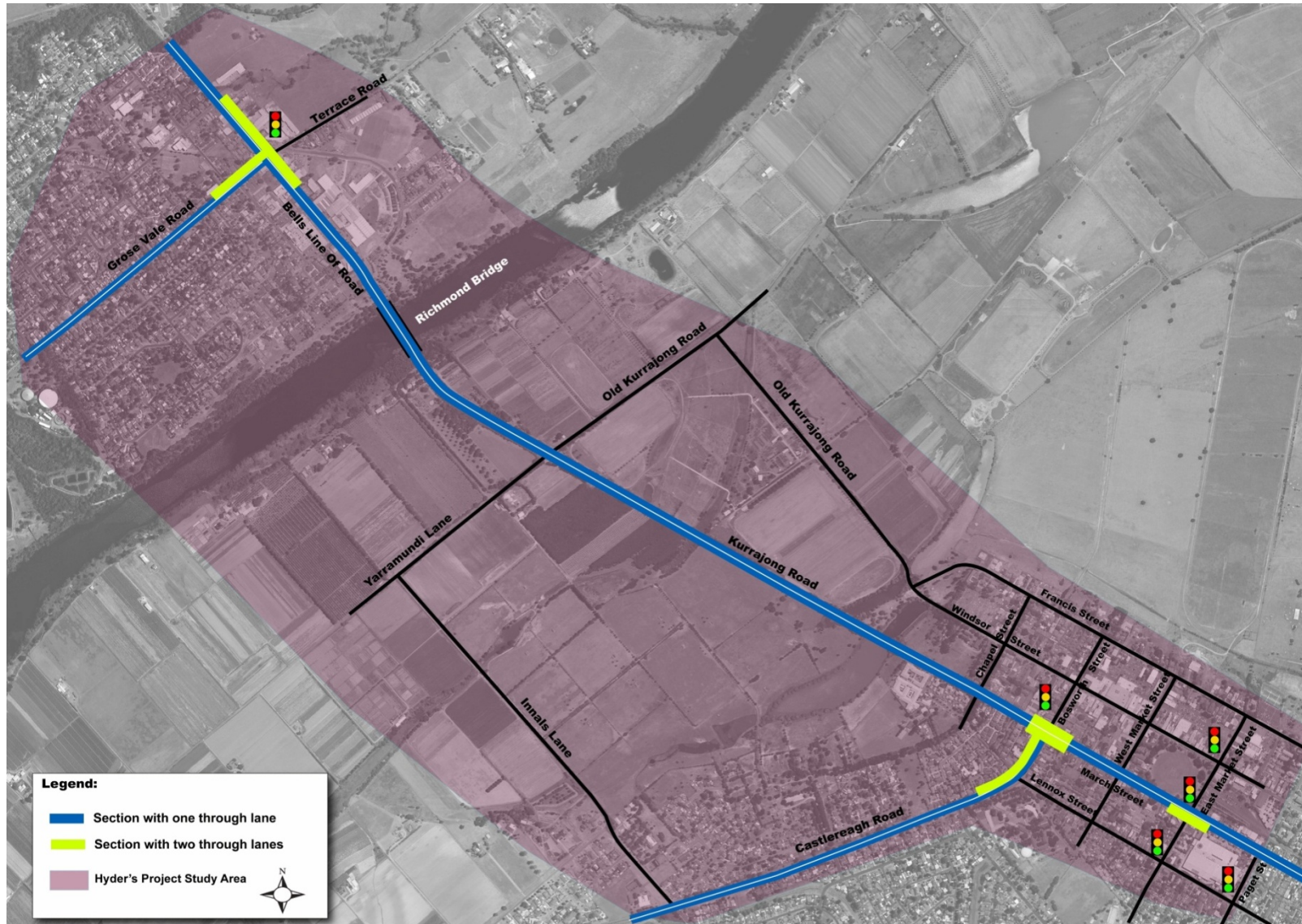


Figure 1-3 Modelling Study Area



## 2 THE ROAD HIERARCHY

The road hierarchy allocated to the road network around the Richmond study area is summarised in Table 2-1 and Figure 2-1. The classification criteria are sourced from the NSW Road Classification Review Panel – Final Report 2007.

**Table 2-1 Existing Road Network Characteristics**

Road Names	Road Hierarchy	Characteristics
Bells Line of Road / Kurrajong Road / March Street	State Road	It connects Richmond and North Richmond with the north western suburbs of Sydney. This road is generally a two-lane arterial road. On-street parking is permitted where it has residential frontages.
Castlereagh Road	Regional Road	This is one alternative road connecting Richmond with the western suburbs of Sydney including Penrith. The road is generally two-lanes wide. On-street parking is permitted where it has residential frontages.
Londonderry Road	State Road	This is the other alternative route connecting Richmond with the western suburbs of Sydney including Penrith. The road is generally two-lanes wide. On-street parking is permitted where it has residential frontages.
Yarramundi Lane / Old Kurrajong Road / Inalls Lane	Local Road	These are local roads but traffic between North Richmond and the western suburbs of Sydney, including Penrith, use it as a 'rat-run' route to avoid congested intersections on Kurrajong Road south east of Richmond Bridge.
Winsor Street / Lennox Street	State Road	March Street splits into two near Richmond Station and provides two alternative routes to the north eastern suburbs of Sydney. The section of road within the study area goes through the major activity centre in Richmond which includes Richmond Market Place and retail frontages. Together with March Street, which is the extension of Bells Line of Road / Kurrajong Road, and four other north south roads including Bosworth Street, East Market Street and Bourke Street, these roads form a grid pattern with a number of closely located intersections.
Bosworth Street, East Market Street, West Market Street and Bourke Street	Local Road	Part of the Richmond activity centre forming grid with the east-west roads including Winsor Street and Lennox Street.

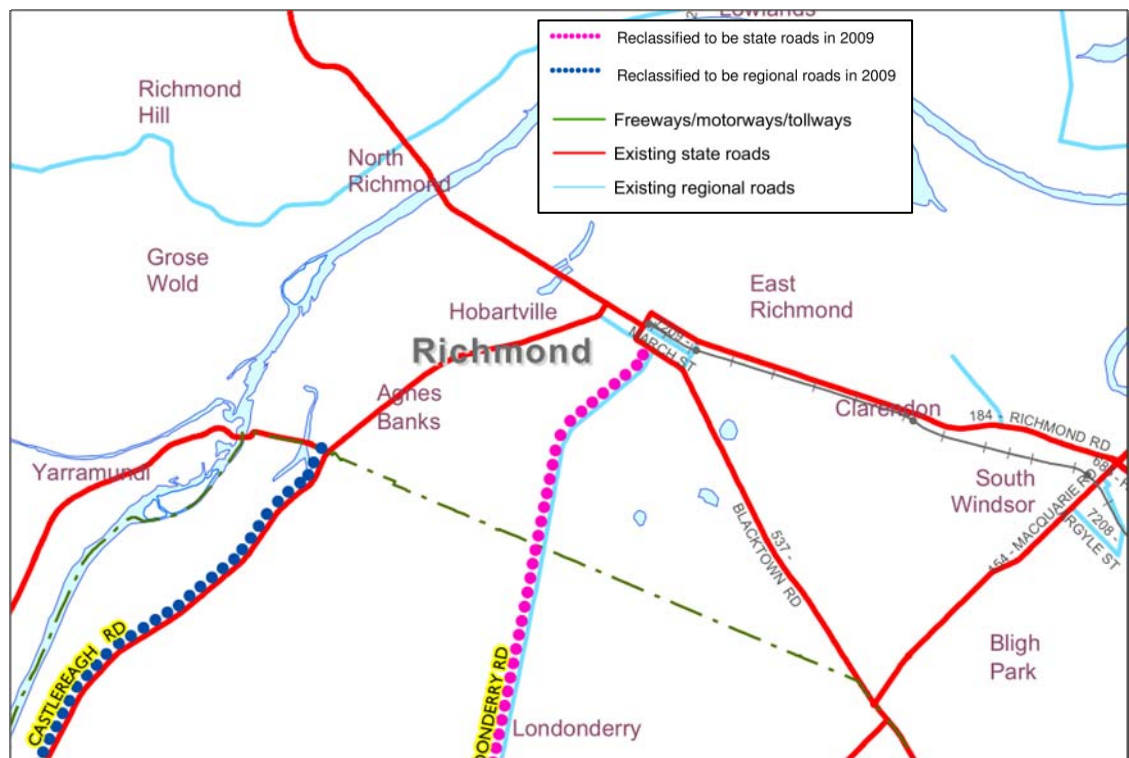


Figure 2-1 The existing road network

## 3 KEY TRANSPORT INDICATORS

### 3.1 HISTORICAL TRAFFIC GROWTH

RMS collect traffic volume data at key count locations across the NSW road network. Historical traffic data for Bells Line of Road at Richmond Bridge were obtained from RMS and BTS.

Table 3-1 shows historical traffic volumes on Richmond Bridge between 2002 and 2011. Table 3-2 shows historical average growth rates per annum.

**Table 3.1 Traffic Trends**

AADT/ ADT in Vehicles		Year			
Count Station	Location	2002 AADT	2005 AADT	2008 ADT <sup>(1)</sup>	2011 ADT <sup>(2)</sup>
89.044	Richmond Bridge	25,706	25,880	26,010	27,239

**Notes:**

- (1) 2008 data represent average daily traffic over one week in June 2008.
- (2) 2011 data represent average daily traffic over one week in June 2011.
- (3) Traffic data for the years 2002 and 2005 were sourced from the RTA. Traffic data in axle pairs has been converted to actual vehicle numbers. It has been assumed that the proportion of trucks with more than two axles represents 5% of the actual traffic mix.

**Table 3.2 Annual average traffic growth (%/year)**

Location	RTA Count station	Annual Average Growth			
		Between 2002-2005	Between 2005-2008	Between 2008-2011	
Richmond Bridge	89.044	0.2 %	0.2 %	1.6 %	
Average (last 3 years)					1.6 %
Average (last 6 years)					0.9 %
Average (last 9 years)					0.7 %

The following is of note from the data in Tables 3.1 and 3.2:

- In 2011, Richmond Bridge carried about 27,200 vehicles per day.
- Between 2002 and 2011 Bridge traffic has grown by about 0.7% per annum. Growth has increased to 1.6% per annum between 2008 and 2011.
- The Bridge traffic growth was found to be consistent with regional growth of 1% to 2% per annum observed at other RMS's road survey locations.



## 3.2 COMMUTER MODE SHARE, RICHMOND AREA

BTS has provided journey to work (JTW) data for the Greater Sydney Metropolitan Area (GMA), collected during the 2006 Census. Work trip origin and destinations are coded to the 2006 travel zones.

This data is summarized in Table 3.3, below. The following should be noted:

- There is some variation in the pattern of trips exhibited by residents and those arriving to the area for work.
- Walking and cycling comprise a significant number of trips.
- Car (as driver or passenger) is the dominant mode of motorised transport.

**Table 3-3 Daily Work Trip Modal Distribution for Richmond**

Travel Mode	Core area as home (Outbound trips)	% Core area as Home	Core area as workplace (Inbound trips)	% Core area as Workplace
Car Driver	3,722	64.6%	5,672	68.1%
Car Passenger	286	5.0%	531	6.4%
Train	317	5.5%	91	1.1%
Bus	15	0.3%	26	0.3%
Other (Walking, Cycle, )	499	8.7%	1,398	16.8%
Worked at home/ Did not travel/ Not stated	925	16.0%	612	7.3%
<b>Total</b>	<b>5,764</b>	<b>100%</b>	<b>8,330</b>	<b>100%</b>

## 3.3 CRASH DATA

This assessment is based on the crash data supplied by RMS for the five-year period from 2005 to 2009 inclusive. The data covers crashes reported to the Police, and includes fatal, injury or 'vehicle damage only' accidents.

A total of 365 crashes were recorded in the five year period within the study area. Of the total crashes 153 (42%) resulted in casualties. Two crashes resulted in fatalities.

Over two thirds of the total crashes occurred at intersections. About 96 (26%) of crashes occurred when a vehicle was hit from behind by the following vehicle. About 74 (20%) of crashes occurred when vehicles undertaking turning manoeuvres were hit by other vehicles. Pedestrians were involved in 15 (4%) of crashes.

About 64 crashes (18%) occurred during the hours of darkness whilst 43 (12%) of crashes occurred when the road surface was wet.

Figure 3.1 shows crash locations within the study area for the period between 2005 and 2009. Crashes on the map are classified by severity, showing fatal, injury and non-casualty (tow-away) crashes.

The spatial crash analysis indicates that crashes occurred along the major trafficable roads but they are more concentrated at intersections. Some particular crash locations include:

- Kurrajong Road/Yarramundi Lane/Old Kurrajong Road intersection (priority sign control);
- Kurrajong Road/Bosworth Street intersection (traffic light control);
- March Street/East Market Street intersection (traffic light control);
- Castlereagh Road/Innals Lane intersection (priority sign control).

Crash classification by severity showed that between 2005 and 2009, one fatal crash occurred at each of the Kurrajong Road/Yarramundi Lane/Old Kurrajong Road and Castlereagh Road/Innals Lane intersections.

Other crash locations in the study area showed mixed injury and non-casualty crashes.

# Richmond Bridge Congestion Study

Various intersection crashes



Transport  
Roads & Traffic  
Authority

Crashes reported 2005 to 2009

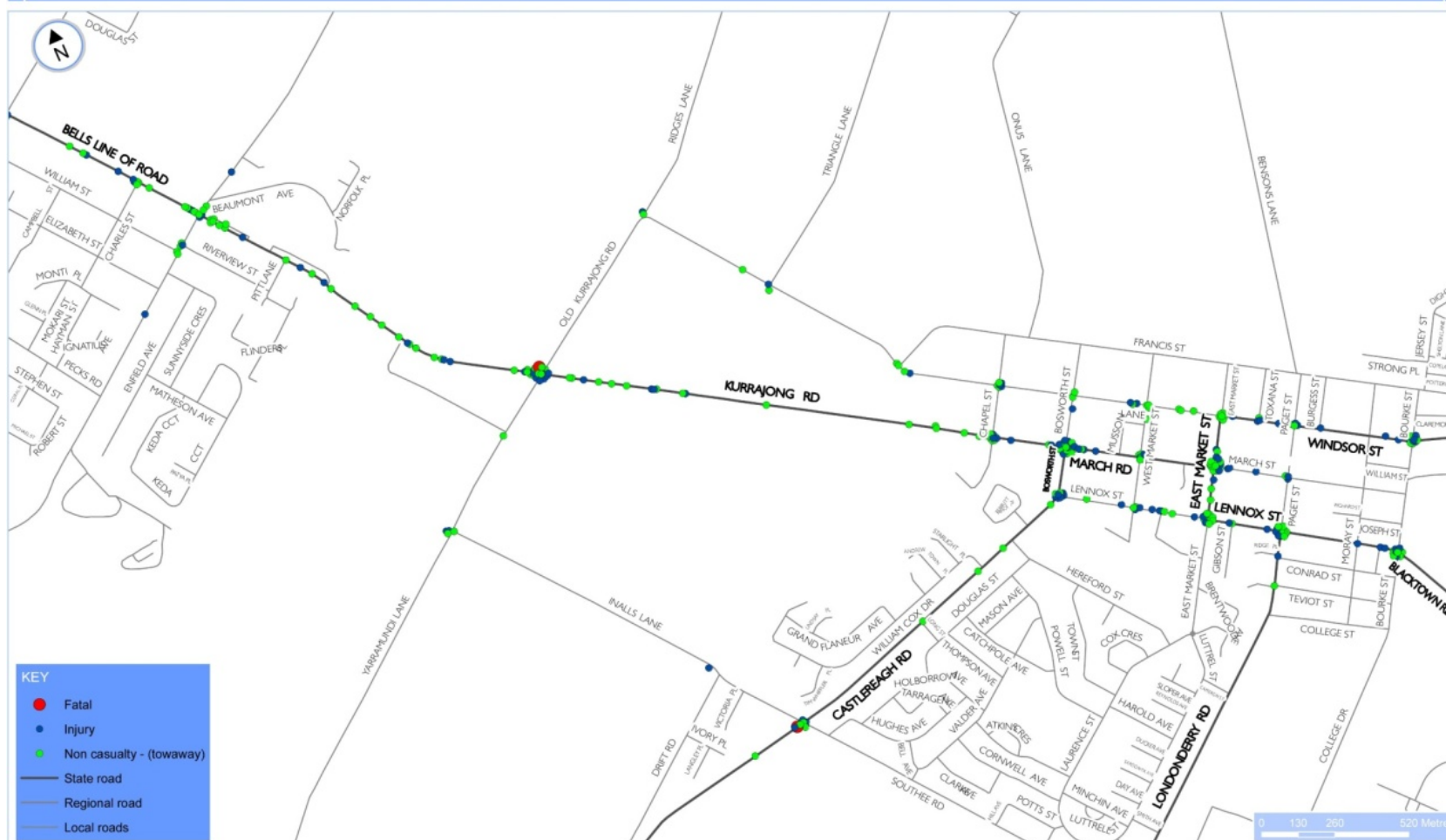


Figure 3.1 Intersection crashes