4 Existing road network performance

The M5 Motorway is a core component of Sydney's extensive road network. Any changes to the M5 Motorway will have impacts across the network as drivers adjust their preferred routes. This chapter focuses on existing traffic performance in the M5 Motorway corridor, and also reflects on current conditions on alternative routes that road users may choose.

4.1 Traffic profile analysis

A detailed analysis of traffic count data has been undertaken at the key midblock locations on the M5 Motorway and King Georges Road to assess the existing traffic conditions within the study area. The data covers the period from 24 May 2014 to 3 June 2014.

4.1.1 M5 Motorway traffic

Existing traffic flows at the King Georges Road interchange and M5 Motorway are presented below in **Figure 4-1 to Figure 4-3.**

Figure 4-1 indicates that the westbound exit ramp carries approximately double the traffic of the entry ramp for the majority of the 24 hour period. Distinctive AM and PM peaks are observed. Flows for the entry ramp remain relatively consistent across both peaks. The exit ramp however experiences high flows of approximately 1,300 vehicles per hour in the PM peak compared to 1,000 per hour in the AM peak.

Figure 4-2 shows clear AM and PM peaks for both of the eastbound ramps. The rate of vehicles accessing the entry ramp in the PM peak is higher than the AM peak. However, the AM peak is spread over a longer period, resulting in higher total flows. This ramp currently experiences significant congestion in the AM peak which explains the lower flow rate.

The eastbound exit ramp experiences generally lower flows than the entry ramp. Flows across both peak periods are more consistent that the entry ramp. Approximately 600 vehicles per hour use the ramp in both the AM and PM peaks.

M5 carriageway flows, shown in **Figure 4-3,** demonstrate very consistent traffic flows throughout the day in both directions. The dip in eastbound flows during the AM peak can be attributed to the very congested downstream conditions rather than a lack of demand. A similar reduction in capacity is observed for westbound traffic in the PM peak.

Across all surveyed sites, total flows in the PM peak were generally higher than in the AM peak.

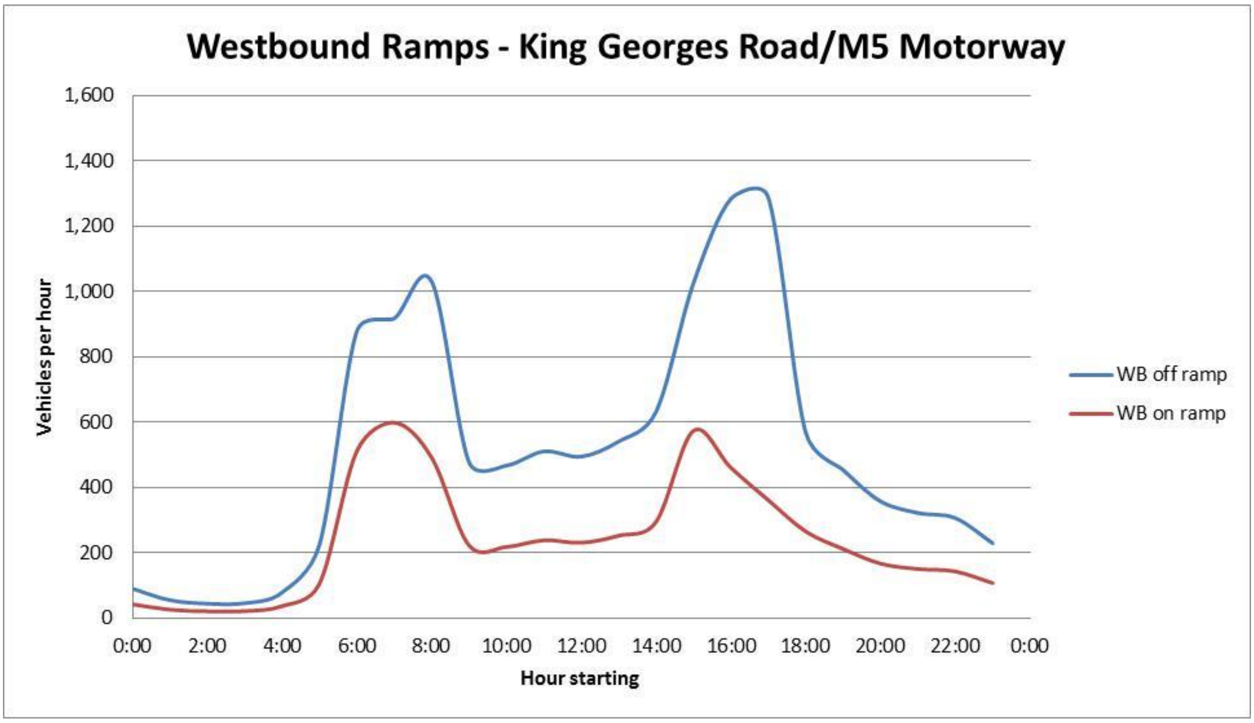

Figure 4-1: Existing traffic flows on westbound ramps at King Georges Road / M5 Motorway interchange

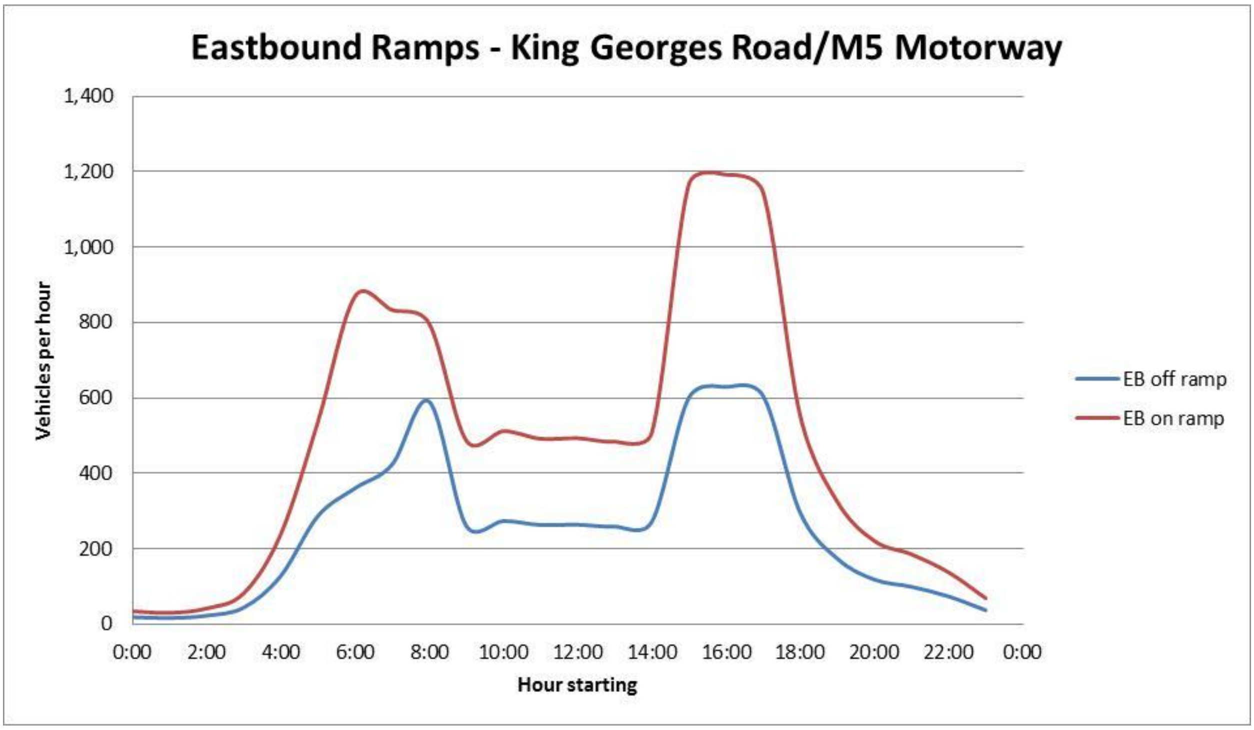

Figure 4-2: Existing traffic flows on the eastbound ramps at King Georges Road / M5 Motorway interchange

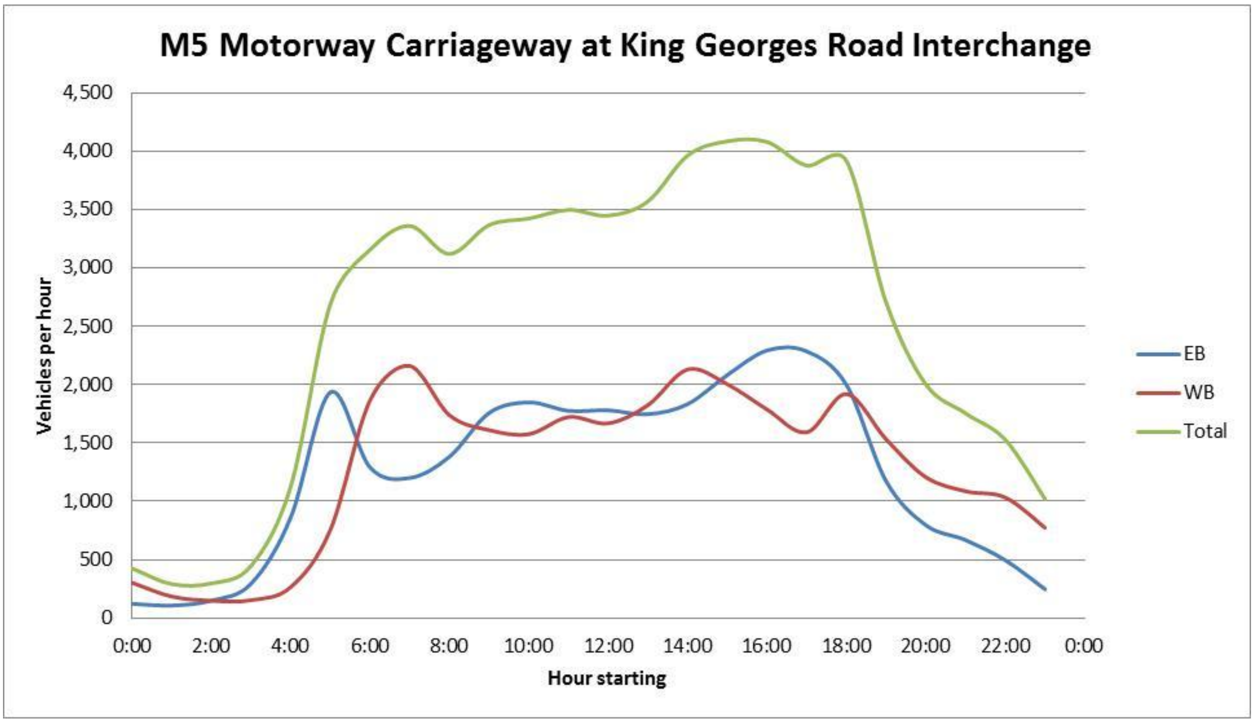

Figure 4-3: Existing traffic flows on M5 Motorway at King Georges Road

4.1.2 King Georges Road traffic

Existing traffic flows on King Georges Road are shown in **Figure 4-4** and **Figure 4-5.** Traffic surveys were undertaken between the M5 Motorway and Moorefields Road to the north, as well as between the M5 Motorway and Stoney Creek Road to the south.

Both locations demonstrate that the northbound direction on King Georges Road experiences its peak during the AM peak period whilst the PM peak sees more southbound trips. Traffic flows on King Georges Road north of the M5 Motorway are generally higher than flows south of the motorway. This indicates that more M5 Motorway trips are generated from areas to the north of the M5 Motorway / King Georges Road interchange.

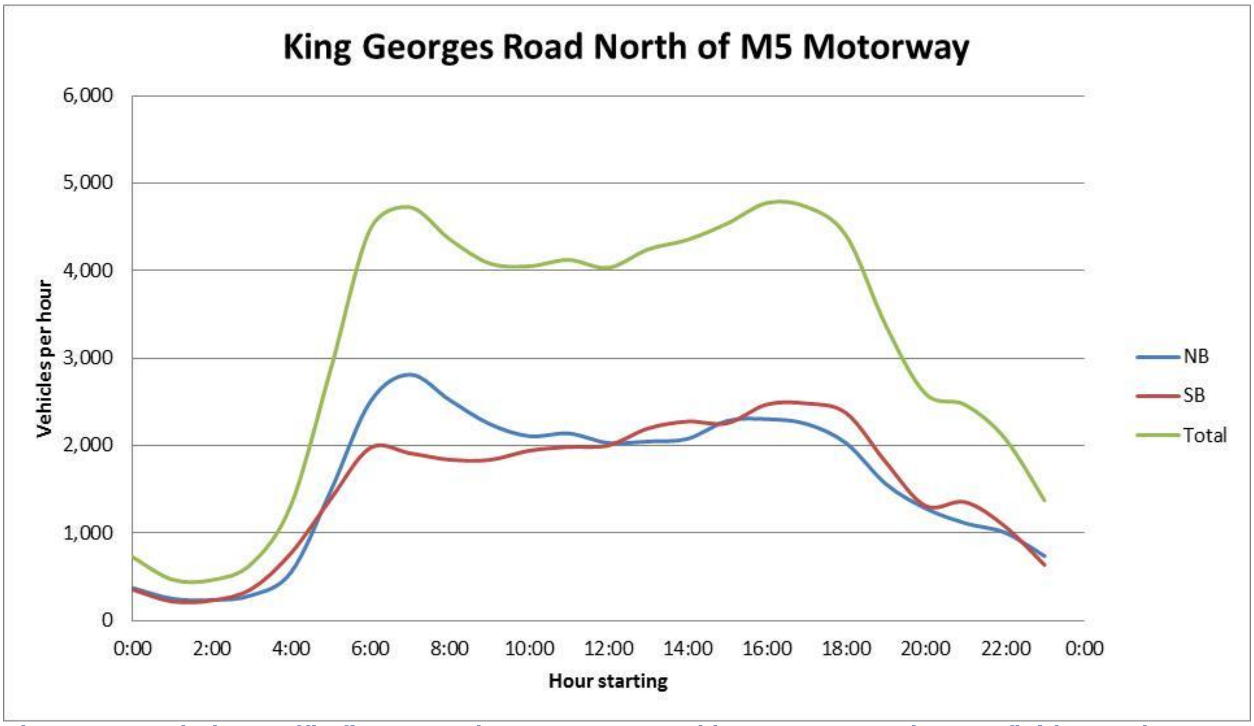

Figure 4-4: Existing traffic flows on King Georges Road between M5 and Moorefields Road

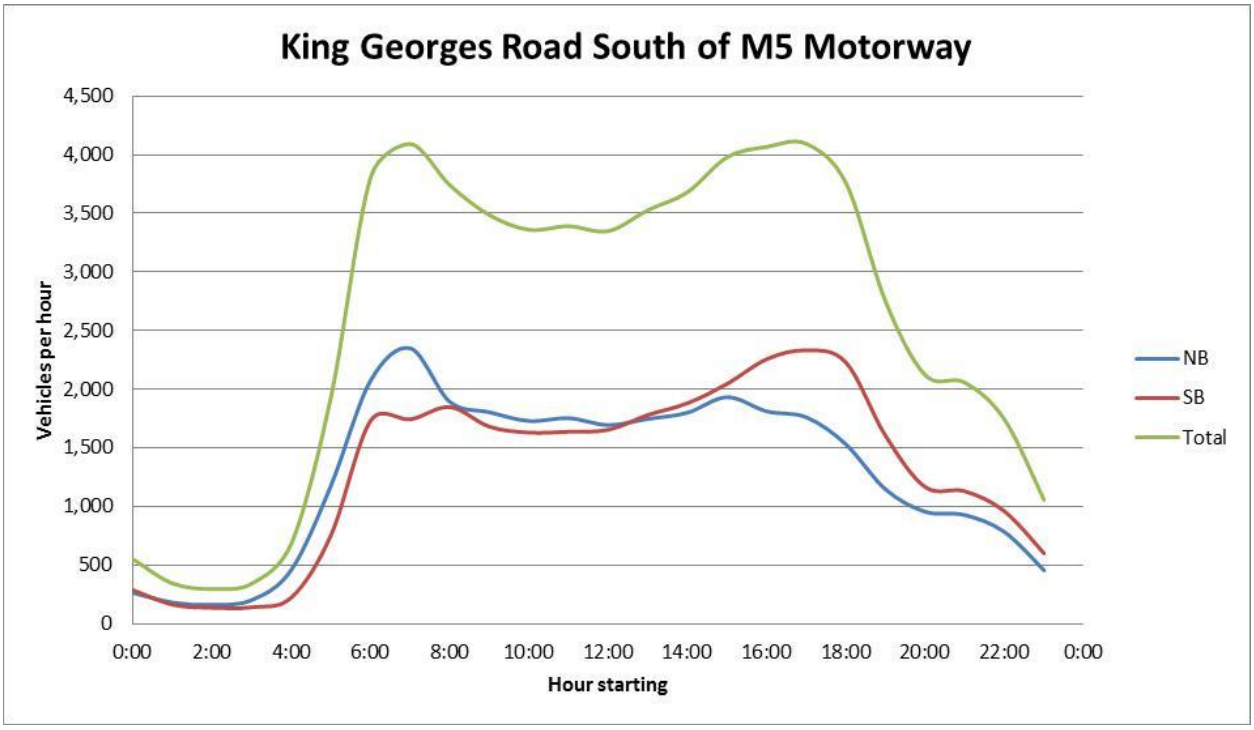

Figure 4-5: Existing traffic flows on King Georges Road between M5 and Broad Arrow Road

4.2 Travel speeds

Travel speeds were recorded at three locations in the study area. Data was collected using pneumatic tube counters to measure both traffic numbers and speeds across 24 hour periods for 7 weekdays and 4 weekend days.

Locations of the pneumatic tube counters are as follow:

- M5 Motorway at King Georges Road
- King Georges Road North between M5 Motorway and Moorefields Road
- King Georges Road South between M5 Motorway and Broad Arrow Road

Recorded travel speeds have been averaged across each weekday and also by time period. Time periods used are shown in **Table 4-1.**

Table 4-1: Survey time periods

Time period	Hours
Morning peak	7:00 am to 9:00am
Inter peak	9.00 am to 4.00 pm
Evening peak	4.00 pm to 6.00 pm
Evening	6.00 pm to 11:00 pm

Figure 4-6 demonstrates the speed degredation experienced int the AM peak for eastbound traffic on the M5 Motorway. Average speeds drop to approximatley 20 kilometres per hour as downstream congestion causes significant delays. For all other periods, speeds remain relativley high and between 70-90 kilometres per hour. The posted speed limit at the surveyed location is 90 kilometres per hour.

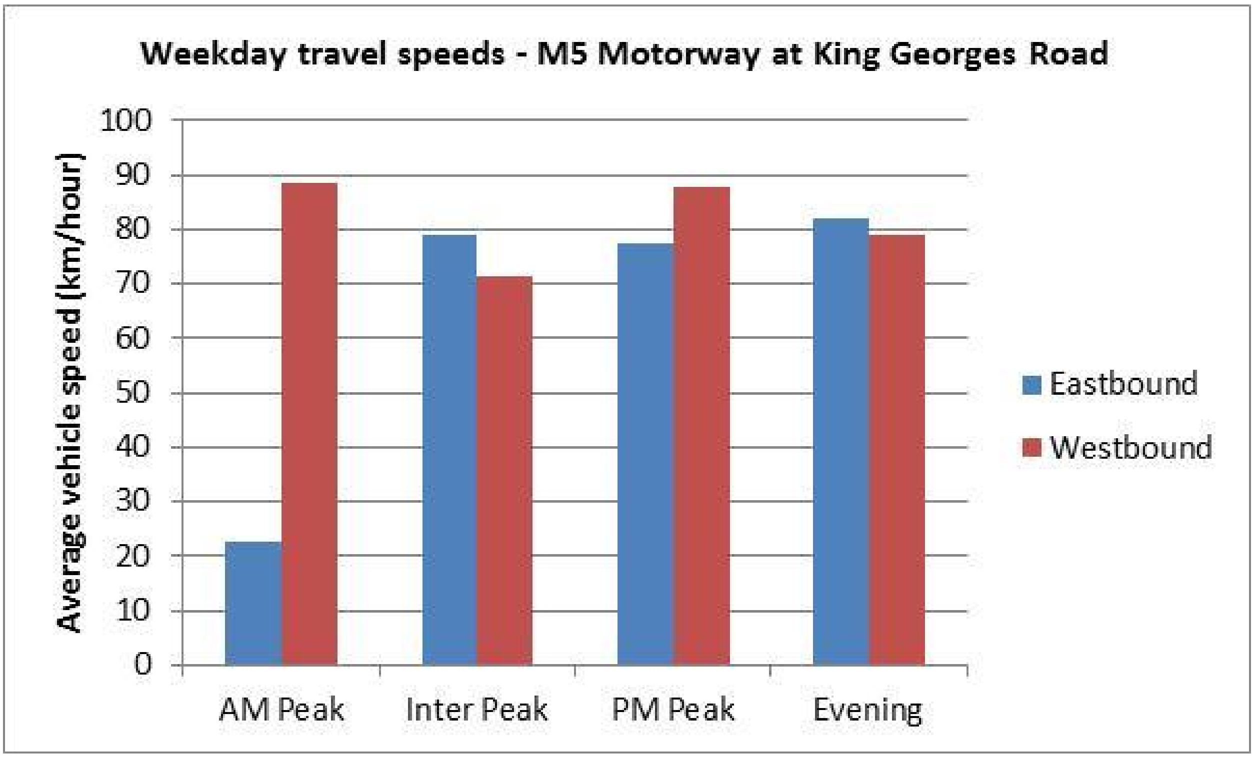

Figure 4-6: Speeds on M5 Motorway at King Georges Road

Figure 4-7 presents the surveyed travel speeds on King Geogres Road between the M5 Motorway and Moorefields Road. The AM peak experiences some congestion in both directions, more so for southbound vehicles.. It should be noted that this section of King Georges Road is a school zone with a speed limit of 40 kilometres per hour for the last hour of the AM peak. The inter peak and PM peak periods operated slightly better however speeds are still well below the 60 kilometres per hour posted speed.

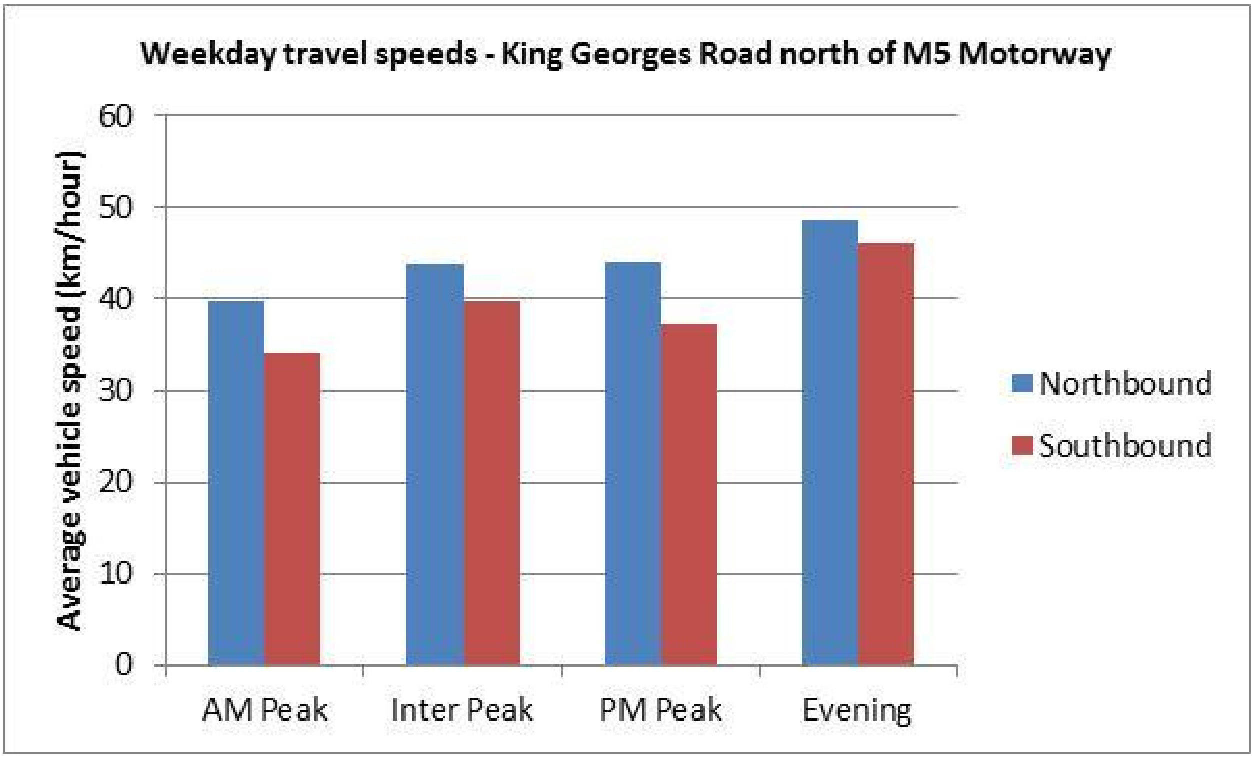

Figure 4-7: Speeds on King Georges Road north of M5 Motorway

Figure 4-8 shows that speeds between the M5 Motorway and Broad Arrow Road remain consistent across all time periods. AM and PM peak period speeds in both directions are generally between 45-50 kilometres per hour. Interpeak and evening peak period speeds are slighty higher, above 50 kilometres per hour.

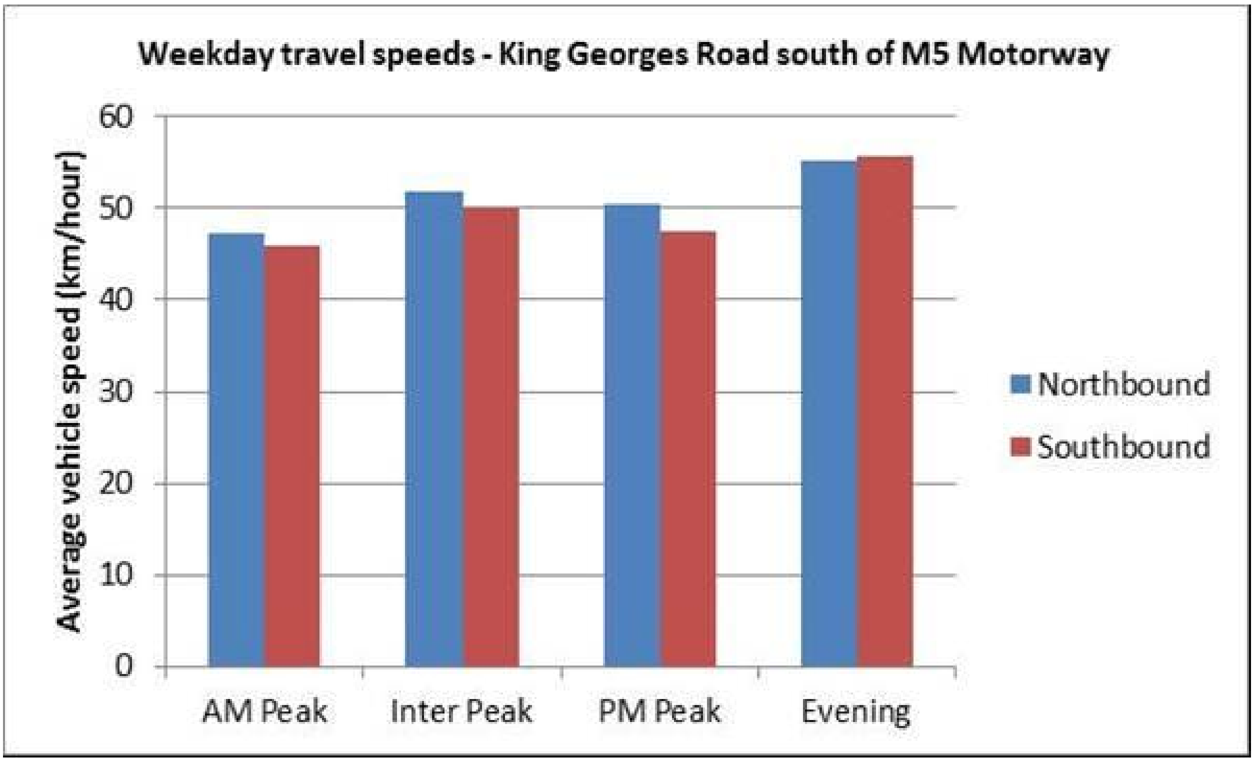

Figure 4-8: Speeds on King Georges Road south of M5 Motorway

4.3 Travel times

Travel time surveys were conducted along King Georges Road between Canterbury Road in the north and Stoney Creek Road in the south. Travel time surveys were conducted on three consecutive weekdays and an average of two hours in each peak hour were used to generate the results. The results of the travel time survey are presented in **Table 4-2**.

Table 4-2: Travel time survey results

Route	Waypoint	2014 AM	2014 PM
King Georges Road Northbound	Stoney Creek Road	00:00	00:00
	Morgan Street	02:06	01:11
	Ponyara Road	03:00	02:26
	M5 Motorway	04:43	04:09
	Moorefields Road	05:24	04:49
	Roselands Drive	06:09	06:14
	Canterbury Road	09:09	08:04
King Georges Road Southbound	Canterbury Road	00:00	00:00
	Roselands Drive	01:13	01:42
	Moorefields Road	02:21	02:33
	M5 Motorway	04:07	03:49
	Ponyara Roa	05:26	05:21
	Morgan Street	08:20	06:40
	Stoney Creek Road	09:46	09:26
M5 Motorway Eastbound	M5 South West Motorway	00:00	00:00
	King Georges Road	00:34	00:27
	M5 East Motorway	04:04	01:09
M5 Motorway Westbound	M5 East Motorway	00:00	00:00
	King Georges Road	01:11	01:06
	M5 South West Motorway	01:49	01:43

Existing travel times on King Georges Road are presented in **Figure 4-9** and **Figure4-10**. The results indicate that travel times remain relatively consistent across both peak periods. The overall pattern of heavier northbound traffic in the AM peak is again indicated in these results with slightly higher AM peak travel times than those observed in the PM peak. Conversely, southbound travel times are higher in the PM peak than the AM peak.

During both peak periods, the southbound journey takes approximately 1.5 minutes longer than the northbound journey.

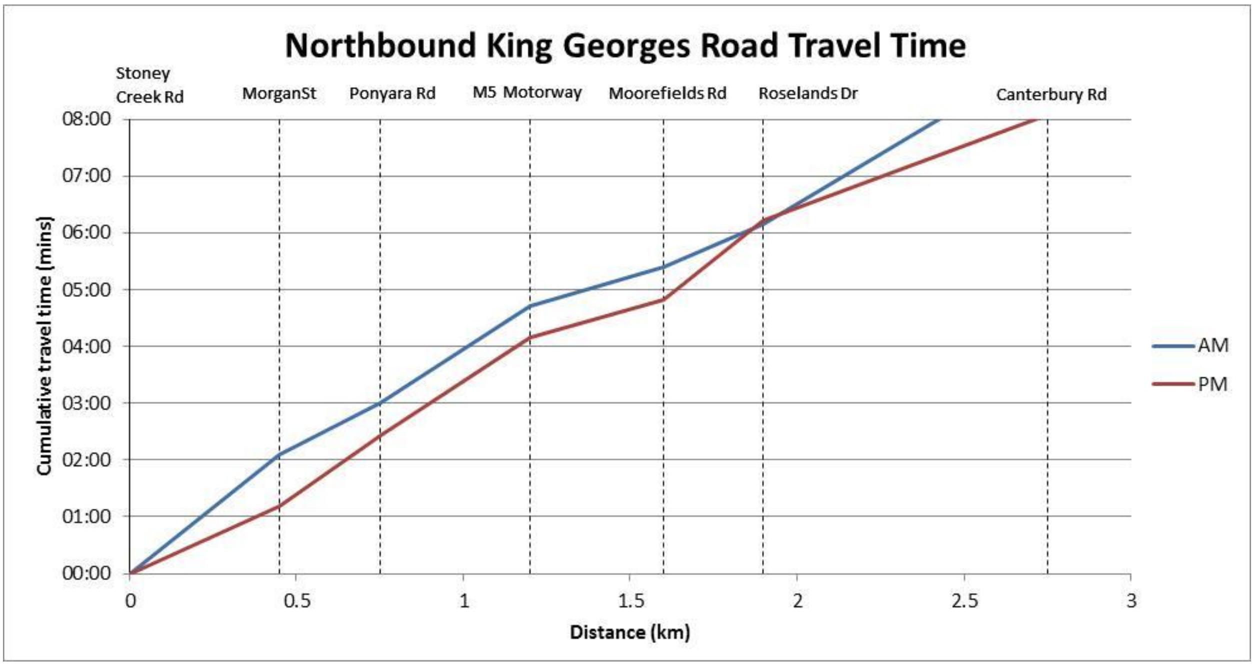

Figure 4-9: King Georges Road northbound travel time

Figure 4-10: Southbound King Georges Road travel time

Travel time surveys were conducted along M5 Motorway over a distance of approximately 1.20 kilometres to the west and east of King Georges Road. Travel time surveys were conducted on three consecutive weekdays and an average of two hours in each peak hour were used to generate the results.

Existing travel times on the M5 Motorway are presented in **Figure 4-11** and **4-12**. The results indicate that travel times in the eastbound direction are longer in the AM peak than they are in the PM peak. The eastbound travel time in the AM peak is approximately four minutes compared to approximately 1 minute in the PM peak. The longer eastbound travel times in the AM peak are result of the downstream congestion during the AM peak period.

Conversely, westbound travel times are constant throughout the day with no discernable difference between the AM and PM peak periods. The westbound travel time over the surveyed distance is approximately one minute and fifty seconds.

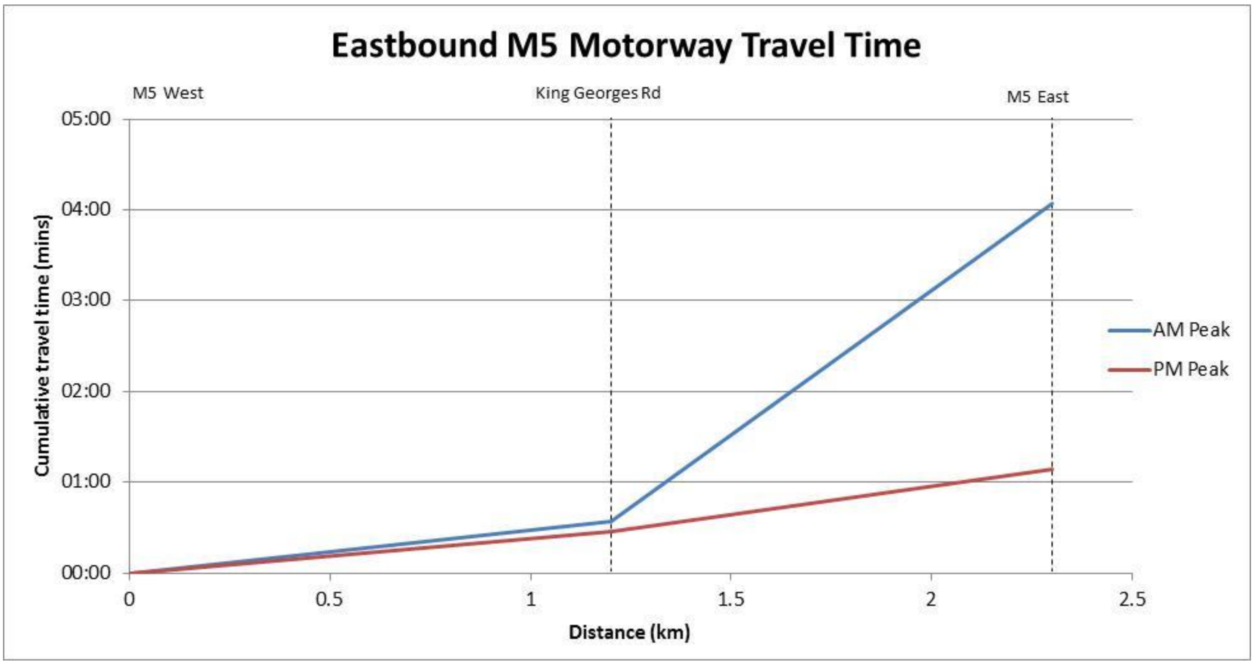

Figure 4-11: M5 Motorway eastbound travel time

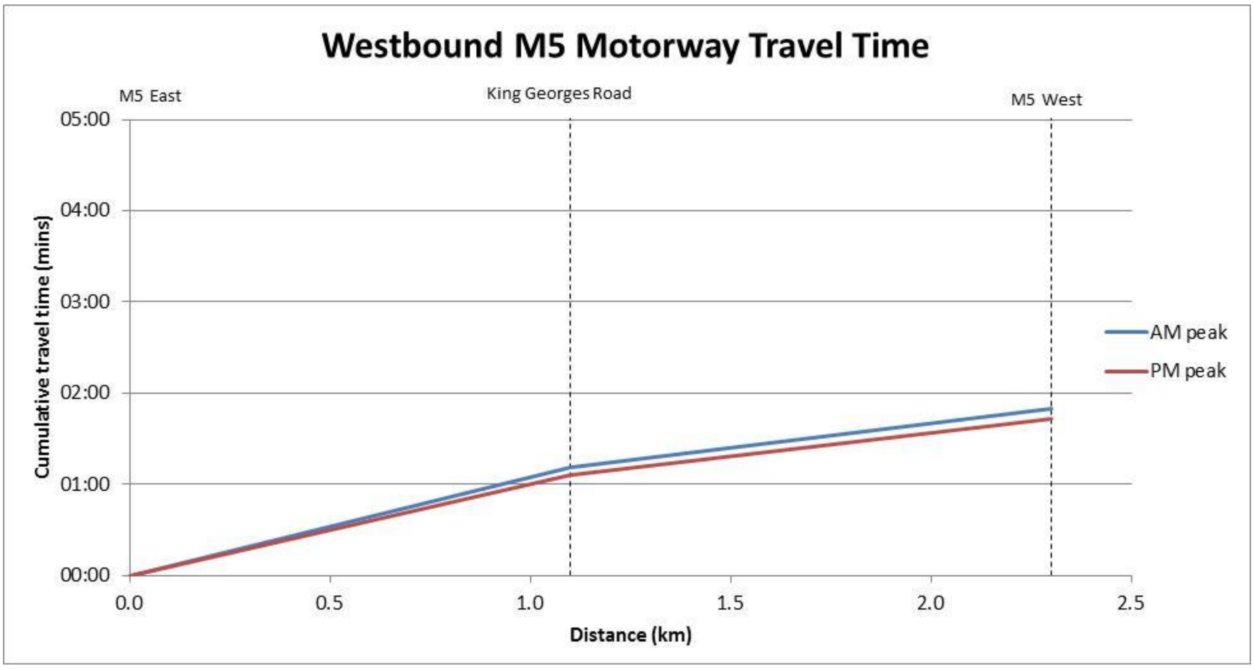

Figure 4-12: M5 Motorway westbound travel time

4.4 Interchange and intersection performance

The assessment of interchange and intersection performance was undertaken using the traffic modelling software Q-Paramics (v6.8) which is a micro-simulation traffic modelling software. This software models individual vehicle behaviour and their interaction with the network and other road users. Micro simulation has its greatest strength in modelling congested road networks, due to its ability to simulate queuing conditions. This capability makes these types of models very useful for analysing traffic operations in urban areas and city centres, including interchanges, roundabouts, unsignalised and signalised intersections, signal coordinated corridors, and area networks.

The critical elements of the assessment of existing conditions are intersection Level of Service (LoS) and the traffic queue on the most affected leg of the intersection. Individual intersections have been assessed using Paramics. One of the major benefits of using this type of micro simulation software is the ability to assess intersections that form part of closely spaced networks and where their operation is likely to be influenced by adjacent intersections. This means that modelled queue lengths and delays at an intersection reflect the impact of downstream congestion effects. This results in a more accurate representation in the model of queue lengths and delays at affected locations when compared to on the ground observations.

The Paramics base models were calibrated and validated against observations of current operational performance demonstrated by the travel time on the approaches to the interchange along the M5 Motorway and King Georges Road.

The assessment of interchange and intersection performance is based on criteria outlined in **Table 4-3**, as defined by Guide to Traffic Generating Developments (Roads and Traffic Authority 2002). The average delay assessed for signalised intersections is for all movements, and is expressed in seconds per vehicle. It is generally accepted that in the long term (15 years plus), when future conditions have been taken into account, LoS should be D or better. In the short term, intersections should be operating at LoS C or better.

Table 4-3: Level of service criteria for intersections

Level of service	Average delay per vehicle (seconds)	Traffic signals	Roundabout, 'Give Way' and 'Stop' signs
A	Less than 15	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity and accident study required
E	57 to 70	At capacity. At signals, incidents will cause delays	At capacity, requires other control mode
F	Greater than 70	Demand exceeds capacity. Unstable traffic flow. Extra capacity required	Extreme delay, traffic signal or other major treatment required

Source: Roads and Traffic Authority, *Guide to Traffic Generating Developments,* 2002

Table 4-4 shows the results of the interchange and intersection analysis. The analysis was based on traffic volumes obtained from a combination of intersection turning volume surveys at traffic signals.

Table 4-4: Existing interchange and intersection operation, 2014

Intersection	AM peak hour		PM peak hour	
	Level of service	Average delay per vehicle (seconds)	Level of service	Average delay per vehicle (seconds)
King Georges Road/Canterbury Road	89.2	F	71.58	F
King Georges Road/Roselands Drive	27.6	B	29.71	C
King Georges Road/Moorefields Road	48.9	D	17.37	B
King Georges Road/M5 Motorway	59.4	E	56.91	E
King Georges Road/Broad Arrow Road	38.3	C	87.60	F
King Georges Road/Morgan Street	22.5	B	45.41	D
King Georges Road/Stoney Creek Road	82.0	F	75.60	F

4.5 Midblock performance

Existing midblock performance has been calculated by comparing measured speeds with posted free flow speeds at certain locations. The actual speed calculated as a percentage of posted speed provides an insight into the midblock performance of the existing road network.

Level of Service categories were obtained from the Highway Capacity Manual (HCM) 2010 and are shown in **Table 4-5.**

Table 4-5: Midblock level of service (HCM 2010)

Level of service	Average speed as a percentage of posted speed
A	> 85%
B	67% to 85%
C	50% to 66%
D	40% to 49%
E	30% to 39%
F	< 30%

Speed data has been taken from the same locations as detailed in **section 4.2.** Level of service results are presented in **Table 4-6**, **Table 4-7** and **Table 4-8** below.

Table 4-6 shows that midblock performance on King Georges Road north of the M5 motorway reduces to level of service C for northbound vehicles in the AM weekday peak. This location also operates at level of service C for the weekday AM, interpeak and PM peak for southbound vehicles. The remaining periods operate satisfactorily at level of service B.

King Georges Road south of the M5 motorway operates well with both directions operating at level of service A or B during all time periods, as seen in **Table 4-7.**

Table 4-8 demonstrates the significant delays experienced eastbound on the M5 motorway during the AM peak. Speeds are only 25% of posted speeds which leads to an unsatisfactory level of service F. All other periods and all westbound movements perform well with level of service A or B.

Table 4-6: King Georges Road between M5 Motorway and Moorefields Road

Period	Northbound		Southbound	
	% of free flow	Level of Service	% of free flow	Level of Service
AM Peak	66%	C	57%	C
Inter Peak	73%	B	66%	C
PM Peak	73%	B	62%	C
Evening	81%	B	77%	B

Table 4-7: King Georges Road between M5 Motorway and Broad Arrow Road

Period	Northbound		Southbound	
	% of free flow	Level of Service	% of free flow	Level of Service
AM Peak	95%	A	92%	A
Inter Peak	86%	A	83%	B
PM Peak	84%	B	79%	B
Evening	92%	A	93%	A

Table 4-8: M5 Motorway at King Georges Road

Period	Eastbound		Westbound	
	% of free flow	Level of Service	% of free flow	Level of Service
AM Peak	25%	F	98%	A
Inter Peak	88%	A	79%	B
PM Peak	86%	A	97%	A
Evening	91%	A	88%	A

4.6 Queuing at M5 Motorway exit ramps

Table 4-9: Queue lengths at M5 Motorway off-ramps

	AM queue (metres)		PM queue (metres)	
	7-8am	8-9am	4-5pm	5-6pm
Eastbound exit ramp	286	209	246	295
Westbound exit ramp	381	451	288	312

4.7 Road safety and crash history

This section presents an analysis of crashes that occurred on the M5 Motorway, 1000 metres either side of King Georges Road, or on King Georges Road, between Canterbury

Road and Stoney Creek Road, during the period July 2008 to June 2013. The data was recorded by Roads and Maritime with all crashes conforming to the national guidelines for reporting and classifying road vehicle crashes. The main criteria for these crashes are:

- The crash was reported to police.
- The crash occurred on a road open to the public.
- The crash involved at least one moving vehicle.
- The crash involved at least one person being killed or injured or at least one motor vehicle being towed away.

Minor crashes where drivers exchange details are not required to be recorded and are not included in the crash data.

During the July 2008 to June 2013 period 231 crashes were recorded on the M5 and 355 crashes on King Georges Road. Crashes that occurred at the M5 / King Georges Road interchange are only included in the King Georges Road crash analysis.

4.7.1 M5 Motorway

Table 4-10 shows the number of crashes on the M5 Motorway by year. Crashes remained relatively steady between 2008 and 2012, and then declined from 2012 to 2013.

Table 4-10: Number of crashes on the M5 Motorway

Year	Number of crashes
July 2008 to June 2009	52
July 2009 to June 2010	51
July 2010 to June 2011	49
July 2011 to June 2012	47
July 2012 to June 2013	32
Total	231

Table 4-11 shows the types of crashes that occurred on the M5 Motorway during the period July 2008 to June 2013. Approximately three-quarters of the crashes were rear end crashes, as is common on near-saturated roads where headways are relatively short. Almost all other crashes also occurred in traffic moving in the same direction, or from vehicles leaving the carriageway or losing control. This reflects the nature of limited-access dual carriageways, which largely prevents crashes involving pedestrians and traffic travelling in opposing directions.

Table 4-11: Types of crashes on the M5 Motorway

Type of crash	Number of crashes
Rear-end	169
Lane change	29
Off road, on straight	1
Off road, on straight, hit object	18
Out of control on straight	4
Off road on curve, hit object	4
Out of control on curve	3
Other crash type	3

Table 4-12 shows the severity of crashes that occurred on the M5 Motorway during the period July 2008 to June 2013. No fatal crashes were recorded. Approximately two-fifths of reported crashes involved an injury, and three-fifths required towing only. These results are indicative of a high standard, limited-access motorway which is engineered to ensure that the severity of crashes is limited.

Table 4-12: Severity of crashes on the M5 Motorway

Severity of crash	Number of crashes
Fatal	0
Injury	96
Non-casualty (tow-away)	135

Table 4-13 shows crash rates of the M5 Motorway to the east and west of King Georges Road during the period July 2008 to June 2013. The 1000 metres to the east of King Georges Road recorded a 48 per cent greater crash rate per kilometre of road than the 1000 metres to the west of King Georges Road.

Table 4-13: Crash rates on each section of the M5 Motorway

Section	One-way length (kilometres)	Crashes per kilometre of road per year	Crashes with casualties per year	Crashes without casualties per year
1000 metres west of King Georges Road	1.0	18.6	6.8	11.8
1000 metres east of King Georges Road	1.0	27.6	12.4	15.2

Figure 4-13 and **Figure 4-14** show the temporal distribution of recorded M5 Motorway crashes on weekdays and weekends, for the 1000 metres to the east and 1000 metres to the west of King Georges Road. On weekdays, there are more crashes with injuries during the evening peak compared to the morning peak. On weekends, crashes are more likely to occur between 10.00 am and 8.00 pm, with peak noticeable around 12.00 pm to 1.00 pm, and 6.00 pm to 7.00 pm.

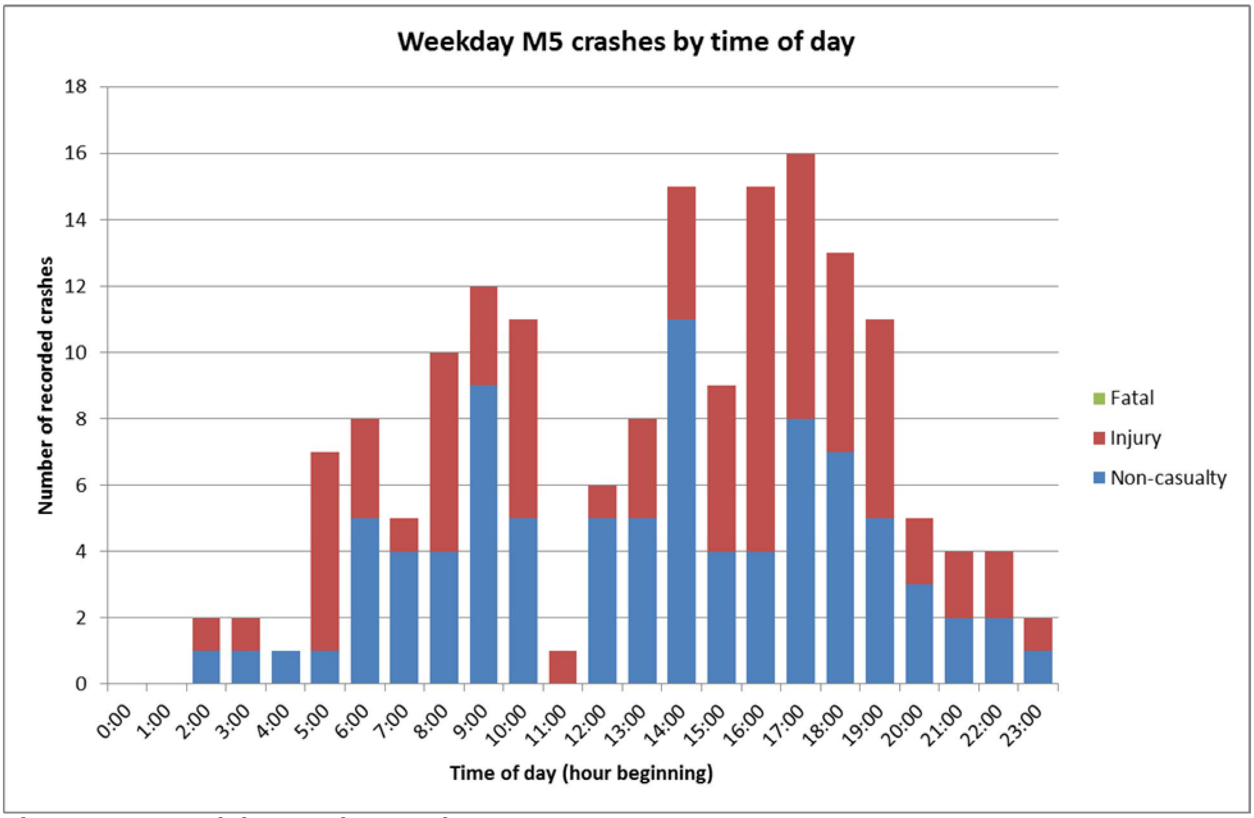

Figure 4-13: Weekday crashes on the M5 Motorway

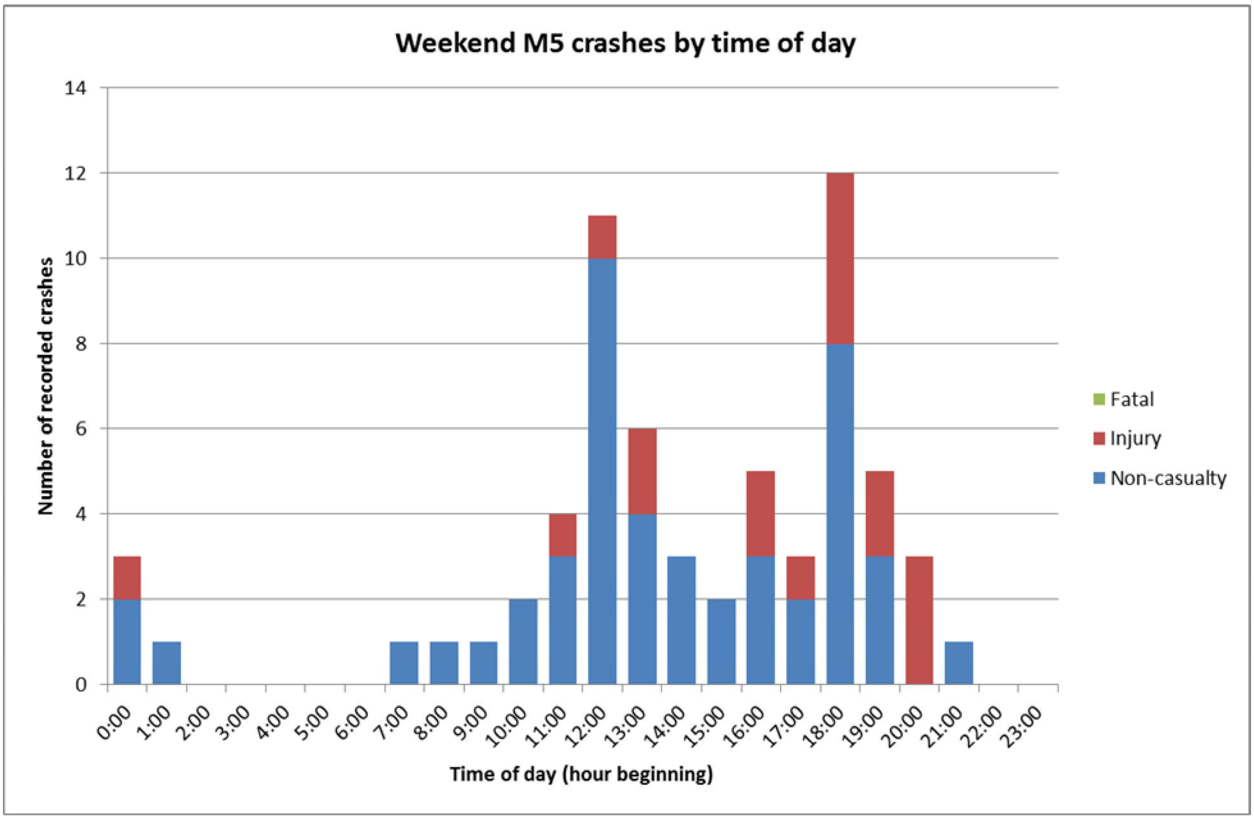

Figure 4-14: Weekend crashes on the M5 Motorway

4.7.2 King Georges Road

Table 4-14 shows the number of crashes on King Georges Road by year. Crashes remained relatively steady between 2008 and 2013, with only a slight peak between 2009 and 2011.

Table 4-14: Number of crashes on King Georges Road

Year	Number of crashes
July 2008 to June 2009	66
July 2009 to June 2010	76
July 2010 to June 2011	78
July 2011 to June 2012	70
July 2012 to June 2013	65
Total	355

Table 4-15 shows the types of crashes that occurred on King Georges Road during the period July 2008 to June 2013. Approximately 55 per cent of crashes were rear end crashes, likely due to heavy traffic conditions. Other significant causes of crashes included vehicles colliding in opposing directions and from lane changes. These types of crashes are typical for periodically congested urban arterial networks with relatively closely spaced signalised intersections.

Table 4-15: Types of crashes on King Georges Road

Type of crash	Number of crashes
Intersection, adjacent approaches	20
Head-on (not overtaking)	1
Opposing vehicles; turning	45
Rear-end	194
Lane change	45
Parallel lanes; turning	5
Vehicle leaving driveway	2
Hit pedestrian	5
Off road, on straight	3
Off road, on straight, hit object	19
Out of control on straight	6
Other crash type	10

Table 4-16 shows the severity of crashes that occurred on King Georges Road during the period July 2008 to June 2013. No fatal crashes were recorded, most likely due to the low speed of the road in congested conditions. Approximately two-fifths of reported crashes involved an injury, and three-fifths required towing only. These results are very similar to crash rates on the analysed section of the M5 Motorway.

Table 4-16: Severity of crashes on King Georges Road

Severity of crash	Number of crashes
Fatal	0
Injury	135
Non-casualty (tow-away)	220

Table 4-17 shows the general location of crashes on King Georges Road during the period July 2008 to June 2013. Two-thirds of the crashes occurred at an intersection.

Table 4-17: Location of crashes on King Georges Road

Location of crash	Number of crashes
Intersection (up to 10 metres away)	241
Non intersection	114

Table 4-18 indicates the crash rates of King Georges Road by section between Canterbury Road and Stoney Creek Road during the period July 2008 to June 2013. The Moorefields Road to Broad Arrow Road section recorded the highest crash rate per kilometre, although rates are fairly similar across all sections.

Table 4-18: Crash rates on each section of King Georges Road

Section	One-way length (kilometres)	Crashes per kilometre of road per year	Crashes with casualties per year	Crashes without casualties per year
Canterbury Road to Moorefields Road	1.2	22.7	10.6	16.6
After Moorefields Road to Broad Arrow Road	0.9	27.1	9.2	15.2
After Broad Arrow Road to Stoney Creek Road	0.75	25.9	7.2	12.2

Figure 4-15 and **Figure 4-16** show the temporal distribution of recorded King Georges Road crashes on weekdays and weekends, between Canterbury Road and Stoney Creek Road. On weekdays, there are generally more crashes during the afternoon and evening compared to the morning. On weekends, crashes are more likely to occur in the morning and early afternoon, although crashes do occur throughout the whole day.

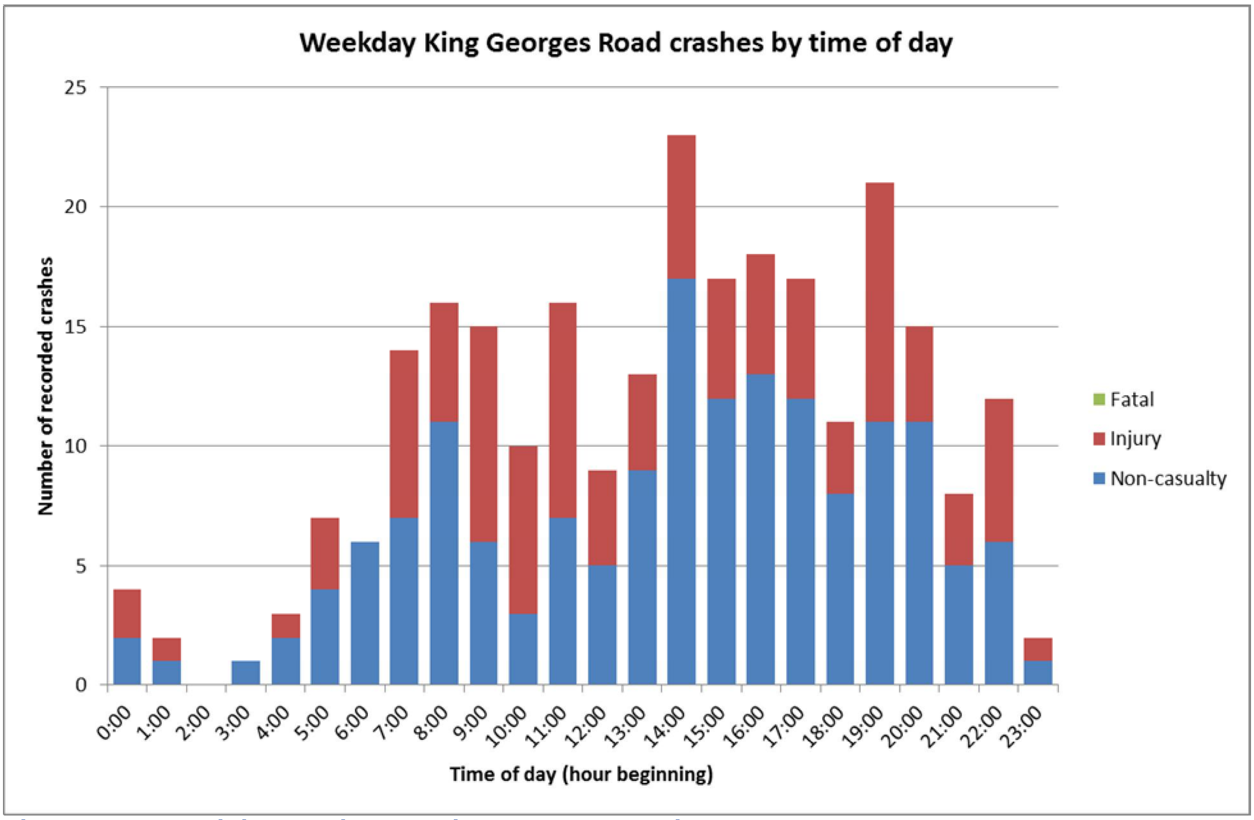

Figure 4-15: Weekday crashes on King Georges Road

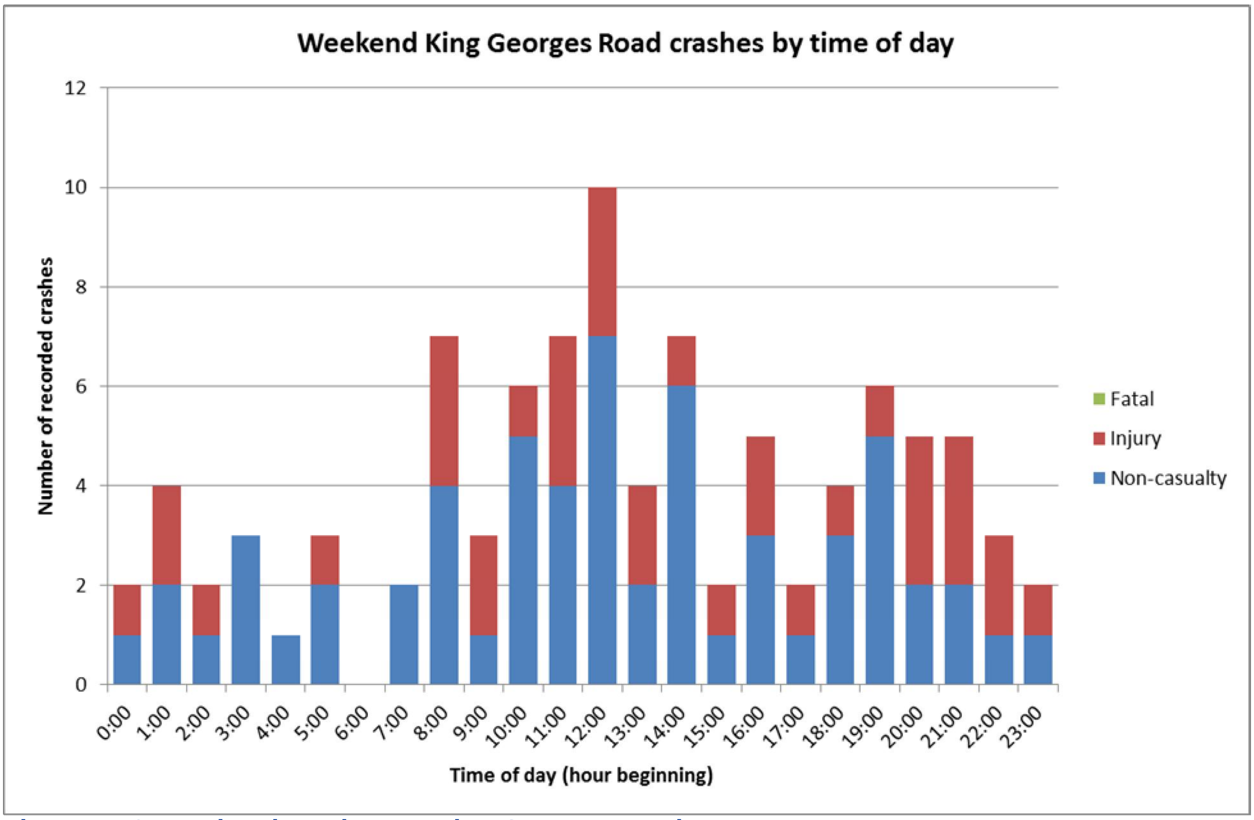

Figure 4-16: Weekend crashes on King Georges Road

5 Traffic forecasting approach

5.1 Introduction

The NSW Government, through the WestConnex Delivery Authority (WDA), engaged a Jacobs SKM-AECOM team to undertake the WestConnex traffic analysis study in support of the *WestConnex Business Case* (Sydney Motorways Project Office 2013b) process.

The purpose of this study was to develop a WestConnex Road Traffic Model (WRTM) to forecast traffic patronage and assess the most likely range of future traffic patronage across the WestConnex network for the proposed franchise period. The WRTM is a regional strategic model considered suitable for demand analysis and future forecasting. It is not an operational model, therefore, to assess detailed impacts, further analysis using operational modelling software is required (refer to **sections 4.4**, **6.6** and **7.4**).The WRTM was progressively developed as follows:

- Stream 1 of the WRTM was a fully functional toll choice model of similar design to the final WRTM however some parameters were adopted from recent studies undertaken in Brisbane as suitable data was not yet available for Sydney. This approach provided a functional model for use in the preliminary Business Case than would otherwise have been possible in the available time. The Stream 1 model was commenced in January 2013 and completed in April 2013 in time for use in the preliminary Business Case.
- The revisions made for the Stream 2 model essentially replaced the Brisbane parameters with Sydney data and refined transport networks and demands. Survey data for Sydney was collected between March and May 2013 to determine Sydney drivers' willingness to pay tolls (Value of Travel Time Surveys - VTTS) and subsequently analysed to replace the Brisbane-based data initially used in Stream 1. Work was also undertaken to improve the model's performance with respect to matching observed traffic volume and travel times. The model is currently in the final stages of review by a Peer Review Committee that includes representatives from the WDA, transport planning specialists and academia. The reviewers have approved the use of the Stream 2 WRTM in this working paper. The Stream 2 model was used to produce the traffic and transport assessment as part of this working paper.

5.2 Modelling approach

A sound approach to traffic demand modelling was undertaken for this study, including the following:

- A review of the currently available transport planning models and data was undertaken to determine the optimal models and data to provide an appropriate foundation for the WRTM.
- Available toll choice modelling techniques were assessed in the current Sydney context where multiple competing toll roads cover a substantial proportion of the developed Greater Sydney metropolitan area, known as the Sydney Statistical Division.
- Base and future population and employment data was sourced from the Bureau of Transport Statistics (BTS) (August 2012a release). The Sydney Strategic Transport Model (STM) data together with a previously developed model database provided by WDA have both been used as the starting point for the development of demand matrices using a matrix estimation process.
- Existing road infrastructure was reviewed for the base 2012 year and converted into a consistent format for representation in the WRTM. A set of future road infrastructure projects for the modelled Sydney metropolitan area for 2021 and 2031 was developed and agreed with (NSW) Roads and Maritime Services (Roads and Maritime) and is

consistent with its current funding and planning policies. These projects formed the basis for the base future networks modelled in WRTM.

- Project specific surveys of drivers' VTTS were undertaken to inform the toll choice modelling to enable the model best to reflect current driver behaviour in the specific context of the WestConnex toll road facilities.
- The WRTM project model was developed and calibrated to current observed travel behaviour, then validated against 2012 Sydney-wide travel behaviour established in a series of traffic count and travel time surveys. It was then adjusted to reflect driver behaviour on Sydney's toll roads observed in the VTTS surveys. The model calibration and validation processes have maintained a specific focus and refinement in the WestConnex study area. The WRTM comprises separate time period models for morning peak, evening peak, daytime off-peak and night-time off-peak.
- WestConnex options, developed by WDA, were coded into the WRTM future year models.
- Future demands were developed by applying the WRTM with future year traffic growth assumptions sourced from the SSTM (that takes account of data like demographics and transport networks) to produce the most likely or Base Case scenario. Forecasts were produced by the WRTM for the years 2012, 2021 and 2031 to produce vehicle demands by toll class and time period for an average weekday at each year.

The WRTM patronage forecasting model developed for this project comprises two separate elements, the Base Demand Model (that is based on the STM with updates to incorporate more recent data) and the Toll Choice Assignment Model (an assignment module to incorporate toll choice behaviour). The role of each model element, and interaction between them, is discussed below.

The Base Demand Model has been developed using the STM with updated information used to produce improved travel demand matrices for detailed toll choice route assignment and project appraisal testing. This Base Demand Model provides the forecast capability to address changes in land use, trip distribution and mode choice and produces vehicle traffic demands for peak and off-peak periods for subsequent allocation to routes in the detailed toll choice assignment model.

The Toll Choice Assignment Model was developed to test impacts of toll and infrastructure strategies and provide infrastructure project traffic forecasts. The model is designed to forecast the traffic choosing to use toll and non-toll routes for the representative peak and inter-peak periods of the day.

Both models run in Emme, an internationally recognised transport modelling package, though much of the Base Demand Model development (i.e. the matrix estimation process) was undertaken using Cube software.

Available data was provided by WDA and Roads and Maritime and was initially used as primary inputs for the development of the WRTM including:

- Traffic volume counts provided by Roads and Maritime for screenlines and project specific counts.
- Road travel time surveys collected by Roads and Maritime for this project in December 2012.
- Base 2011 and future years (2021 and 2031) vehicle demand matrices by travel purpose from the SSTM sourced from BTS in February 2013.

- Population and employment by small zone area provided by BTS consistent with demographics released by the (NSW) Department of Planning and Environment (August 2012 release).
- Toll plaza average day transaction data provided through WDA for many of the toll roads in Sydney, including the M5 Motorway, M7 Motorway, M2 Motorway and the Lane Cove Tunnel.
- Household travel survey data collected by BTS.
- Private car driver stated and revealed preference value of travel time survey data collected by SKM for this study in early 2013.
- Commercial vehicle stated preference value of travel time survey data collected by SKM in late 2012.
- Aerial photography collected in 2011 by SKM for detailed auditing of road networks.
- Recently completed and future infrastructure project lists from WDA. The major projects assumed to be in place for the various years is given in **section 6.2**.
- Existing strategic models and data within the Sydney region from WDA.

The development of improved road traffic demand matrices was required for this study to provide a better performance for road traffic forecasting ability than the STM and particularly for the study area. The development of the base demand model included:

- Historical data analysis including collection of existing traffic volumes and existing travel time data across Sydney.
- VTTS analysis to investigate people's willingness to pay tolls to use toll roads based on project specific market research surveys.
- Annualisation and ramp-up assessments to develop the Average Annual Daily Traffic forecasts from the peak hour models.
- Development of improved road traffic demand matrices.
- Development of a Toll Choice Model for assigning road traffic to toll routes through the application of a toll choice diversion model, known as a distributed Value of Time (VOT) multi-class equilibrium assignment model.

To support the development of the WRTM, an investigation was undertaken into the various toll choice assignment methods in the Sydney and Australian context. Based on the assessment, it was determined that the WRTM toll choice model should adopt a distributed VOT multi-class equilibrium assignment methodology. The key reasons were:

- The methodology was considered a valid approach for the WRTM toll choice model for assessment of WestConnex. It would address the functional requirements of the project model with capabilities to consider a range of tolling strategies and scenario tests.
- Of the two methodologies considered, that approach would be more flexible as a multi-purpose approach for WDA and BTS to use in the assessment of the broader Sydney network.
- The approach appears to be emerging within the local market and has recently been used as the preferred modelling approach for a number of Australian toll roads.

Available data from a recent project in Brisbane for the Queensland Government was used for the private vehicle VTTS values for Stream 1. This data was supplemented by VTTS data from commercial vehicle surveys conducted by SKM in Sydney in late 2012. The data collection and analysis methods were similar and compatible for these two VTTS studies.

To support the development of the WRTM toll choice model, further similar and compatible project specific VTTS surveys for private vehicles in Sydney were conducted in March and April 2013 to inform the toll choice modelling. Analysis of these surveys was not available for the Stream 1 delivery which was required for the Business Case in September 2013 but is included in Stream 2 modelling.

The WRTM toll choice model was constructed to directly model the range of driver behaviour and was adjusted to match the observed patronage on the existing toll facilities.

A series of validation checks was undertaken to verify the performance of both the base demand and toll choice models within the WRTM. Development of the Stream 2 model was undertaken in parallel to preliminary investigations using the Stream 1 model. The primary difference between the Stream 1 and Stream 2 model is the use of locally collected information on VTTS as opposed to the preliminary Brisbane information. Results from the Sydney private vehicle surveys showed that the toll choice parameters used were relatively similar to those used initially from the Brisbane data.

The data contained within this traffic and transport assessment has been taken from the Stream 2 model following assessment of the model calibration and validation by peer reviewers and agreement that the model is suitable for this purpose. At the time this assessment was undertaken, further work was being performed on the Stream 2 model to refine it further for use in final financial assessment and design.

5.3 Land use projections

This section summarises key demographic and land use inputs to the WRTM for both the base year 2012 models and each of the future year models (ie 2021 and 2031). The WRTM is linked to the STM which includes the trip generation, trip distribution and mode choice modules and incorporates demographic data related to land uses including population, employment and education enrolment projections. For WRTM this data has been supplied by BTS as data extracts from the STM and is understood to have been based on the latest population and employment projections.

A summary of the policy context within which the demographic projections have been made is presented in **section 3.2**. A review of the demographic and land use inputs against these policies was then undertaken to test their integrity and suitability for use.

WDA established an Assumptions Review Group that has determined many of the basic parameters that have formed the basis of the development and forecasting process used by the WRTM. The Assumptions Review Group has prepared the *WestConnex Assumptions Book version 1.4* (WDA 2013) that presents the core assumptions and parameters adopted by the WRTM.

The WestConnex Assumptions Book confirmed the base demographic and land use information (Census year base) would be based on the December 2012 data release from BTS. This data has been projected from 2006 Census data and although a later release of the data was being prepared, it was not available for this assessment. The base vehicle demands from STM are consistent with this demographic assumption and therefore provide a consistent base for the future demands used in the WRTM.

It should be noted the BTS projections will be updated in future to reflect planning work being undertaken for the Carter Street and Wentworth Point Urban Activation Precincts and more broadly concepts being developed through WestConnex revitalisation work on a land use and transport structure plan. This information was also not yet available for this assessment.

5.4 Induced demand and traffic assessment base case

An assessment of 'induced demand', ie additional traffic on the road network that might result from implementation of the project was carried out by BTS using the STM that showed that no significant increase in overall road traffic demand was anticipated as a result of the project. Based on this assessment, the road traffic demands supplied earlier in the project were originally deemed suitable for use in the future project case modelling.

5.5 Examined scenarios

In considering the future, several scenarios need to be considered, reflecting the timeframe under which the infrastructure can be delivered and the extent of other infrastructure developments. Five scenarios have been explored through development of specific modelled scenarios, reflecting various future travel demands.

Examined demand cases were represented by specific modelled forecast years:

- 2014 was adopted as the existing case to correlate with the traffic survey undertaken for the King Georges Road Interchange Upgrade;
- 2017 was adopted as the project opening case for the King Georges Road Interchange Upgrade ;
- 2027 was adopted as the case for 10 years after opening and was considered to allow for full ramp-up of traffic demand as travellers respond to the provision of the fully completed WestConnex and the associated toll.

The scenarios examined were modelled in WRTM by combining future year demands with future networks. Traffic was assigned using the calibrated road assignment model, taking suitable account for changes in toll choice behaviour over time. The modelled scenarios therefore were:

- **Existing case (2014)**: Current road network with no new projects or upgrades.
- **Base 'do minimum' (2017)**: The Base 'do minimum' case assumes that the King Georges Road Interchange Upgrade and the remainder of the WestConnex projects are not built. It is called 'do minimum' rather than 'do nothing' as it assumes that on-going improvements will be made to the broader transport network including some new infrastructure and intersection improvements to improve capacity and cater for traffic growth but does not include the M4 Widening or other WestConnex projects.
- **King Georges Road Interchange Upgrade (2017)**: The King Geirges Road Interchange Upgrade complete and open to traffic but without any other WestConnex projects.
- **Future 'do minimum' (2027)**: A future network including some upgrades to the broader transport network over time to improve capacity and cater for traffic growth but does not include the King Georges Road Interchange Upgrade or other WestConnex projects. The Future 'do minimum' case is at a time ten years later than the Base 'do minimum' case.
- **Full WestConnex (2027)**: With all WestConnex projects completed (Note: The NSW Government has committed to achieving completion of all WestConnex projects by 2023).

5.6 Demand forecasting limitations

Traffic forecast modelling is highly complex. Reasonable variations in input parameters, data and assumptions result in variations in forecast traffic demand. Forecast traffic from models should therefore be considered as a range as opposed to absolute numbers. For the purposes of this traffic and transport assessment, the WRTM within its inputs and assumptions has been constructed to produce the best estimate of the future traffic demands given the constraints of time and data availability.

The future forecast traffic demands and the implied associated benefits and impacts of the project may vary from what has been presented in this assessment. Specifically, the following may logically cause variations to the future scenarios:

- Land use and demographics projections change progressively from one release to the next. Revised projections currently under development by Department of Planning and Environment are anticipated to change population and employment projections at the 2021 and 2031 years across Sydney.
- The effectiveness of improvements to public transport services within the M5 Motorway corridor and the relative capacity of public versus private transport will affect the growth of private vehicle travel in the corridor. The adopted demand case used for this traffic and transport assessment was reasonable given the available information.

6 Future base traffic conditions

6.1 Introduction

This chapter outlines future network performance assuming that no components of WestConnex are built (the 'do minimum' scenario). This will be used to assess the need for the King Georges Road Interchange Upgrade project and to act as a baseline to measure the impact of the project in the future.

6.2 Future network assumptions

Future year network development is shown in **Table 6-1**. This has been based on the Strategic Travel Model assumptions (Bureau of Transport Statistics (BTS) 2012e). Some timing assumptions have been reviewed in consultation with (NSW) Roads and Maritime Services (Roads and Maritime) to reflect project assumptions.

Table 6-1: Strategic travel model network assumptions

By Year	Road	Rail / light rail	Bus
2006	Network version July 2009	Network version March 2007	Network version March 2007
2011	Lane Cove Tunnel Inner West Busway (Iron Cove Bridge duplication) F3 Freeway (M1 Pacific Motorway) widening Hume Highway widening	Enhanced 2009 timetable network Cronulla Rail Line duplication Epping to Chatswood Rail Line	Integrated bus networks phase one
2016	Hunter Expressway M2 Motorway widening M5 West widening Western Sydney employment hub Great Western Highway widening	A variety of rail projects to improve operability of the rail network South West Rail Link Inner West light rail extension to Dulwich Hill	Integrated bus networks completed Additional 1,000 buses Increased frequencies
2021		North West Rail Link Central business district (CBD) and South East Light Rail	Northern Beaches busway Bus network extensions and frequency adjustments aligned with changes in land use and rail network assumptions
2026	NorthConnex	Western Express	
2031	South West Growth Centre	Three tier railway plan – railway services based on three service types to meet different customer needs Parramatta to Epping Rail Line	
2036	F6 Freeway (M1 Princes Motorway)	Three tier railway plan – railway services based on three service types to meet different customer needs	

By Year	Road	Rail / light rail	Bus
(2041)	M2 Motorway extension via Gladesville Bridge to M4 East extension		

Source: BTS, *Strategic Travel Model assumptions*, 2012e

6.3 Study area network and corridor performance

Network performance

The anticipated performance of the road network across the study area and in the M5 Motorway corridor is detailed in **Table 6.2.**

Table 6-2 demonstrates that overall demand on the study road network is set to continue to grow strongly.

The average network speed values represented in **Table 6-2** were calculated by determining the total number of kilometres travelled by all vehicles across the modelled network and dividing that value by the total number of hours spent travelling. It shows a significant degradation in travel speeds on the road network within the study area is anticipated if no WestConnex were to be built. Of further note is the fact that travel speeds in the inter peak period are anticipated to be slower in 2027 than during peak periods in 2014.

Table 6-2 Study area network performance, 'do minimum' scenarios

'Do minimum' scenario	AM peak (2 hours)			PM peak (2 hours)		
	VKT (km)	VHT (hrs)	Average Speed (km/h)	VKT (km)	VHT (hrs)	Average Speed (km/h)
Existing case 2014	103,237.9	4,605.4	22.4	109,121.6	4,453.3	24.5
2017	110,981.2	5,616.6	19.8	117,021.7	5,275.5	22.2
2027	95,873.4	10,075.3	9.5	112,968.6	10,635.2	10.6

Source: Paramics Traffic Model, 2014

Corridor performance

The growth in the use of the M5 Motorway and King Georges Road corridors are summarised in **Table 6-3** and **Table 6-4** respectively.

Table 6-3: Corridor performance in the M5 Motorway corridor between Cooloongatta Road and Penhurst Road

'Do minimum' scenario	AM peak (2 hours)			PM peak (2 hours)		
	VKT (km)	VHT (hrs)	Average Speed (km/h)	VKT (km)	VHT (hrs)	Average Speed (km/h)
Existing case 2014	1,058.5	26.9	39.3	928.9	18.6	49.8
2017	1,444.9	42.0	34.4	1,069.4	22.6	47.4
2027	1,617.4	52.1	31.1	1,362.5	34.4	39.6

Source: Paramics Traffic Model, 2014

Table 6-4: Corridor performance in the King Georges Road between Moorefields Road and Broad Arrow Road

'Do minimum' scenario	AM peak (2 hours)			PM peak (2 hours)		
	VKT (km)	VHT (hrs)	Average Speed (km/h)	VKT (km)	VHT (hrs)	Average Speed (km/h)
Existing case 2014	500.7	20.7	24.2	378.5	11.9	31.8
2017	536.8	23.4	23.0	432.1	14.5	29.9
2027	584.7	27.7	21.1	441.5	16.4	27.0

Source: Paramics Traffic Model, 2014

It should be noted that the network and corridor results are derived from the Paramics model simulations. The simulations take into account the actual demand attempting to make that movement, however, the traffic volume outputs reflect only the traffic that arrives at the intersection not the total demand flow. Upstream queued flow that does not arrive at the various intersections may be significant when the network experiences severe congestion.

6.4 Future traffic flows

Average Daily Traffic (ADT) figures have been calculated using the traffic survey count data. The daily traffic profile is expected to remain the same and so counts from Paramics have been extrapolated to produce expected future ADT figures as shown in Table 5-5.

Table 6-5 illustrates the future daily traffic distribution within the study precinct.

There is a difference in the Average Daily Traffic (ADT) values in situations where the future scenario has resulted in severe congestion. It is likely that the demand at these locations remains relatively similar to the base case with the reported ADT values being as a result of vehicles not being able to access the network due to insufficient network capacity in the broader network outside of the study area.

Table 6-5: Average daily traffic flow (Base and Future 'do minimum')

Road	Direction	2014 (Existing)			2017 (Do Minimum)			2027 (Do Minimum)		
		AM Peak (2-hr)	PM Peak (2-hr)	ADT	AM Peak (2-hr)	PM Peak (2-hr)	ADT	AM Peak (2-hr)	PM Peak (2-hr)	ADT
M5 Motorway (East of King Georges Road)	EB	4,211	6,913	41,529	4,875	5,815	42,210	5,067	5,891	42,640
	WB	5,843	5,948	43,338	6,589	6,774	47,942	7,287	6,238	49,035
	Total	10,054	12,862	84,867	11,464	12,589	90,152	12,353	12,129	91,675
M5 Motorway (West of King Georges Road)	EB	3,594	5,810	36,209	5,042	5,713	42,387	5,417	6,157	44,355
	WB	4,985	4,198	36,767	5,841	6,043	44,274	6,467	5,296	44,575
	Total	8,579	10,009	72,976	10,883	11,756	86,661	11,884	11,453	88,930
M5 Eastbound (Exit ramp)	EB	1,013	1,234	6,104	1,627	1,912	9,849	1,954	2,030	11,089
	WB	-	-	-	-	-	-	-	-	-
	Total	1,013	1,234	6,104	1,627	1,912	9,849	1,954	2,030	11,089
M5 Eastbound (Entry ramp)	EB	1,630	2,337	11,424	1,460	2,014	9,672	1,603	1,763	9,374
	WB	-	-	-	-	-	-	-	-	-
	Total	1,630	2,337	11,424	1,460	2,014	9,672	1,603	1,763	9,374
M5 Westbound (Exit ramp)	EB	-	-	-	-	-	-	-	-	-
	WB	1,947	2,571	12,312	2,213	2,442	13,025	2,457	2,512	13,904
	Total	1,947	2,571	12,312	2,213	2,442	13,025	2,457	2,512	13,904
M5 Westbound (Entry ramp)	EB	-	-	-	-	-	-	-	-	-
	WB	1,089	821	5,741	1,465	1,712	9,357	1,637	1,570	9,444
	Total	1,089	821	5,741	1,465	1,712	9,357	1,637	1,570	9,444

6.5 Travel Times

This section presents the modelled travel times on the M5 Motorway and King Georges Road between Canterbury Road and Stoney Creek Road for the Existing case (2014), Base 'do minimum' (2017) and Future 'do minimum' (2027) scenarios.

The results presented in **Table 6-6** are the average travel times during the two hours of each peak hour. Northbound travel times on King Georges Road increase in line with increasing traffic volumes between the existing situation and the Base 'do minimum' (2017), and again between 2017 and the Future "do minimum' (2027). This increasing travel time in line with increasing traffic volumes is the same for King Georges Road southbound and both directions along the M5 Motorway for all time periods.

These results indicate that without the construction of the project and WestConnex as a whole, travel times will increase as the M5 Motorway and surrounding road network become more congested due to the forecast increase in traffic volumes.

Table 6-6: Existing, Base and Future 'do minimum' modelled travel times

Do minimum scenario	2014 AM	2017 AM	2027 AM	2014 PM	2017 PM	2027 PM
King Georges Road Northbound (between Stoney Creek Road and Canterbury Road)	09:09	11:03	13:13	08:04	09:43	13:20
King Georges Road Southbound (between Canterbury Road and Stoney Creek Road)	09:46	15:06	19:39	09:26	11:01	16:49
M5 Motorway Eastbound (between West of Penshurst Road and East of Coolangatta Road)	04:04	05:49	06:39	01:09	02:15	02:52
M5 Motorway Westbound (between East of Coolangatta Road and West of Penshurst Road)	01:49	02:22	02:54	01:43	02:27	03:04

Figure 6-1 to Figure 6-6 graphically show the increase in travel times over time due to the increase in traffic volumes on the M5 Motorway and King Georges Road.

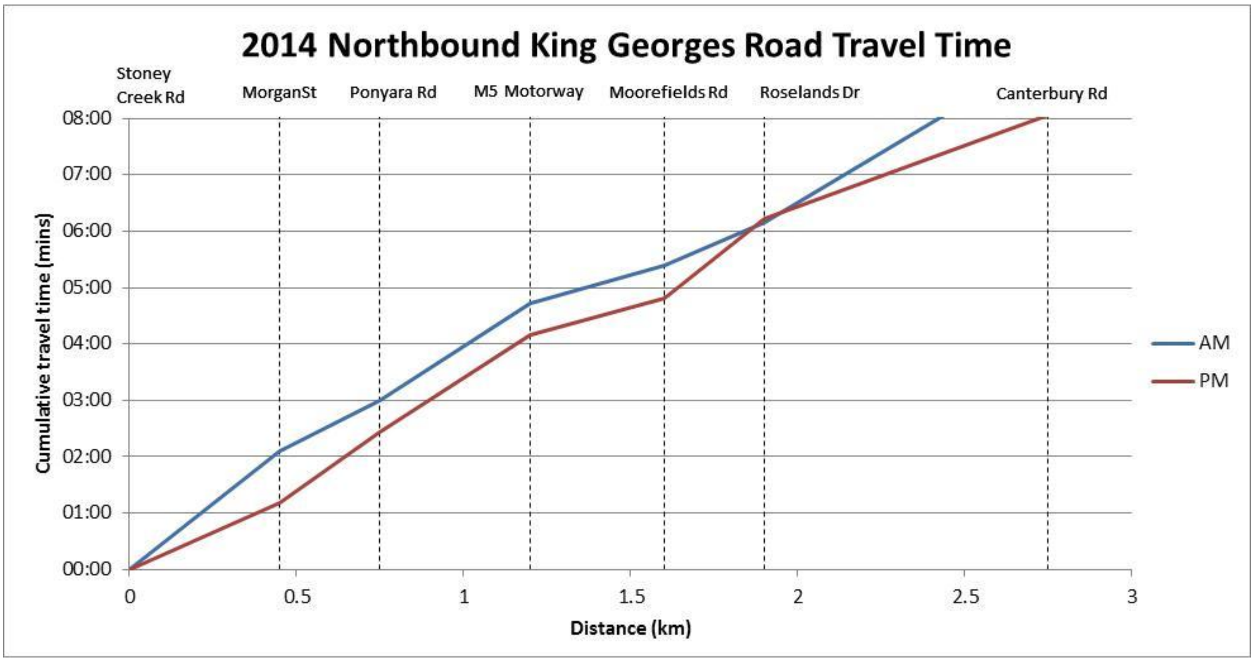

Figure 6-1: King Georges Road northbound modelled travel time 2014

Figure 6-2: King Georges Road southbound modelled travel time 2014

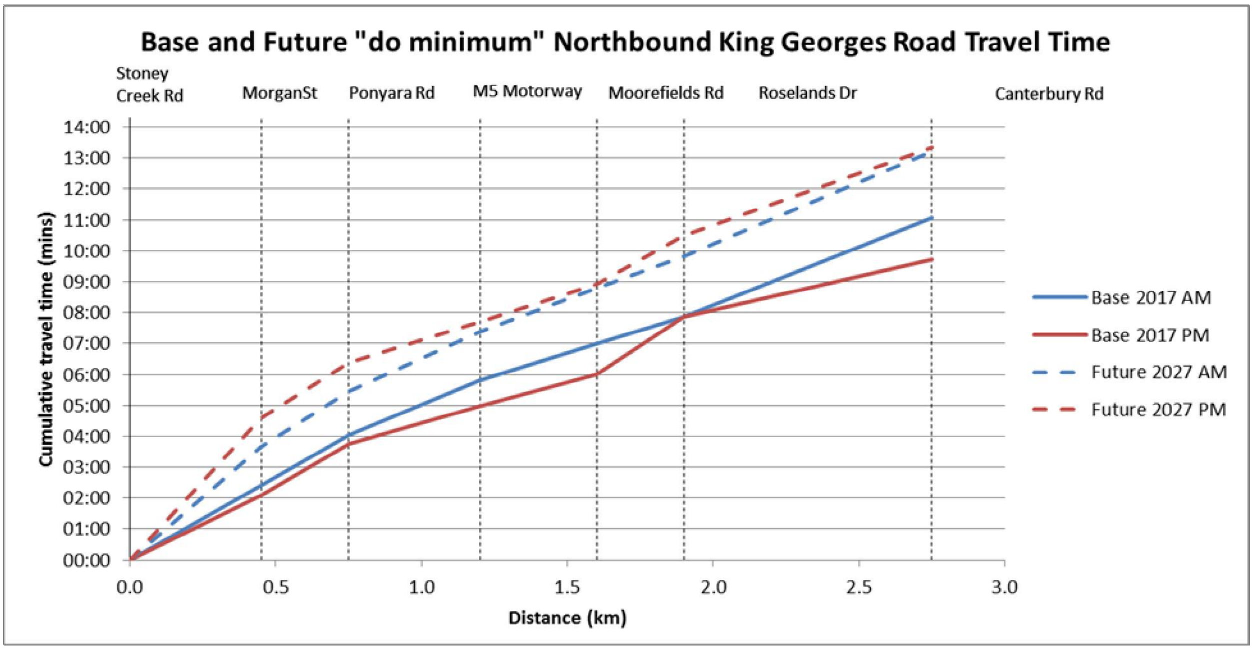

Figure 6-3: Base and Future "do minimum" Northbound King Georges Road modelled travel time

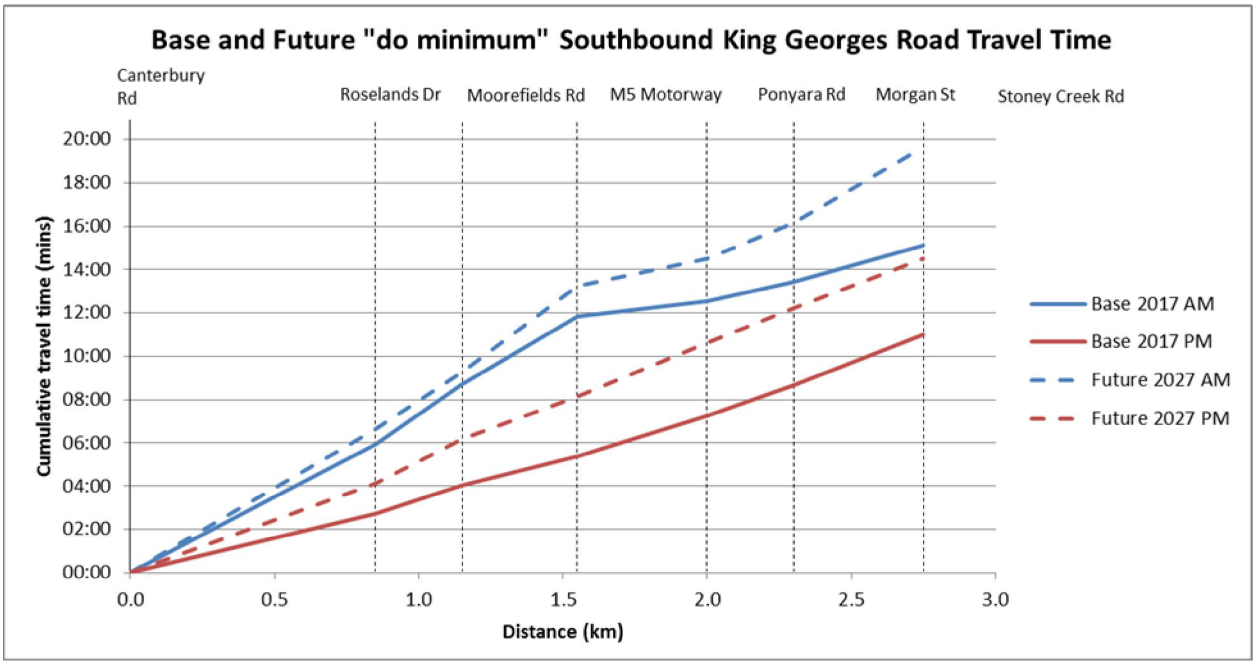

Figure 6-4: Base and Future "do minimum" Southbound King Georges Road modelled travel time

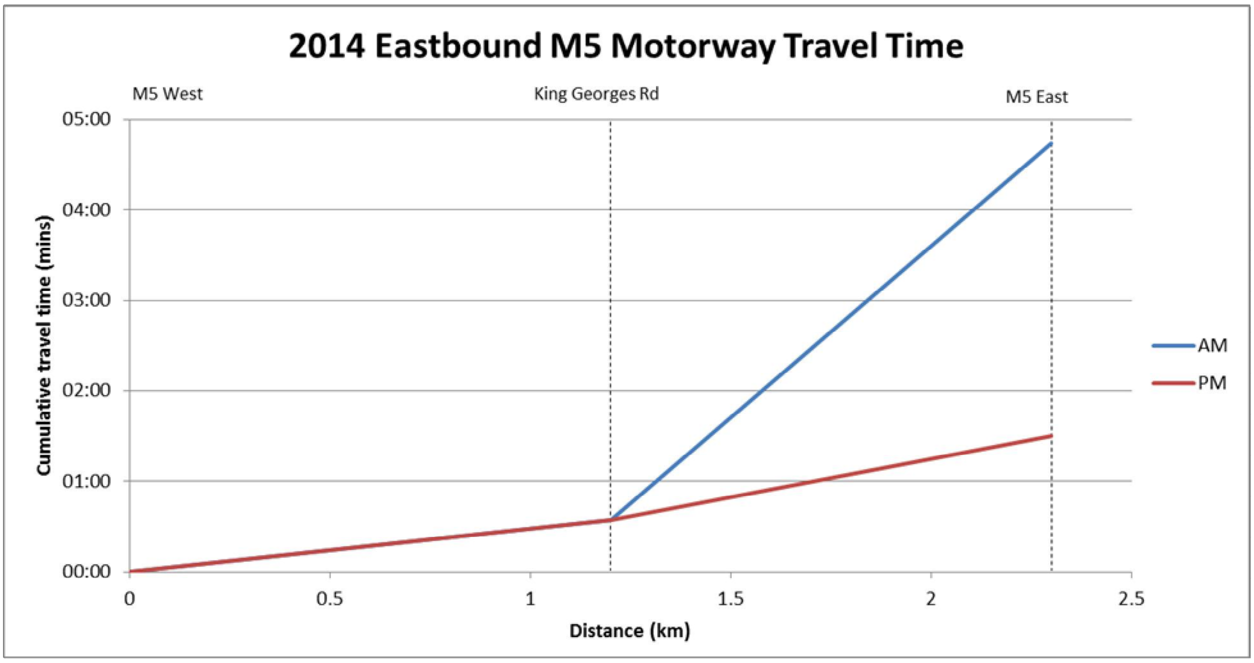

Figure 6-5: M5 Motorway eastbound modelled travel time 2014

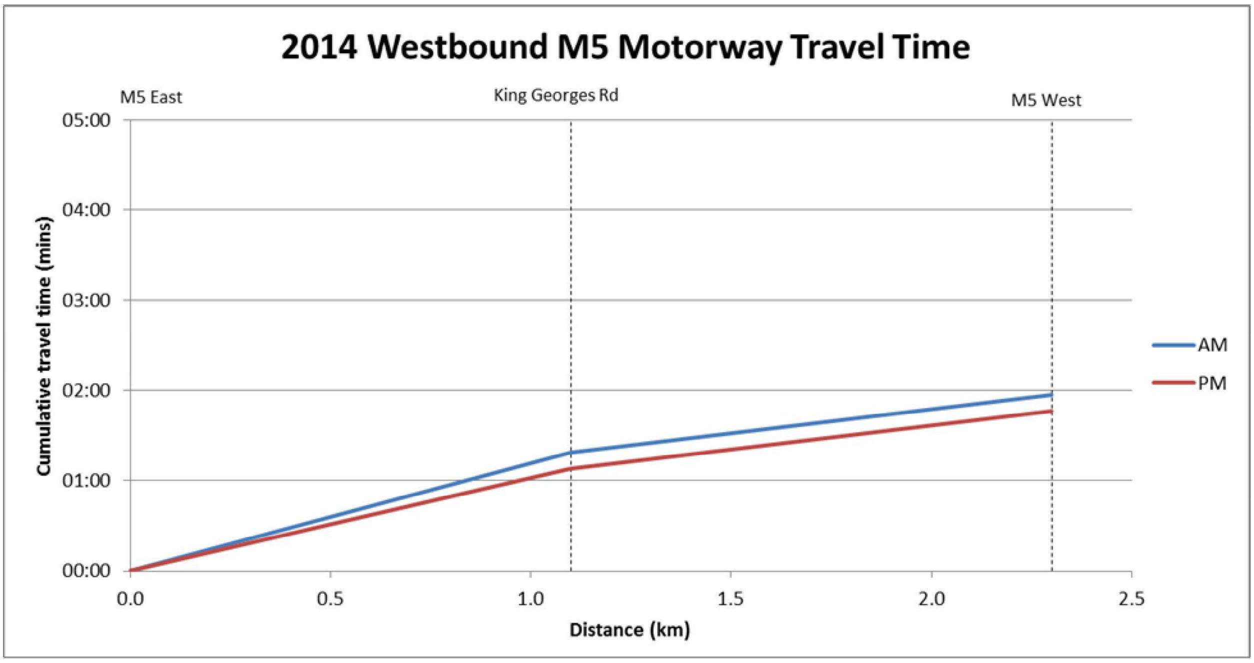

Figure 6-6: M5 Motorway westbound modelled travel time 2014

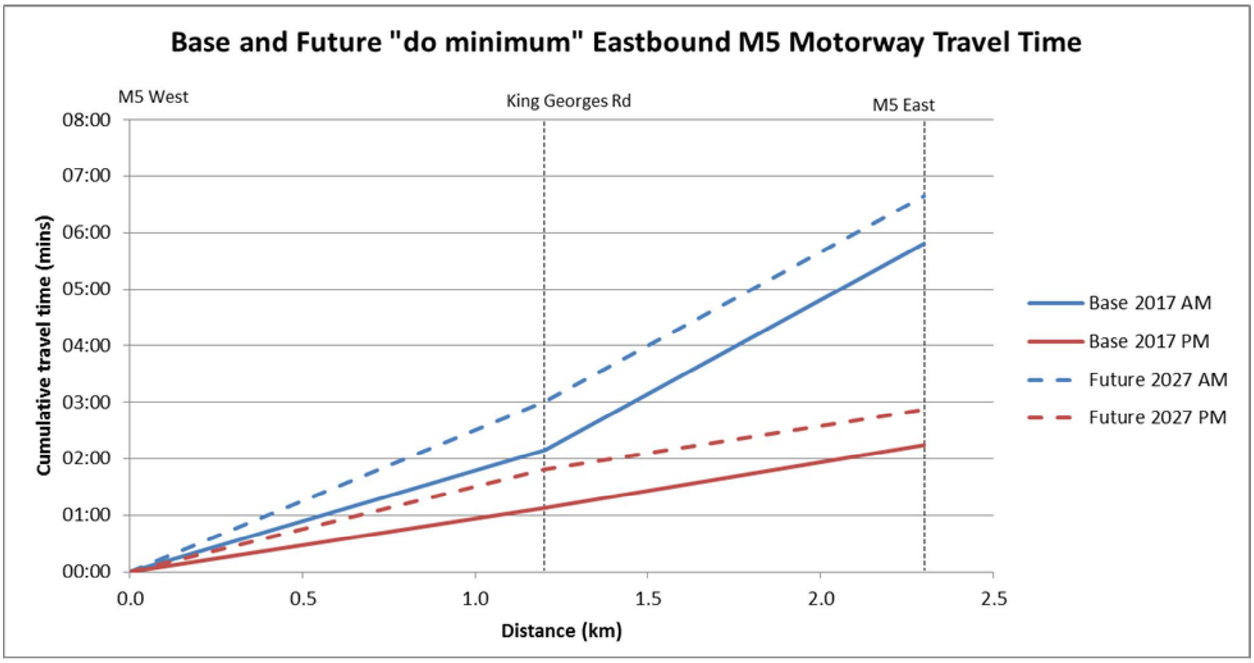

Figure 6-7 : Base and Future “do minimum” eastbound M5 Motorway modelled travel time

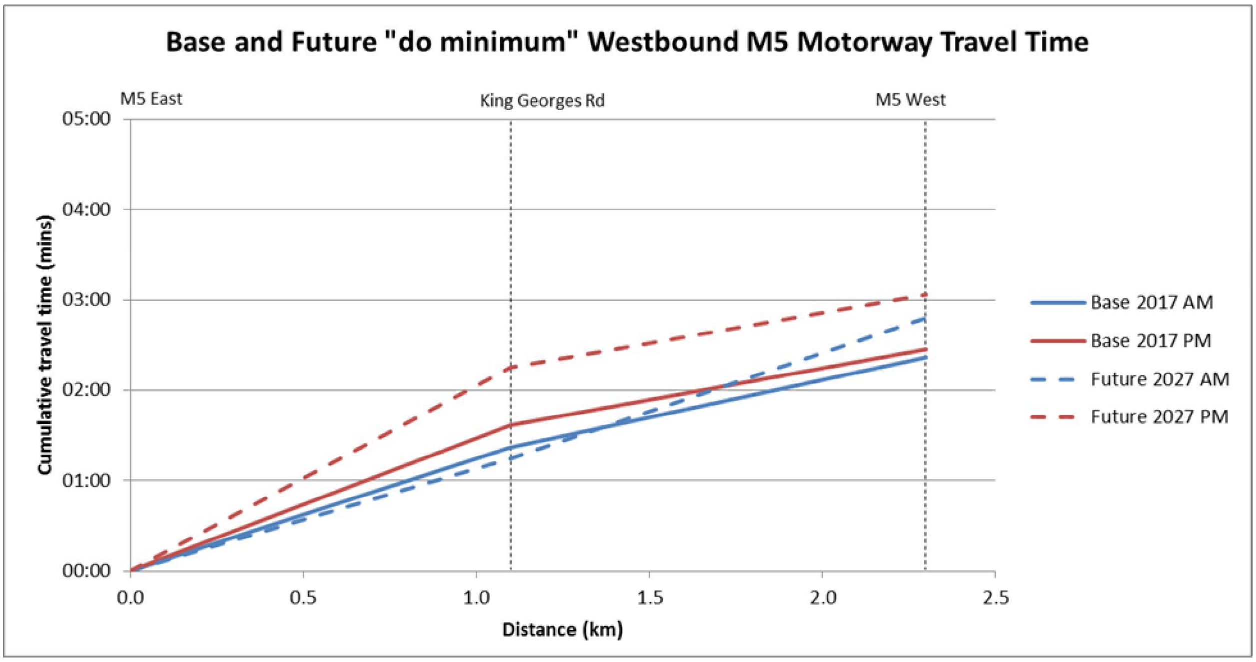

Figure 6-8 : Base and Future “do minimum” westbound M5 Motorway modelled travel time

6.6 Interchange and intersection performance

The assessment of interchange and intersection performance is based on criteria outlined in **Table 4-3**, as defined by *Guide to Traffic Generating Developments* (Roads and Traffic Authority 2002). The average delay assessed for signalised intersections is for all movements, and is expressed in seconds per vehicle. It is generally accepted that in the long term (15 years plus), when future conditions have been taken into account, LoS should be D or better. In the short term, intersections should be operating at LoS C or better.

In assessment of intersection performance in the future without the project, the analysis is based on modelled traffic volumes as opposed to the actual traffic counts used to assess existing operations (refer to **section 4.4**). The modelled trip distribution may differ from actual counts, within the tolerances allowed in the modelling process, resulting in variations in operational performance from those obtained for the existing network assessment. The assessment of interchange and intersection performance using forecast future traffic volumes without the project is undertaken to provide a base case against which to evaluate the impact of the project under the same forecast future traffic conditions.

The results of the assessment are presented in **Table 6-7** and **Table 6-8**.

These tables show that intersection performance will continue to worsen under the do minimum scenario. The M5 Motorway/King Georges Road interchange will degrade to level of service F by 2027 in both the AM and PM peaks. Other intersections which will perform unsatisfactorily by 2027 include King Georges Road at Canterbury Road and Stoney Creek Road in both the AM peak and PM peak. Furthermore, King Georges Road/Broad Arrow Road will perform at level of service F in the PM peak.

Table 6-7: Operational performance of intersections - AM peak (Existing, Base and Future 'do minimum')

Scenario	2014 AM		2017 AM		2027 AM	
	Level of service	Average delay per vehicle (seconds)	Level of service	Average delay per vehicle (seconds)	Level of service	Average delay per vehicle (seconds)
King Georges Road/Canterbury Road	F	89.2	F	109.5	F	>140.0
King Georges Road/Roselands Drive	B	27.6	B	24.5	B	19.3
King Georges Road/Moorefields Road	D	48.9	D	47.6	B	26.5
King Georges Road/M5 Motorway	E	59.4	F	74.8	F	82.7
King Georges Road/Shorter Avenue	D	46.4	F	75.4	F	78.6
King Georges Road/Broad Arrow Road	C	38.3	C	38.5	F	94.6
King Georges Road/Morgan Street	B	22.5	B	19.9	B	17.7
King Georges Road/Stoney Creek Road	F	82.0	F	93.7	F	128.8

Table 6-8: Operational performance of intersections - PM peak (Existing, Base and Future 'do minimum')

Scenario	2014 PM		2017 PM		2027 PM	
	Level of service	Average delay per vehicle (seconds)	Level of service	Average delay per vehicle (seconds)	Level of service	Average delay per vehicle (seconds)
King Georges Road/Canterbury Road	F	71.6	F	>140.0	F	>140.0
King Georges Road/Roselands Drive	C	29.7	C	30.6	B	22.1
King Georges Road/Moorefields Road	B	17.4	B	17.4	B	26.5
King Georges Road/Shorter Avenue	C	31.5	D	44.1	D	47.7
King Georges Road/M5 Motorway	E	56.9	F	72.6	F	81.4
King Georges Road/Broad Arrow Road	F	87.6	F	80.5	F	88.4
King Georges Road/Morgan Street	D	45.4	D	44.7	D	47.8
King Georges Road/Stoney Creek Road	F	75.6	F	74.5	F	128.6

6.7 Midblock performance

Midblock performance has been measured by comparing posted free flow speed to modelled speed at several locations in the study area. This gives an indication of how well traffic is able to proceed through these locations as well as how much delay is being experienced. **Table 6-9** and **Table 6-10** outline midblock performance for the do minimum scenarios in the AM and PM peaks.

2027 results indicate that key locations in the study will experience worsening performance under the do minimum scenario. IN the AM peak, eastbound congestion on the M5 Motorway will propagate back past Penshurst Road with this location going from level of service A in 2014 to level of service F by 2027. All eastbound M5 motorway locations will operate at level of service F by 2027 under the do minimum scenario in the AM peak.

PM peak results also demonstrate unsatisfactory midblock performance under the 2027 do minimum scenario. Westbound traffic on the M5 Motorway experiences significant performance degradation with the westbound off ramp moving from level of service B in 2014 to level of service E in 2027.

Table 6-9: Midblock performance - AM peak (Existing, Base and Future 'do minimum')

		2014 AM		2017 AM		2027 AM	
		% of free flow	LOS	% of free flow	LOS	% of free flow	LOS
M5 East Motorway (East of Coolangatta Road)	EB	12%	F	13%	F	13%	F
	WB	71%	B	74%	B	77%	B
M5 South West Motorway (West of Penshurst Road)	EB	100%	A	46%	D	14%	F
	WB	96%	A	97%	A	96%	A
M5 East Motorway (Eastbound On Ramp)	EB	7%	F	7%	F	7%	F
	WB	-	-	-	-	-	-
M5 East Motorway (Westbound Off Ramp)	EB	-	-	-	-	-	-
	WB	91%	A	88%	A	100%	A
M5 South West Motorway (Eastbound Off Ramp)	EB	100%	A	100%	A	100%	A
	WB	-	-	-	-	-	-
M5 South West Motorway (Westbound On Ramp)	EB	-	-	-	-	-	-
	WB	70%	B	70%	B	69%	B
King Georges Road (South of Moorefield Road)	NB	95%	A	95%	A	95%	A
	SB	18%	F	13%	F	22%	F
King Georges Road (North of Broad Arrow Road)	NB	80%	B	85%	B	87%	A
	SB	80%	A	76%	B	77%	B

Table 6-10: Midblock performance - PM peak (Existing, Base and Future 'do minimum')

		2014 PM		2017 PM		2027 PM	
		% of free flow	LOS	% of free flow	LOS	% of free flow	LOS
M5 East Motorway (East of Coolangatta Road)	EB	63%	C	64%	C	64%	C
	WB	71%	B	70%	B	51%	C
M5 South West Motorway (West of Penshurst Road)	EB	100%	A	97%	A	62%	C
	WB	98%	A	95%	A	97%	A
M5 East Motorway (Eastbound On Ramp)	EB	59%	C	64%	C	67%	B
	WB	-	-	-	-	-	-
M5 East Motorway (Westbound Off Ramp)	EB	-	-	-	-	-	-
	WB	79%	B	79%	B	31%	E
M5 South West Motorway (Eastbound Off Ramp)	EB	100%	A	100%	A	39%	E
	WB	-	-	-	-	-	-
M5 South West Motorway (Westbound On Ramp)	EB	-	-	-	-	-	-
	WB	70%	B	64%	C	63%	C
King Georges Road (South of Moorefield Road)	NB	86%	A	75%	B	78%	B
	SB	51%	C	51%	C	44%	D
King Georges Road (North of Broad Arrow Road)	NB	91%	A	85%	A	88%	A
	SB	28%	F	30%	F	12%	F

6.8 Queueing at M5 Motorway exit ramps

Queue lengths at the M5 Motorway exit ramps have been presented for 2014 in **Table 4-9**.

Table 6-11 and **Table 6-12** below show the modelled queue lengths for the Existing case (2014), Base (2017) and Future (2027) 'do minimum' scenarios. As traffic volumes increase the queue lengths at both exit ramps to the King Georges Road interchange would increase without the project.

Table 6-11: Queue length on M5 Motorway exit ramps in the AM peak

	7-8am		8-9am	
Scenario	Eastbound exit Ramp	Westbound exit Ramp	Eastbound exit Ramp	Westbound exit Ramp
Existing case 2014	286	381	209	451
2017	371	243	382	321
2027	610	440	424	450

Table 6-12: Queue length on M5 Motorway exit ramps in the PM peak

	4-5pm		5-6pm	
Scenario	Eastbound exit Ramp	Westbound exit Ramp	Eastbound exit Ramp	Westbound exit Ramp
Existing case 2014	246	288	295	312
2017	340	389	433	321
2027	478	536	868	593

7 Effects of the King Georges Road Interchange Upgrade project

7.1 Network and corridor performance

It is advised that this network and corridor results are assessed from the Paramics models simulations. The models have taken account of actual demand attempting to make that movement which means that the traffic volume outputs reflect the traffic that arrives at the intersection not the total demand flow. Upstream queued flow not arriving at the various intersections may be significant when the network experiences severe congestion.

Network performance

Table 7-1: Study area network performance, Future scenarios

scenario	AM peak (2 hours)			PM peak (2 hours)		
	VKT (km)	VHT (hrs)	Average Speed (km/h)	VKT (km)	VHT (hrs)	Average Speed (km/h)
2017 ('do minimum')	110,981.2	5,616.6	19.8	117,021.7	5,275.5	22.2
2017 (Project)	110,468.7	5,308.3	20.8	129,253.2	5,525.4	23.4
2027 ('do minimum')	95,873.4	10,075.3	9.5	112,968.6	10,635.2	10.6
2027 (Full WestConnex)	133,441.9	7,635.3	17.5	128,917.7	7,705.7	16.7

Source: Paramics Traffic Model, 2014

Table 7-1 demonstrates that overall demand on the study road network is set to continue to grow strongly. It also shows that without the project, network performance will continue to decrease with average speeds in 2027 falling to approximately 10km/h in both the AM and PM do minimum scenarios.

With the King Georges Road Interchange Upgrade project completed, average speeds on the network are maintained at higher level.

Corridor performance

The growth in the use of the M5 Motorway corridor and King Georges Road is summarised in **Table 7-2** and **Table 7-3.**

Table 7-2: Corridor performance in the M5 Motorway corridor between Cooloongatta Road and Penhurst Road

scenario	AM peak (2 hours)			PM peak (2 hours)		
	VKT (km)	VHT (hrs)	Average Speed (km/h)	VKT (km)	VHT (hrs)	Average Speed (km/h)
2017 ('do minimum')	1,444.9	42.0	34.4	1,069.4	22.6	47.4
2017 (Project)	1,431.3	39.9	35.9	1,071.5	21.7	49.4
2027 ('do minimum')	1,617.4	52.1	31.1	1,362.5	34.4	39.6
2027 (Full WestConnex)	1,958.2	49.6	39.4	1,429.9	30.6	46.7

Source: Paramics Traffic Model, 2014

Table 7-3: Corridor performance in the King Georges Road between Moorefields Road and Broad Arrow Road

scenario	AM peak (2 hours)			PM peak (2 hours)		
	VKT (km)	VHT (hrs)	Average Speed (km/h)	VKT (km)	VHT (hrs)	Average Speed (km/h)
2017 ('do minimum')	536.8	23.4	23.0	432.1	14.5	29.9
2017 (Project)	522.8	22.1	23.6	425.7	14.1	30.1
2027 ('do minimum')	584.7	27.7	21.1	441.5	16.4	27.0
2027 (Full WestConnex)	561.3	19.6	28.7	421.0	12.5	33.6

Source: Paramics Traffic Model, 2014

It is apparent that performance under project conditions is better than under the 'do minimum' scenarios. The performance of the fully completed WestConnex scenario in 2027 is better than the Base 'do minimum' scenario despite the increased traffic demand expected over that 10 year period.

7.2 Future traffic flows

Forecast traffic flows for 2017 and 2027 scenarios are presented in **Table 7-4** and **Table 7-5**. Flows for 2 hour peaks in the AM and PM are presented as well as the expected average daily traffic (ADT) flows for each location.

Flows in the 2017 Project scenario are seen to be generally higher than under the do minimum scenario. Increased capacity in the Project scenario allows for more vehicles to access the network without impacting on network performance.

Table 7-4: Forecast traffic flows, 2017

Road	Direction	2017 'do minimum'			2017 Project		
		AM Peak	PM Peak	ADT	AM Peak	PM Peak	ADT
M5 Motorway (East of KGR)	EB	4,875	5,815	42,210	5,146	5,866	43,083
	WB	6,589	6,774	47,942	6,611	7,075	49,065
	Total	11,464	12,589	90,152	11,757	12,941	92,148
M5 Motorway (West of KGR)	EB	5,042	5,713	42,387	5,121	5,943	43,224
	WB	5,841	6,043	44,274	5,804	6,402	45,440
	Total	10,883	11,756	86,661	10,926	12,345	88,664
M5 Eastbound (Exit ramp)	EB	1,627	1,912	9,849	1,616	2,099	10,339
	WB	-	-	-	-	-	-
	Total	1,627	1,912	9,849	1,616	2,099	10,339
M5 Eastbound (Entry ramp)	EB	1,460	2,014	9,672	1,641	2,022	10,198
	WB	-	-	-	-	-	-
	Total	1,460	2,014	9,672	1,641	2,022	10,198
M5 Westbound (Exit ramp)	EB	-	-	-	-	-	-
	WB	2,213	2,442	13,025	2,225	2,752	13,926
	Total	2,213	2,442	13,025	2,225	2,752	13,926
M5 Westbound (Entry ramp)	EB	-	-	-	-	-	-
	WB	1,465	1,712	9,357	1,419	2,079	10,301
	Total	1,465	1,712	9,357	1,419	2,079	10,301

Table 7-5: Forecast traffic flows, 2027

Road	Direction	2027 'do minimum			2027 Full WestConnex		
		AM Peak (2-hr)	PM Peak (2-hr)	ADT	AM Peak (2-hr)	PM Peak (2-hr)	ADT
M5 Motorway (East of KGR)	EB	5,067	5,891	42,640	5,814	7,143	46,601
	WB	7,287	6,238	49,035	7,161	5,728	49,256
	Total	12,353	12,129	91,675	12,975	12,871	95,857
M5 Motorway (West of KGR)	EB	5,417	6,157	44,355	6,092	7,219	47,585
	WB	6,467	5,296	44,575	6,497	5,023	45,990
	Total	11,884	11,453	88,930	12,589	12,243	93,575
M5 Eastbound (Exit ramp)	EB	1,954	2,030	11,089	2,256	2,330	12,765
	WB	-	-	-	-	-	-
	Total	1,954	2,030	11,089	2,256	2,330	12,765
M5 Eastbound (Entry ramp)	EB	1,603	1,763	9,374	1,978	2,253	11,781
	WB	-	-	-	-	-	-
	Total	1,603	1,763	9,374	1,978	2,253	11,781
M5 Westbound (Exit ramp)	EB	-	-	-	-	-	-
	WB	2,457	2,512	13,904	2,511	2,694	14,562
	Total	2,457	2,512	13,904	2,511	2,694	14,562
M5 Westbound (Entry ramp)	EB	-	-	-	-	-	-
	WB	1,637	1,570	9,444	1,846	1,989	11,296
	Total	1,637	1,570	9,444	1,846	1,989	11,296

7.3 Travel times

Travel time results are shown below comparing the Base 'do minimum' scenario with the Project scenarios in 2017. Results are shown in **Figure 7-1** to **Figure 7-5** and **Table 7-6**

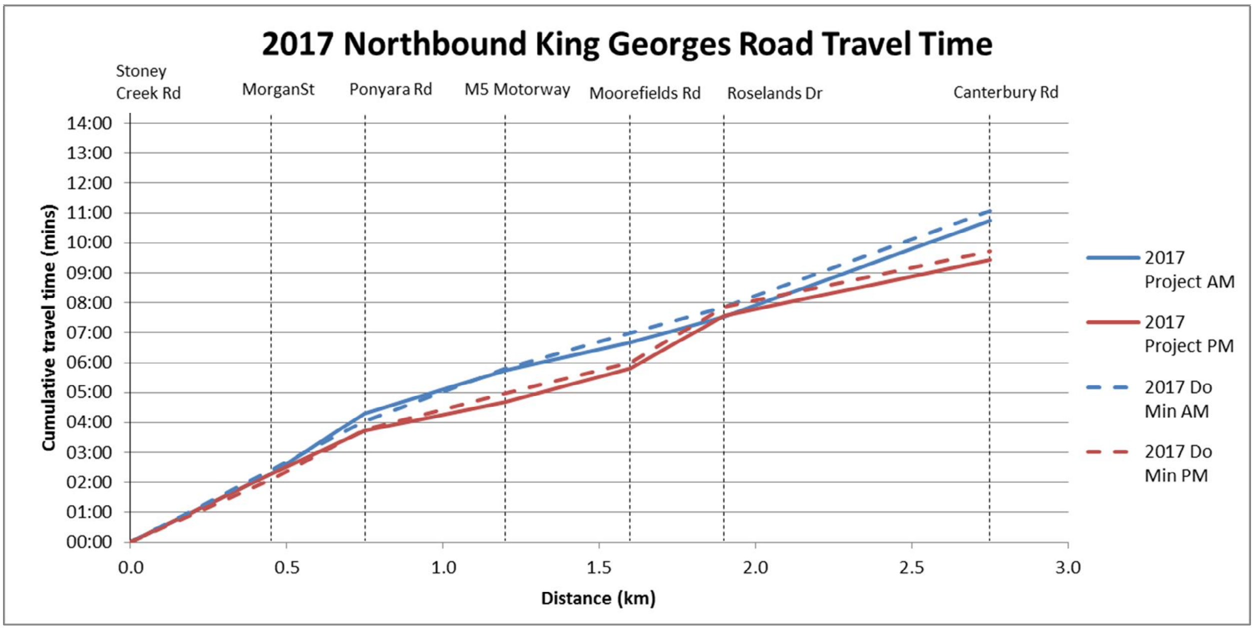

Figure 7-1: Base 'do minimum' and Project (2017) King Georges Road northbound travel time

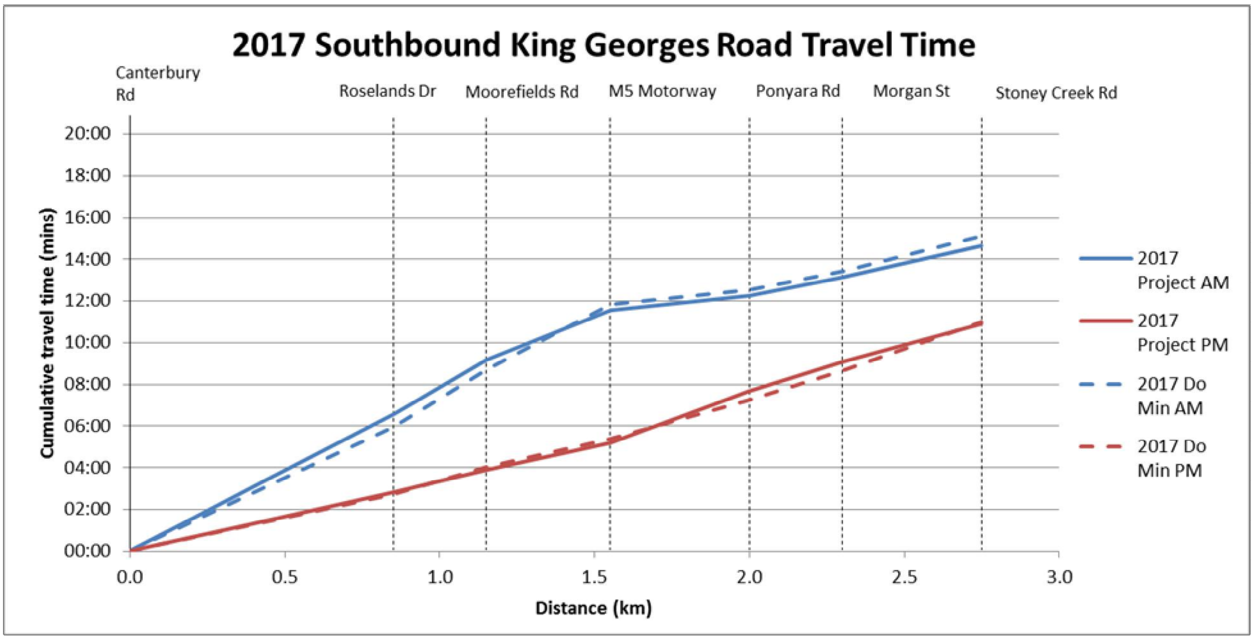

Figure 7-2: Base 'do minimum' and Project (2017) King Georges Road southbound travel time

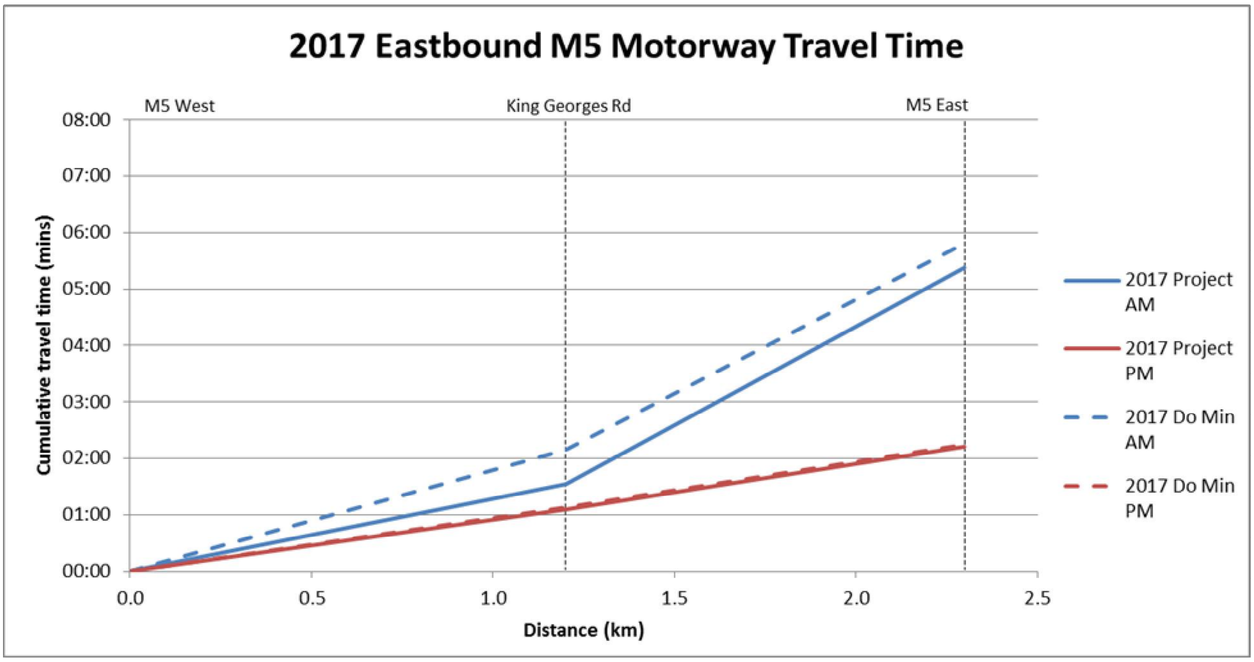

Figure 7-3: Base 'do minimum' and Project (2017) M5 Motorway eastbound travel time

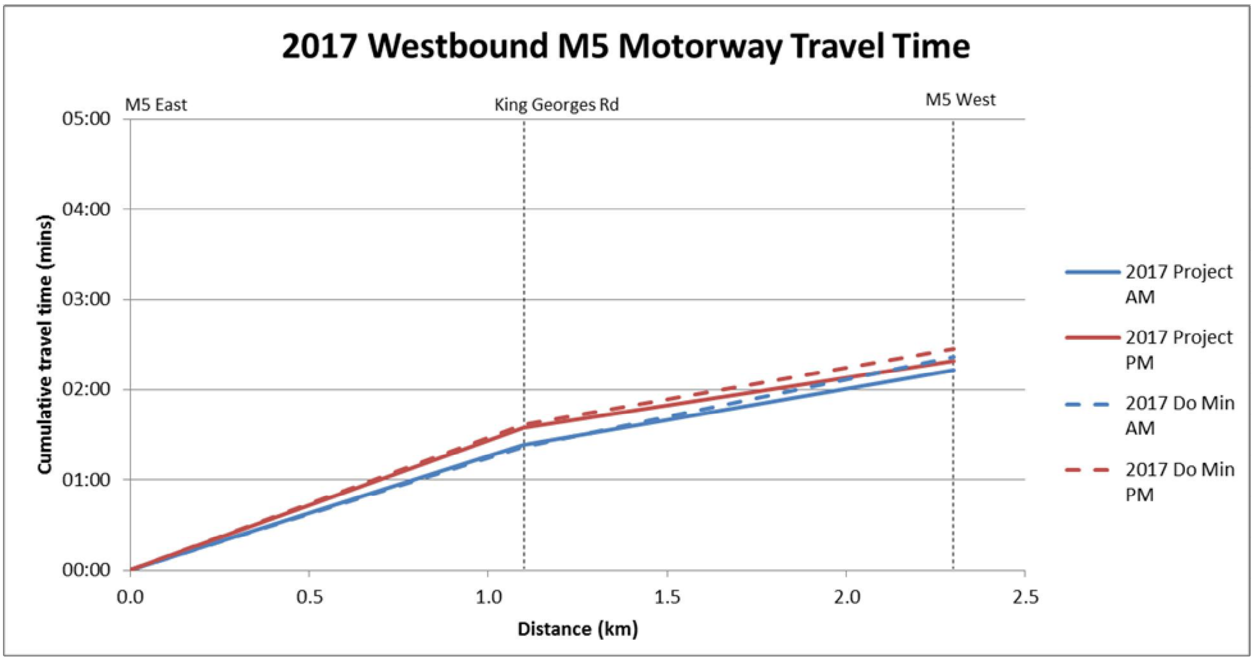

Figure 7-4: Base 'do minimum' and Project (2017) M5 Motorway westbound travel time

The travel time results for the King Georges Road Interchange Upgrade project compared to the Base 'do minimum scenario are summarised in **Table 7-6**. The travel time results for 2017 show improvement for all routes under the Project scenario compared to 'do minimum' scenario. Eastbound M5 Motorway travel times in the AM peak show the most improvement, demonstrating decreased congestion for this route with the project implemented.

Table 7-6: 2017 travel times

Route	2017 'do minimum'		2017 With project	
	AM	PM	AM	PM
King Georges Road Northbound (between Stoney Creek Road and Canterbury Road)	11:03	09:43	10:44	09:25
King Georges Road Southbound (between Canterbury Road and Stoney Creek Road)	15:06	11:01	14:39	10:55
M5 Motorway Eastbound (between West of Penshurst Road and East of Coolangatta Road)	05:49	02:15	05:23	02:12
M5 Motorway Westbound (between East of Coolangatta Road and West of Penshurst Road)	02:22	02:27	02:13	02:19

Travel time results are shown below comparing the Future 'do minimum' scenario with the fully completed WestConnex scenarios in 2027. Results are shown in **Figure 7-5** to **Figure 7-8** and **Table 7-6** and **Table 7-7**

The travel time results for the fully completed WestConnex in 2027 show significant improvement compared to the Future 'do minimum' scenario. King Georges Road northbound travel times decrease by approximately 3 minutes in both the AM and PM peak periods.

With the project and WestConnex implemented, southbound King Georges Road traffic would experience travel time savings of approximately 4 minutes in the AM and 5 minutes in the PM.

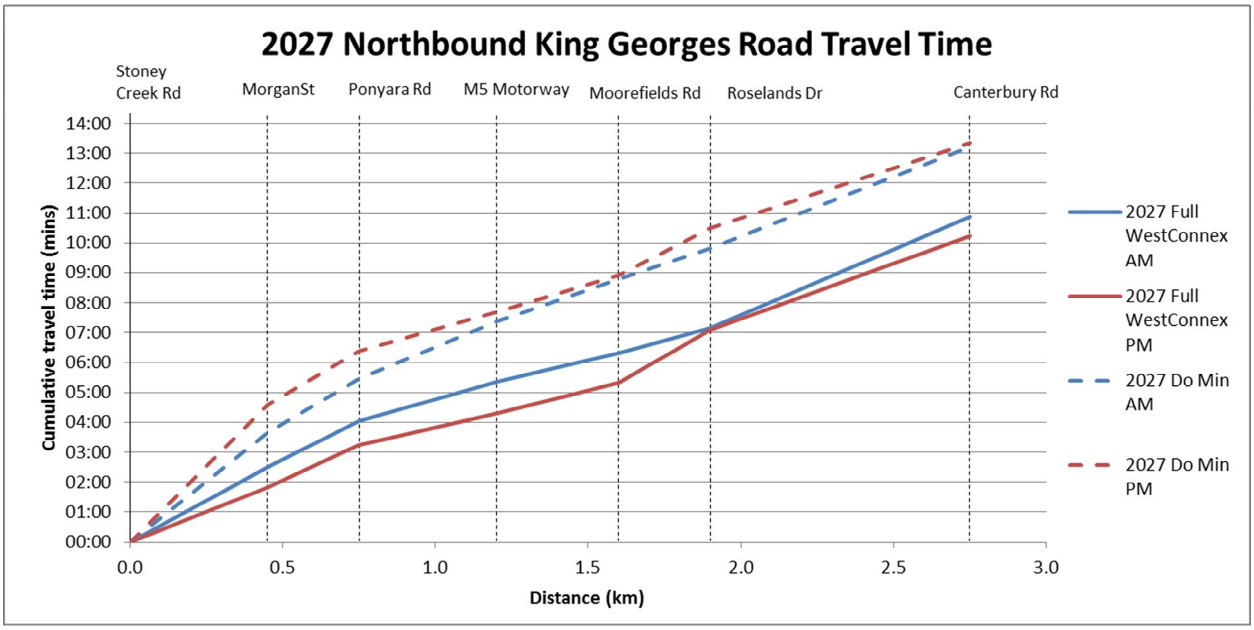

Figure 7-5: Future 'do minimum' and Full WestConnex (2027) King Georges Road northbound travel time

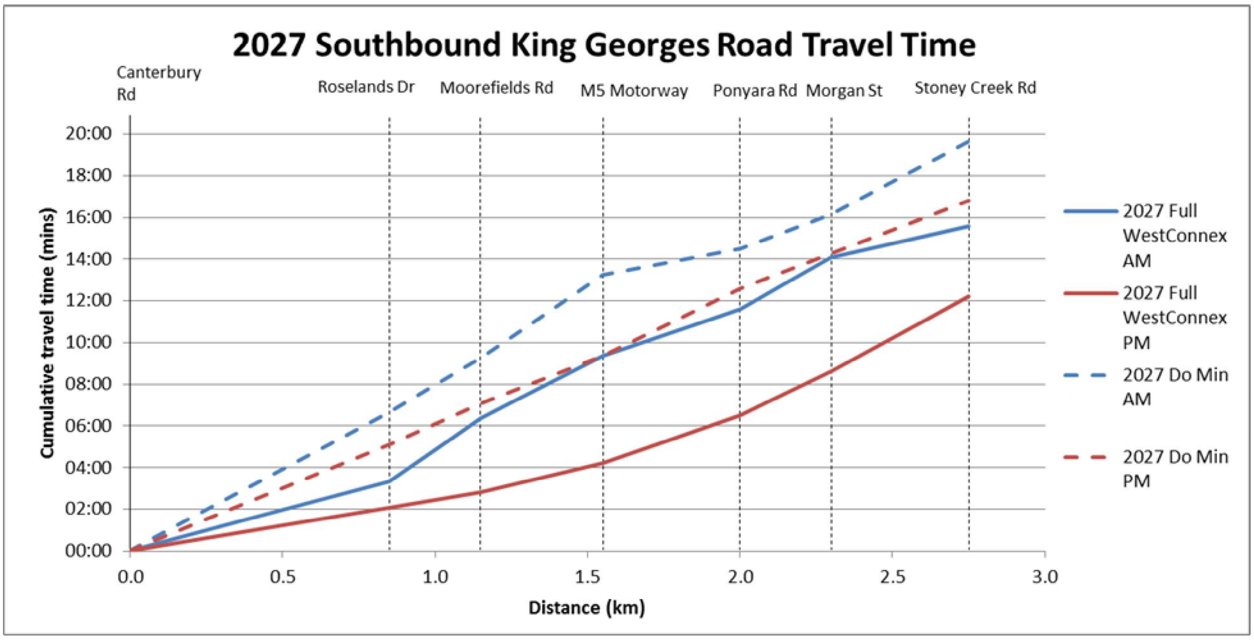

Figure 7-6: Future ‘do minimum’ and Full WestConnex (2027) King Georges Road southbound travel time

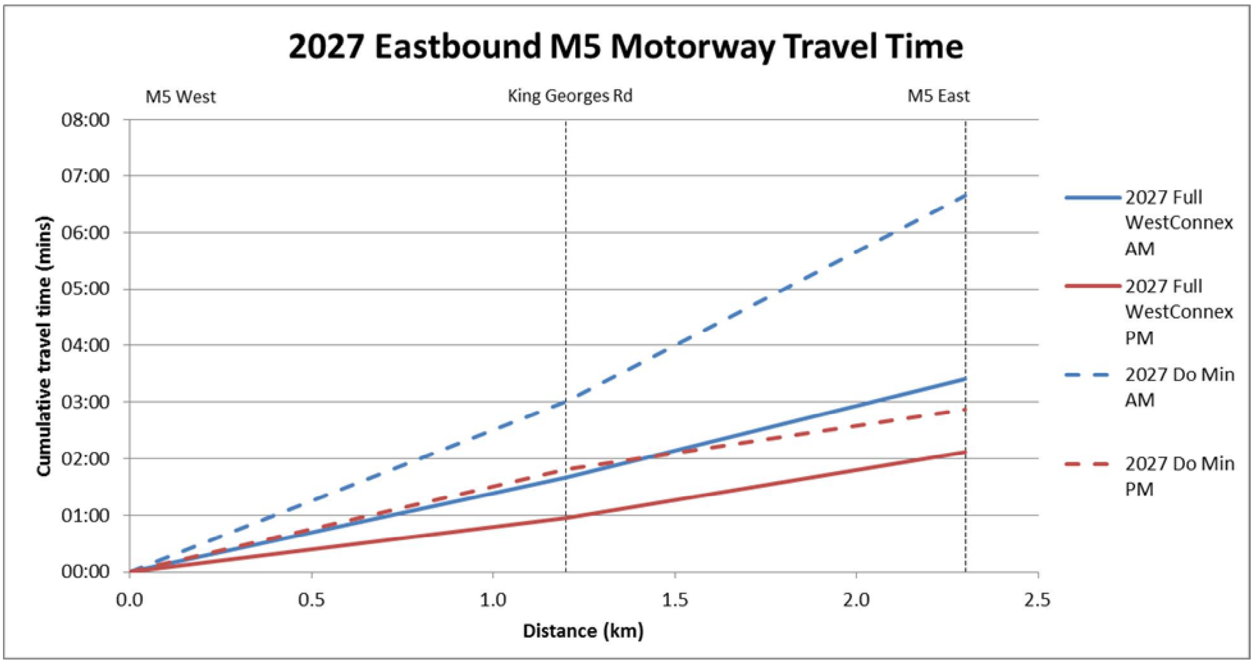

Figure 7-7: Future ‘do minimum’ and Full WestConnex (2027) M5 Motorway eastbound travel time

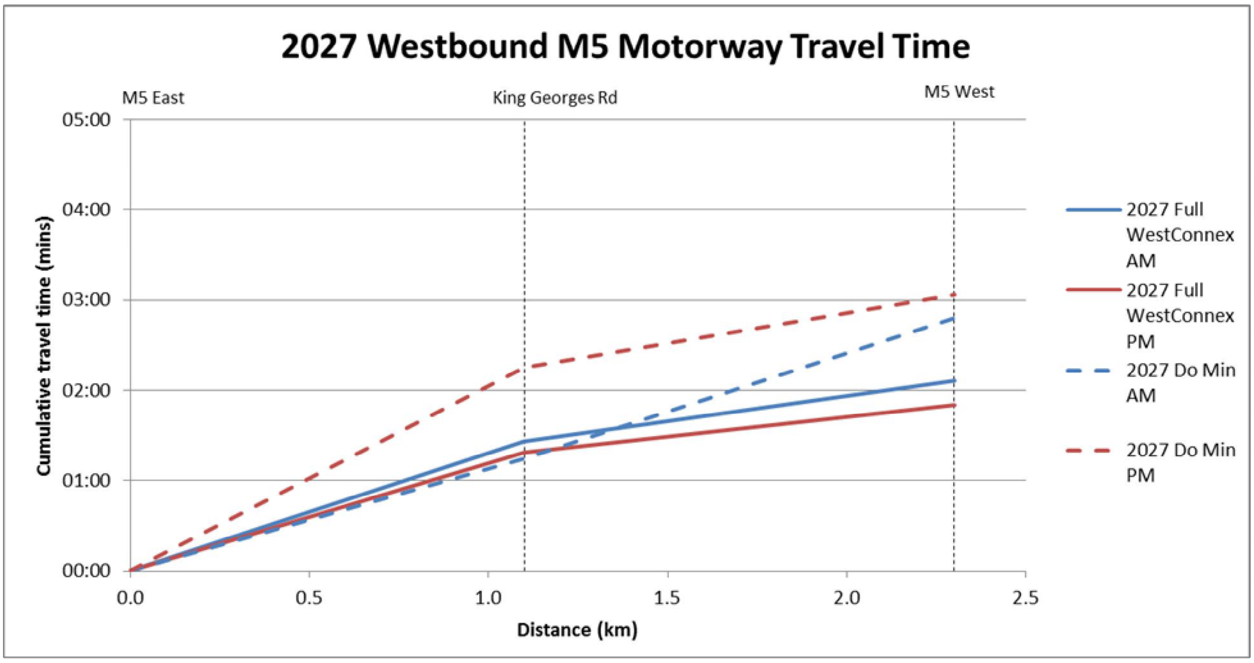

Figure 7-8: Future 'do minimum' and Full WestConnex (2027) M5 Motorway eastbound travel time

The travel time results for the fully completed WestConnex compared to the Future 'do minimum scenario are summarised in **Table 7-7**. The travel time results for 2027 show improvement for all routes under the Full WestConnex scenario compared to the Future 'do minimum' scenario. Eastbound M5 Motorway travel times in the AM peak show the most improvement, demonstrating decreased congestion for this route with the project implemented. The AM peak experiences travel time reductions of more than 50% in the Full WestConnex scenario whilst PM savings are also observed.

Westbound M5 Motorway travel times also experience a reduction under the Full WestConnex scenario with savings of approximately 30% in both the AM and PM peaks.

Table 7-7: 2027 travel times

Route	2027 'do minimum'		2027 Full WestConnex	
	AM	PM	AM	PM
King Georges Road Northbound (between Stoney Creek Road and Canterbury Road)	13:13	13:20	10:53	10:14
King Georges Road Southbound (between Canterbury Road and Stoney Creek Road)	19:39	16:49	15:34	12:13
M5 Motorway Eastbound (between West of Penshurst Road and East of Coolangatta Road)	06:39	02:52	03:24	02:08
M5 Motorway Westbound (between East of Coolangatta Road and West of Penshurst Road)	02:48	03:04	02:07	01:50

7.4 Interchange and intersection performance

The assessment of interchange and intersection performance is based on criteria outlined in **Table 4-2**, as defined by *Guide to Traffic Generating Developments* (Roads and Traffic Authority 2002). The average delay assessed for signalised intersections is for all movements, and is expressed in seconds per vehicle. It is generally accepted that in the long term (15 years plus), when future conditions have been taken into account, LoS should be D or better. In the short term, intersections should be operating at LoS C or better.

The traffic volumes used for the intersection analysis in this section have been taken from the WestConnex Road Traffic Model (WRTM). Results are shown for the same interchanges and intersections as assessed in Chapters 4 and 6 for the present and future base scenarios, respectively.

In this scenario, the analysis is based on modelled traffic volumes as opposed to the actual traffic counts used to assess existing operations (refer to **section 4.4**). The modelled trip distribution may differ from actual counts, within the tolerances allowed within the model, resulting in variations in operational performance from those obtained for the existing network assessment. The assessment of interchange and intersection performance using forecast future traffic volumes without the project (refer to **section 6.6**) is undertaken to provide a base case against which to evaluate the impact of the project under the same forecast future traffic conditions. **Table 7-8** and **Table 7-9** outline intersection performance for 2017 scenarios.

The operational performance of intersections along King Georges Road remains generally consistent across both the 'do minimum' and Project scenarios. Under project conditions, improvements are observed at the M5 Motorway interchange with average delays decreasing slightly in both the AM and PM peaks.

Table 7-8: Intersection performance, Base 'do minimum' and Project, 2017 AM peak scenarios,

Intersection	2017 'do minimum'		2017 Project	
	Level of service	Average delay per vehicle (seconds)	Level of service	Average delay per vehicle (seconds)
King Georges Road/Canterbury Road	F	109.5	F	116.5
King Georges Road/Roselands Drive	B	24.5	D	43.6
King Georges Road/Moorefields Road	D	47.6	E	65.1
King Georges Road/M5 Motorway	F	74.8	F	71.4
King Georges Road/Broad Arrow Road	C	38.5	C	36.5
King Georges Road/Morgan Street	B	19.9	B	16.2
King Georges Road/Stoney Creek Road	F	93.7	F	86.9
King Georges Road/Shorter Avenue	F	75.4	E	66.4

Table 7-9 Intersection performance, Base 'do minimum' and Project, 2017 PM peak scenarios,

Intersection	2017 'do minimum'		2017 Project	
	Level of service	Average delay per vehicle (seconds)	Level of service	Average delay per vehicle (seconds)
King Georges Road/Canterbury Road	F	143.0	F	130.8
King Georges Road/Roselands Drive	C	30.6	C	31.5
King Georges Road/Moorefields Road	B	17.4	B	18.1
King Georges Road/M5 Motorway	F	72.6	F	71.0
King Georges Road/Broad Arrow Road	F	80.5	F	72.6
King Georges Road/Morgan Street	D	44.7	C	35.7
King Georges Road/Stoney Creek Road	F	74.5	F	79.2
King Georges Road/Shorter Avenue	D	44.1	C	36.9

Table 7-10 and **Table 7-11** outline the intersection performance for 2027 scenarios.

The operational performance of intersections along King Georges Road is generally improved with the fully completed WestConnex in 2027 compared to the 'do minimum' scenarios. The M5 Motorway interchange experiences significant improvement in the PM peak. Some increased performance is also observed in the AM peak. These improvements occur despite the increased traffic demand that will arise under the Full WestConnex scenario.

Table 7-10: Interchange and intersection performance, Future 'do minimum' and 'Full WestConnex' scenarios, AM peak

Intersection	2027 'do minimum'		2027 'Full WestConnex'	
	Level of service	Average delay per vehicle (seconds)	Level of service	Average delay per vehicle (seconds)
King Georges Road/Canterbury Road	F	>140	F	129.3
King Georges Road/Roselands Drive	B	19.3	B	20.3
King Georges Road/Moorefields Road	B	26.5	B	23.7
King Georges Road/M5 Motorway	F	82.7	F	73.5
King Georges Road/Broad Arrow Road	F	94.6	F	88.4
King Georges Road/Morgan Street	B	17.7	B	19.8
King Georges Road/Stoney Creek Road	F	128.8	F	113.0
King Georges Road/Shorter Avenue	F	78.6	C	42.7

Table 7-11: Interchange and intersection performance Future 'do minimum' and 'Full WestConnex' scenarios, PM peak

Intersection	2027 'do minimum'		2027 'Full WestConnex'	
	Level of service	Average delay per vehicle (seconds)	Level of service	Average delay per vehicle (seconds)
King Georges Road/Canterbury Road	F	>140	F	>140
King Georges Road/Roselands Drive	D	52.1	C	33.6
King Georges Road/Moorefields Road	B	26.5	B	18.8
King Georges Road/M5 Motorway	F	81.4	E	65.4
King Georges Road/Broad Arrow Road	F	88.4	F	88.0
King Georges Road/Morgan Street	D	47.8	D	51.0
King Georges Road/Stoney Creek Road	F	128.6	F	105.4
King Georges Road/Shorter Avenue	D	47.7	B	25.9

7.5 Midblock performance

Table 7-12 and **Table 7-13** outline the midblock performance of do minimum and Project scenarios for both 2017 and 2027.

2017 Project results are generally similar or slightly improved compared to the do minimum scenario. Westbound M5 Motorway performance is increased in both the AM and PM peaks under project conditions. Westbound on ramp performance is also improved compared to the do minimum scenario.

2027 Full WestConnex results show significant improves compared to the 'do minimum' scenarios. All M5 Motorway locations operate at level of service C or better in the AM and PM peaks in the Full WestConnex scenarios. This is a large improvement compared to the 'do minimum' scenarios, particularly for the main M5 Motorway carriageway which would operate at level of service F in both directions in the AM 'do minimum' scenario.

Table 7-12: Midblock performance (2017 Future 'do minimum' and Project scenarios)

		2017 'do minimum'				2017 Project			
		AM		PM		AM		PM	
		% free flow	LOS	% free flow	LOS	% free flow	LOS	% free flow	LOS
M5 East Motorway (East of Coolangatta Road)	EB	13%	F	64%	C	9%	F	61%	C
	WB	74%	B	70%	B	100%	A	95%	A
M5 South West Motorway (West of Penshurst Road)	EB	46%	D	97%	A	100%	A	98%	A
	WB	97%	A	95%	A	100%	A	100%	A
M5 East Motorway (Eastbound On Ramp)	EB	7%	F	64%	C	2%	F	60%	C
	WB	-	-	-	-	-	-	-	-
M5 East Motorway (Westbound Off Ramp)	EB	-	-	-	-	-	-	-	-
	WB	88%	A	79%	B	82%	B	65%	C
M5 South West Motorway (Eastbound Off Ramp)	EB	100%	A	100%	A	100%	A	100%	A
	WB	-	-	-	-	-	-	-	-
M5 South West Motorway (Westbound On Ramp)	EB	-	-	-	-	-	-	-	-
	WB	70%	B	64%	C	70%	B	70%	B
King Georges Road (South of Moorefield Road)	NB	95%	A	75%	B	96%	A	79%	B
	SB	13%	F	51%	C	13%	F	49%	D
King Georges Road (North of Broad Arrow Road)	NB	85%	B	85%	A	87%	A	86%	A
	SB	76%	B	30%	F	81%	B	19%	F

Table 7-13: Midblock performance (2027 Future 'do minimum' and Full WestConnex scenarios)

		2027 'do minimum'				2027 Full WestConnex			
		AM		PM		AM		PM	
		% free flow	LOS	% free flow	LOS	% free flow	LOS	% free flow	LOS
M5 East Motorway (East of Coolangatta Road)	EB	13%	F	68%	B	60%	C	59%	C
	WB	77%	B	51%	C	100%	A	100%	A
M5 South West Motorway (West of Penshurst Road)	EB	14%	F	62%	C	100%	A	100%	A
	WB	96%	A	97%	A	100%	A	100%	A
M5 East Motorway (Eastbound On Ramp)	EB	7%	F	67%	B	74%	B	75%	B
	WB	-	-	-	-	-	-	-	-
M5 East Motorway (Westbound Off Ramp)	EB	-	-	-	-	-	-	-	-
	WB	100%	A	31%	E	69%	B	100%	A
M5 South West Motorway (Eastbound Off Ramp)	EB	100%	A	39%	E	100%	A	100%	A
	WB	-	-	-	-	-	-	-	-
M5 South West Motorway (Westbound On Ramp)	EB	-	-	-	-	-	-	-	-
	WB	69%	B	63%	C	69%	B	69%	B
King Georges Road (South of Moorefield Road)	NB	95%	A	89%	A	93%	A	53%	C
	SB	22%	F	44%	D	58%	C	62%	C
King Georges Road (North of Broad Arrow Road)	NB	87%	A	88%	A	82%	B	87%	A
	SB	37%	E	12%	F	46%	D	28%	F

7.6 Queuing at M5 Motorway exit ramps

Table 7-14 and **Table 7-15** outline the modelled queue lengths for both M5 Motorway exit ramps at the King Georges Road interchnage.

The results show that both the 2017 Project and the 2027 Full WestConnex scenarios are able to reduce exit ramp queuing compared to their corresponding ‘do minimum’ scenarios.

The Project and Full WestConnex scenarios are particularly effective at reducing queue lengths in the PM peak. All ramp queues are significantly smaller compared to the corresponding ‘do minimum’ scenarios.

Table 7-14: M5 Motorway ramps queue length, AM peak

	7-8am		8-9am	
Scenario	Eastbound Off Ramp	Westbound Off Ramp	Eastbound Off Ramp	Westbound Off Ramp
2017 ‘do minimum’	371	243	382	321
2017 Project	358	229	323	284
2027 ‘do minimum’	610	440	424	450
2027 Full WestConnex	397	396	356	374

	7-8am		8-9am	
Scenario	Eastbound Off Ramp	Westbound Off Ramp	Eastbound Off Ramp	Westbound Off Ramp
2017 ‘do minimum’	371	243	382	321
2017 Project	358	229	323	284
2027 ‘do minimum’	610	440	424	450
2027 Full WestConnex	397	396	356	374

Table 7-15: M5 Motorway ramps queue length, PM peak

	4-5pm		5-6pm	
Scenario	Eastbound Off Ramp	Westbound Off Ramp	Eastbound Off Ramp	Westbound Off Ramp
2017 ‘do minimum’	340	389	433	321
2017 Project	247	257	273	290
2027 ‘do minimum’	478	536	868	593
2027 Full WestConnex	252	215	282	239

7.7 Pedestrian and cycling impacts

The off-road pedestrian and shared paths described in **Section 3.6** would be retained. The M5 motorway would be closed to cyclists between Belmore Road and Bexley Road. Cyclists would be directed onto the shared paths or local roads at the commencement of construction works on the motorway carriageways.

Following on from the King Georges Road Interchange Upgrade project, the subsequent WestConnex M5 project will require motorway shoulders to be narrowed to accommodate the changed lane configuration and, as such, would not be suitable for use by cyclists. Consequently, all cyclists will be prohibited from riding on the motorway shoulder between Belmore Road and Bexley Road. The existing shared paths on either side of the M5 Motorway corridor will retained and provide an adequate alternative route for cyclists.

7.8 Freight vehicle movements

There is a significant freight movement between the M4 and M5 Motorways that currently use King Georges Road, Roberts Road, Centenary Drive and Homebush Bay Drive (route A3) as a north-south link between the M4 Motorway and M5 Motorway. These vehicles would benefit from the King Georges Road Interchange Upgrade through the increased ramp storage and improved merging arrangements with the M5 Motorway. These infrastructure improvements would reduce delays and improve travel times.

Furthermore, the fully completed WestConnex would also attract traffic, including heavy vehicles, that currently use King Georges Road, Roberts Road, Centenary Drive and Homebush Bay Drive (route A3) as a north-south link between the M4 Motorway and M5 Motorway by providing continuous motorway access to Sydney's east and Sydney's ports. The resulting reduction in traffic volumes on the A3 route would improve safety and reliability along these important strategic routes.

7.9 Road safety

The road safety analysis undertaken in **section 4.7** identified that approximately three-quarters of the crashes on the M5 Motorway were rear end crashes, as is common on near-saturated roads where headways are relatively short. Furthermore, almost all other crashes also occurred in traffic moving in the same direction, or from vehicles leaving the carriageway or losing control.

The King Georges Road Interchange Upgrade, and later the fully completed WestConnex, will remove congestion on the M5 Motorway to the east of King Georges Road and a commensurate reduction in the number of rear end crashes is anticipated. The improvements to the entry ramp arrangements delivered by the project would improve the efficiency of the merge and weave areas of the M5 Motorway thereby reducing the likelihood of conflict at these locations.

7.10 Public transport

7.10.1 Bus services

There is an extensive network of bus services in the local area, providing connections to centres, retail and employment areas, residential areas and railway stations. No significant impact on these services is anticipated as a result of the King Georges Road Interchange Upgrade.

Intercity coach services, such as those operated by Murrays or Greyhound, use the M5 East Freeway or M5 South Western Motorway. These services would benefit from improvements to travel speeds on the M5 Motorway as a result of the King Georges Road Interchange Upgrade and later the fully completed WestConnex.

7.10.2 Rail services

The fully completed WestConnex would potentially encourage a modal shift from road to rail for some travellers where rail offers a potential alternative. Overall the King Georges Road Interchange Upgrade project would have some marginal impacts on rail patronage but the net effect is unlikely to be significant.

7.11 Cumulative traffic and transport impacts

7.11.1 Introduction

Cumulative impacts result when the effects of an action are added to or interact with other effects in a particular place and within a particular time. It is the combination of these effects, and any resulting impact on traffic and transport operations, that is the focus of the cumulative impact assessment.

7.11.2 WestConnex M5 project

Increasing traffic capacity within the M5 Motorway corridor would alleviate congestion on the M5 Motorway. On its own, the King Georges Road Interchange Upgrade would allow improved traffic flows and faster travel times along its route, but would not address or alleviate congestion on king Georges Road. The cumulative impact of the delivery of the WestConnex M5 project a few years after the King Georges Road Interchange Upgrade project would alleviate congestion at the eastbound entry ramp to the M5 Motorway at King Georges Road due to the increased downstream capacity provided.

7.11.3 Fully completed WestConnex

As indicated in the *NSW Long Term Transport Master Plan* (Transport for NSW (TfNSW) 2012a), WestConnex is a key project in providing a step change in Sydney’s network. It is considered a critical link in Sydney’s motorway network, particularly with respect to its function to improve access to international gateways and support urban revitalisation opportunities. WestConnex would ease congestion, connect communities and create jobs.

WestConnex would be delivered within an integrated package of transport improvements across Sydney including complementary enhancements to the existing road network (including associated surface road changes, bus priority measures, heavy vehicle access improvements) redesign of bus services and facilities, improved access to rail stations and upgrades to cyclist and pedestrian facilities.

Similarly the (*Draft) Metropolitan Strategy for Sydney to 2031* ((NSW) Department of Planning and Environment 2013a) identifies WestConnex as essential to support major growth and urban revitalisation in the inner part of Sydney, with the Parramatta Road corridor in particular being identified in the Strategy as a key ‘City Shaper’.

The comprehensive assessment of the impact of the fully completed WestConnex is detailed in this chapter, **Chapter 7**.

7.12 Future road network and Main Western Rail Line changes

7.12.1 Road network

Other developments in the Sydney motorway network would affect and be affected by the King Georges Road Interchange Upgrade project. These include completion of the M5 Motorway widening and construction of NorthConnex. These changes in the road network have been incorporated into the WestConnex Road Traffic Model and are reflected in traffic forecasts.

7.12.2 Rail network

The NSW Government's strategy for the rail network across Sydney is presented in *Sydney's Rail Future, Modernising Sydney's Trains* (Sydney's Rail Future) (TfNSW 2012b). The focus of the Government's approach is to modernise Sydney's rail network so that it is better able to meet forecast demand. A significant component of the approach is to provide customers with real alternatives to using their car or other transport modes.

Specific components of the strategy would address existing capacity constraints on the East Hills Rail Line in the M5 Motorway corridor:

The cumulative effect of transport network improvements would change the relative attractiveness of rail and road travel in the M5 Motorway corridor and this would be reflected in traffic forecasts undertaken for the King Georges Road Interchange Upgrade project.

The rail passenger demand forecasts used in the development of Sydney's Rail Future (TfNSW 2012b) have recognised WestConnex however the detailed impact of, for example, the tolling strategy of WestConnex on modal split and therefore passenger demand for rail services would require further detailed analysis.

8 Construction impacts

8.1 Introduction

The assessment of construction impacts is based on the WDA concept design of the King Georges Road Interchange Upgrade project as at July 2014 and currently proposed land availability for compounds and access. This will be refined and updated as part of the detailed design.

The King Georges Road Interchange Upgrade project comprises widening and upgrading the existing M5 Motorway between Penshurst Street, Beverley Hills and Kooemba Road, Beverly Hills and upgrades to existing entry and exit ramps.

The project would tie into the completed M5 South West Motorway Widening project in the west. Minor treatment would be required to the existing M5 dual carriageways to retain two through lanes in each direction and accommodate the possible future construction of WestConnex M5. The eastern end of the project would tie into the existing M5 East Motorway, near Kooemba Road, Beverly Hills.

To the west of King Georges Road work would be required to the eastbound off-ramp and the westbound on-ramp to make provision for the possible future construction of the WestConnex M5 project and tie in with the completed M5 South West Motorway widening project respectively.

To the east of King Georges Road the eastbound on-ramp would be extended by shifting the merge further to the east and a new bridge span would be constructed to the north of Cooloongatta Road overbridge. Similarly the westbound off-ramp diverge would be shifted further to the east and a new bridge span would be constructed to the south of Cooloongatta Road overbridge.

8.2 Construction strategy

The construction strategy for the project focuses on allowing construction to occur in a safe and efficient manner while managing constructability constraints and minimising impacts, including to existing motorway users. Detailed construction planning would be undertaken by the successful construction contractor.

The objectives for managing the impact of the project construction activities on traffic are:

- Safety of all road users, including pedestrians and cyclists.
- Minimise disruption to all road users, including pedestrians and cyclists.
- Ensure the M4 Motorway and surrounding road network continues to function adequately.
- Limit impacts on public transport services.
- Minimise changes to traffic operations.
- Minimise access disruptions to adjoining properties.
- Minimise construction activities on local roads in residential areas wherever possible.
- Avoid heavy vehicle movements in peak traffic and outside of standard working hours.

To minimise construction duration and overall disruption, the construction strategy would rely on switching existing traffic to alternate sides of the same motorway carriageway to allow safe construction. It is expected that work in the central median and on the shoulders and verges would be undertaken in separate traffic management phases, although some early work on the median may be undertaken at night with the implementation of lane closures.

The construction program would rely upon key traffic switches such as using the existing road shoulders and/or new road surface on the outside of the eastbound and westbound carriageways to allow median works to be completed.

8.3 Construction program

Construction of the project is anticipated to commence in mid 2015 and take approximately 18 months.

The program is based on the following broad stages:

- Property acquisition finalisation
- Site establishment
- Work on the non-motorway side of the existing noise walls north of the motorway, including work to the shared path, noise walls and retaining walls
- Work on the non-motorway side of the existing noise walls south of the motorway, including work to the shared path, noise walls and retaining walls
- Extension of Cooloongatta Road overbridge
- Widening of Penshurst Road bridge
- Work on the motorway side of the existing noise walls north of motorway including work to retaining walls, earthworks, drainage and pavements
- Work on the motorway side of the existing noise walls south of the motorway and west of King Georges Road including work to retaining walls, earthworks, drainage and pavements
- Work on the motorway side of the existing noise walls south of the motorway and east of King Georges Road including work to retaining walls, earthworks, drainage and pavements
- Finishing work including final pavement surfacing, line marking, installation of final signage, finalisation of lighting, OMCS and landscaping.

The construction program may change based on further development of the project during the detailed design and construction planning phases. The specified durations cover the active construction period and works may be undertaken intermittently during the entire construction period. Other factors that may influence the timing and duration of construction activities include wet weather periods, changes to construction methods and/or materials, uncovering an unexpected item (for example heritage items/areas), management of unsuitable material, community interests or complaints, and management of traffic impacts.

8.4 Construction methodology

8.4.1 Construction area

Figure 8-1 shows the proposed construction footprint of the project, including indicative locations for construction site compounds and / or stockpile and material storage areas. The majority of work would be undertaken within the existing M5 corridor. The construction area includes the area required for:

- Ramp widening
- Bridges and structures
- Construction of new noise walls and retaining walls
- Realignment of the shared path
- Drainage works
- Utilities and services relocation or protection.

Temporary work such as construction site compounds, stockpiles and storage areas would be established inside and outside the road corridor. The indicative location for these facilities are also shown on **Figure 8-1** and discussed in **Section 8.5**.

There would be some work required outside the motorway corridor to divert cyclists away from the motorway. This work would be carried out on local roads outside the M5 corridor and would include installation of signage and other work associated with the shared path. Management of cyclists during construction is discussed in **Section 8.8.1** below.

Permanent signage including Variable Message Signage may be implemented on King Georges Road to assist with way-finding in the future. Removing cyclists from the M5 corridor requires signage and line marking and access modifications at Belmore, Kingsgrove and Bexley Roads. Construction of a new entry to the shared path south of the motorway at Bexley Road would be required. This may include the provision of an appropriate connection for cyclists entering onto the shared path from Bexley Road.

Figure 8-1 Construction areas

Information on noise walls, retaining walls, drainage features and temporary construction facilities is subject to detailed design

8.4.2 Construction activities and equipment

The construction activities and equipment that would likely be required are outlined in **Table 8-1**. The plant and equipment requirements would be refined during detailed design and construction planning. Traffic control and environmental controls would be established as required.

Table 8-1: Construction phases, plant and equipment

Phase	Construction activities	Plant and equipment	
Enabling works	• Establishment of construction site compounds including offices and storage areas • Delivery of plant and equipment	• Trucks • Light vehicles	• Crane
Clearing and grubbing and earthworks	• Vegetation clearing and grubbing • Excavation of soil and rock • Loading material and haulage.	• Excavator • Dump trucks • Compactors • Water carts	• Bulldozers • Graders • Profilers • Vibrating rollers
Road work (areas of new road formation)	• Ripping and re-compacting of subgrade, placing selected material, and compacting • Construction of pavement, kerbing and barriers	• Bulldozers • Excavators • Water carts • Plate compactors	• Graders • Dump trucks • Vibrating rollers • Spray sealing equipment
Road re-surfacing works (areas of existing road)	• Milling and re-sheeting of pavement surfaces • Asphalt paving, saw cutting, lane marking.	• Welding equipment • Concrete paving machines • Concrete trucks • Concrete saws • Compactors	• Cranes • Slip-forming machines • Concrete pumps • Vibrating rollers • Generators • Compressors
Bridges and structures	• Excavation of soil, installing piles, constructing footings, forming of steel reinforcements, concrete pouring and installing precast units • Construction of retaining walls	• Excavators • Rock breaker • Concrete pumps • Welding equipment • Cranes • Vibrating rollers	• Piling machines • Concrete trucks • Generators • Oxy-cutting equipment • Cherry pickers
Noise attenuation	• Construction of new noise walls or modification of existing noise walls	• Piling machines • Concrete pumps • Cranes • Welding equipment • Light vehicles	• Concrete trucks • Generators • Oxy-cutting equipment • Sprayers

Phase	Construction activities	Plant and equipment	
Drainage works	• Excavation of trenches and pits, delivery and placement of precast pipes and pits, filling and compacting • Modification to existing water quality basins and associated concrete and drainage works	• Excavators • Jackhammers • Concrete pumps • Welding machines	• Boring machines • Concrete trucks • Cranes • Vibrating rollers
Operational Management Control System	• Installation of utilities and conduits along the route • Installation of variable message signs and variable speed limit signs. This would involve trenching, constructing footings, delivering equipment and installing the signs • Replacement of existing signs and installation of new static signs	• Excavators • Boring machines • Piling machines • Cranes • Generators	• Dump trucks • Plate compactors • Concrete pumps • Concrete truck
Finishing works	• Landscaping and vegetation works would involve planting new areas and rehabilitating disturbed areas • Installation of static signage • Installation of permanent road safety barriers • Installation of lighting	• Milling machines • Asphalt paving machines • Piling machines • Concrete pumps • Cranes • Welding equipment • Light vehicles	• Trucks • Rollers • Road marking machine • Concrete trucks • Generators • Oxy-cutting equipment • Sprayers

8.5 Construction sites and access

8.5.1 Work sites and compounds

There are limited opportunities to locate construction compounds within the motorway corridor. Compounds and laydown areas would therefore be established at locations as close as possible to the corridor. The compounds would comprise:

- Temporary buildings (generally prefabricated) including:
  - Offices and meeting rooms
  - Reception and general administration area
  - Amenity, first aid and toilet facilities
- Hardstand parking areas
- Materials laydown and storage areas, including purpose-built temporary structures as required
- Perimeter fencing, including visual screening of compounds where necessary.

Proposed locations of these compounds, together with details of their size, proposed use and access points are outlined in **Table 8-2** Some additional minor ancillary sites may be required for minor construction activities such as for material laydown. No building demolition would be required to establish the construction site compounds. Construction compounds and laydown sites would be used for the duration of the construction period.

Table 8-2: Construction compounds

Compound	Location	Size (approx)	Proposed use	Proposed access
King Georges Road (south)	South-east of the intersection of King Georges Road and the M5 westbound off-ramp	6,200 m^2	• Main office • Amenities • Materials laydown	• Main access from King Georges Road • Secondary access from Allambee Crescent
King Georges Road (north)	North-east of the intersection of King Georges Road and the M5 eastbound on-ramp	1,000 m^2	• Materials laydown	• From King Georges Road
Kirrang Street	Adjacent 25 Kirrang Street	1,600 m^2	• Materials laydown	• From Kirrang Street / Tallawalla Street / Yarallah Place / Ponyara Road
Elouera Street (east)	Adjacent 40 Elouera Street	500 m^2	• Materials laydown	• From Elouera Street / Alkoomie Street / Cooloongatta Road / Moorefields Road
Elouera Street (west)	Adjacent 19 Elouera Street	900 m^2	• Materials laydown • Amenities	• From Elouera Street / Alkoomie Street / Cooloongatta Road / Moorefields Road via shared path
Penshurst Road	Off Windarra Street, behind the properties on Penshurst Road	250 m^2	• Materials laydown • Amenities	• From Windarra Street / Penshurst Road / Broadmeadow Road

8.5.2 Construction site access

Construction sites would be accessed via local roads, King Georges Road and the motorway. Left-in left-out movements along the M5 motorway may require construction vehicles to circulate from the existing ramps at King Georges Road. The existing westbound Heavy Vehicle Inspection Bay may provide a waiting area for access to westbound widening works, and widening works east of King Georges Road. Likely construction vehicle routes for haulage and delivery have been identified on **Figure 8-2**. Assessment of the potential impacts of construction traffic on local access roads during the construction period, especially in the areas surrounding proposed construction site compounds, is included in **section 8.7**.

Table 8-3: Construction site access arrangements

Work site type	Vehicle access arrangement
Sites located adjacent to the motorway	Left-in left-out from the motorway where possible
Compounds	As per **Table 8-2**
Laydown areas	Left-in left-out from the motorway with some local road access if necessary
Local road work sites	Access and egress via local roads
Truck call-up areas	Left-in left-out from the motorway where possible

Table 8-4 lists the local roads that would be used to provide direct access to work sites and ancillary sites. Estimates of the number of heavy vehicle movements related to each work site are provided in **Table 8-5**.

Roads in **Table 8-4** have been classified according to a hierarchy in order to determine their functional role within the road network. Roads are classified according to the role they fulfil and the volume of traffic they can appropriately convey. The guidelines for the functional classification of roads were developed by (NSW) Roads and Maritime Services (Roads and Maritime) and are detailed below:

- Arterial road – typically a main road carrying over 15,000 vehicles per day and fulfilling a role as a major inter-regional link (over 1,500 vehicles per hour).
- Sub-arterial road – defined as secondary inter-regional links, typically carrying volumes between 5,000 and 20,000 vehicles per day (500 to 2,000 vehicles per hour). These roads supplement arterial roads in providing for through movement, to an individually determined limit that is sensitive to both roadway characteristics and abutting land uses.
- Collector road – provides a link between local roads and regional roads, typically carrying between 2,000 and 10,000 vehicles per day (250 to 1,000 vehicles per hour). At volumes greater than 5,000 vehicles per day, residential amenity deigns to decline noticeably. Trunk collector and spine roads with limited property access can reasonably carry traffic flows greater than 5,000 vehicles per day.
- Local road – provides access to individual allotments, carrying low volumes, typically less than 2,000 vehicles per day (250 vehicles per hour).

Table 8-4: Local road access to work and ancillary sites

Local roads used for access	Road characteristic
King Georges Road	Arterial
Broadmeadow Road	Collector
Penshurst Road	Collector
Welfare Avenue	Local
Shorter Avenue	Local
Windarra Street	Local
Moorefields Road	Collector
Cooloongatta Road	Collector
Ponyara Road	Collector
Tallawalla Street	Local
Kirrang Street	Local
Alkoomie Street	Local
Elouera Street	Local

Access points at each of the compound frontages would be provided with adequate sight distances relating to the posted road speed. This would allow vehicles on the main road to see vehicles egressing from the compound and would allow sufficient room to slow down and stop if necessary. Similarly it would allow vehicles waiting to egress from the compound adequate sight distance to see approaching vehicles and determine acceptable gaps.

8.5.3 Construction workforce travel

It is anticipated that the total on-site staff and workforce would consist of up to 100 people over the duration of the construction period. Construction staff would have limited parking available at the compounds and work sites. Personnel would be advised of suitable parking arrangements as part of the compulsory project induction and would be encouraged to car pool.

It is expected that a proportion of the workforce would use public transport to commute to and from the work sites (existing public transport provision is detailed in **section 3.5**). Public transport and therefore a reduction in work site-related vehicle movements and parking on local roads could be promoted via the use of shuttle services from designated points, collecting personnel and transporting them to site prior to the beginning of each shift and transporting them from the site at the end of each shift. An on-demand service could then operate during the shift. The collection and delivery points for the shuttle service would vary as activities and work sites change as construction progresses. This would be identified in the CEMP as part of management of site traffic and transport arrangements.

8.5.4 Working hours and arrangements

Standard working hours for the sites would be between 7.00 am and 6.00 pm Monday to Friday and 8.00 am to 1.00 pm on Saturday.

Traffic Management Plans (TMPs) would be developed by the contractor to allow safe work sites to be created along the motorway and local roads. These work sites would be protected by temporary concrete barriers where applicable while maintaining the lane capacity on the road with the potential for changes to lane widths and realignment of lanes. The TMPs would consider the convenience and safety of all road users, including public transport, pedestrians and cyclists.

In some cases, works may be required to be undertaken outside standard working hours, subject to approval organisations including the Transport Management Centre (TMC) and agencies if the impacts on traffic flow as a result of daytime activities are considered unacceptable by WestConnex Delivery Authority (WDA). Works outside standard working hours are expected to include:

- Any works requiring lane closures.
- Removal of existing traffic barriers and installation of temporary and permanent traffic barriers.
- Removal of existing line marking and new line marking.
- Removal of existing static signage and installation of new signage.
- Road re-surfacing.
- Pavement tie-in works.
- Ramp tie-in works.
- Reconfiguration of traffic lanes, installation of additional pavement drainage and relocation of existing Type F barrier on the existing viaduct.
- Some bridge works including piling for abutments, construction of piers, and installation of structures such as girders and concrete deck works and drainage works.
- Some concreting works.
- Some Operation and Management Control System (OMCS) works including trenching which requires lane closures.
- Delivery of plant and materials which is required outside normal working hours as requested by the police or WDA for safety and / or traffic flow reasons.

Where there is a requirement for construction activities to be undertaken outside standard working hours, the Construction Environmental Management Plan (CEMP) would outline an Out of Hours Works procedure which would include communication and notification to local residents, businesses and sensitive receivers of the out of hours works required and a complaints line.

Access points in and out of the work sites would be designed to minimise the potential for disruption to traffic caused by the turning movements of construction vehicles.

8.6 Proposed construction activity

8.6.1 Vehicle movements

Proposed construction activities, heavy vehicle movements and number of personnel at each work site are detailed in **Table 8-5**.

Table 8-5: Proposed construction activities, heavy vehicle movements and number of personnel

Construction location	Estimated daily heavy vehicle movements	Estimated personnel and daily light vehicle movements
Work outside noise walls south of motorway	Up to 12	Between 12 and 50
Extension of Cooloongatta Road overbridge	Up to 6	Between 12 and 20
Widening of Penshurst Road bridge	Up to 6	Between 12 and 20
Work outside noise wall north of motorway	Up to 12	Between 12 and 50
Work inside noise wall south of motorway (west of King Georges Road)	Up to 12	Between 12 and 50
Work inside noise wall south of motorway (east of King Georges Road)	Up to 12	Between 12 and 50
Work inside noise wall north of motorway (east and west of King Georges Road)	Up to 12	Between 12 and 50

Vehicle Management Plans would be developed to reduce the impact of construction vehicle movements on the motorway and local roads. Such methods include controlled access points, radio contact to drivers and off-motorway truck staging. Staging sites for delivery and haulage trucks would be selected as appropriate for the capacity required and location relative to residential areas and other sensitive land uses.

Impact due to local road access of work and ancillary sites

The estimated vehicle movements to work sites are provided in **Table 8-5**. While the preferred access is via the motorway there would be some construction vehicles using local roads. **Table 8-4** lists the local roads around the motorway corridor that would be used to various degrees by construction-related vehicles depending on the nature of the site.

Based on the existing volumes and proportion of heavy vehicles it is expected that only the residential streets would have a noticeable increase in vehicle movements due to construction traffic accessing the work areas. Assessment of suitable routes and access points would be made as part of the CEMP with TMPs developed to limit the impact as detailed in **section 8.9**.

Selection of construction traffic routes

Routes for construction vehicles to and from compounds and work sites would be developed in the context of minimising impacts on local roads and maximising use of arterial roads. The approach for development of the routes is to consider the following:

- Preference for the motorway network and arterial roads.
- Restrictions on size and load of vehicles.

- Sensitive land uses, for example schools.
- Hours of operation of sensitive land uses.
- Access needs for residents, pedestrians, emergency services and buses.
- Out of hours impact on residential areas.
- Consultation with the Traffic and Transport Liaison Group and local residents.
- Guidance from relevant documents and standards, for example the *RMS Traffic Control at Work Sites* manual and *AS1742.3: Manual of Uniform Traffic Control Devices – Traffic control for works on roads*.

8.6.2 Haulage routes

Proposed haulage routes to and from each compound from the nearest arterial road are detailed in **Figure 8-2.**

Figure 8-2 Potential haulage and delivery routes

Information on noise walls, retaining walls, drainage features and temporary construction facilities is subject to detailed design

- Primary access to haulage and delivery routes
- Compound site and work area access
- Potential motorway haulage / delivery routes
- Potential arterial haulage / delivery routes
- Potential local road haulage / delivery routes
- Proposed temporary construction compound sites
- Proposed construction work area

8.6.3 Night works

Vehicle movements during proposed night works would include:

- General light vehicles.
- Floats.
- Tipper trucks.
- Truck and dog combinations.
- Flatbed crane trucks.
- Concrete trucks.
- Asphalting.

Works undertaken at night would be dictated by allowable lane occupancies. These occupancies would be operated through TMPs approved by the TMC with suitable detours (where applicable) to minimise impacts on the local road network. Appropriate communication strategies would be implemented to ensure that road users and the adjacent community are informed prior to any works commencing that may affect local traffic conditions.

A more detailed construction methodology would be prepared in association with the detailed design prior to commencement of construction works as part of the CEMP.

8.6.4 Partial and temporary road closures

Proposed temporary and partial road closures to facilitate construction activities are detailed in **Table 8-6**. Details of detours (where applicable) and measures to reduce the impact of the road closures would be addressed in the TMPs that are developed for the planning and staging of works.

Table 8-6: Proposed temporary road closures

Road	Description of temporary closure
Cooloongatta Road (collector)	Construction of the additional bridge spans would require a partial closure of the road with contraflow traffic arrangements in progress. This would enable construction of one side of the bridge. Once the first side of the bridge was completed, the traffic would move across to the newly completed side while work continued on the other side. The width of the existing bridge has the potential to accommodate the required safe working width as well as two traffic lanes. The ability to maintain two traffic lanes would negate the need for contra flow traffic management arrangements and to minimise delay. The option to maintain two trafficable lanes will be investigated further during the detailed design process.
Penshurst Road (collector)	Penshurst Road may need to be periodically closed for short periods for the purpose of erecting new bridge beams. This work may be undertaken at night and would require detours to be established.
Booragul Street (local road)	Partial closure of Booragul Street may be required for use as a site compound during the construction of the Cooloongatta Road Bridge. Generally Booragul Street would be diverted via Allambee Crescent, with partial access available for properties with driveway access from this portion of the street.

8.6.5 Special loads

Special load deliveries for the project are anticipated for items such as large bridge beams, viaduct deck and structural elements and paving equipment. These movements would, in general, occur at night under escort to locations along the motorway corridor. Oversized loads would be restricted by the routes and access hours allowed by Roads and Maritime, the TMC and WDA. Deliveries to sites on the motorway or local roads would have minimal impact on traffic due to the low volumes experienced during the permissible hours of movement. Some deliveries on local roads would require stop and go procedures to facilitate access by oversized loads resulting in short term closures to assist in movement and unloading.

8.7 Impact on traffic flows

8.7.1 M5 Motorway

Construction activities would have a temporary and minor impact on existing traffic flows along the M5 Motorway, arterial roads and various local roads in close proximity to the motorway corridor. Arterial and local roads, identified in **Table 8-4** would experience some additional traffic during the construction period, however, this is anticipated to generate only minor delays.

During construction, a series of TMPs would be developed by the construction contractor for approval by WDA, Roads and Maritime and the TMC. The TMPs provide the overall plan and staging for managing traffic through and around each work site. These would be in accordance with the *RMS Road Design Guide*, the *RMS Traffic Control at Work Sites* manual and *AS1742.3: Manual of Uniform Traffic Control Devices – Traffic control for works on roads*, and any other relevant standard, guide or manual and reviewed by the Traffic and Transport Liaison Group. The Traffic and Transport Liaison Group would include relevant stakeholders such as NSW Police, affected bus operators, Transport for NSW, Roads and Maritime, NSW Taxi Council and local councils.

Speed limits and capacity

During construction, the M5 Motorway between Penshurst Road and Elouera Street, Beverley Hills would generally have a reduced daytime speed limit of 80 kilometres per hour with some sections reduced to 60 kilometres per hour during night works. The speed limit reductions are required to facilitate reduced lane widths, works in the median and other works that would be undertaken in close proximity to travel lanes. Lane and shoulder widths would be consistent with *AS1742.3: Manual of Uniform Traffic Control Devices – Traffic control for works on roads.*

The implementation of an 80 kilometres per hour roadwork speed limit between Penshurst Road and Elouera Street, Beverley Hills would increase travel times on the motorway by less than one minute in free-flow conditions.

During peak periods, the existing provision of lanes would be maintained during construction – two lanes from Penshurst Road and Elouera Street, Beverley Hills in both directions of travel. During peak periods on the M5 Motorway, the current operational vehicle speeds are below the proposed roadwork speed limit, therefore the average travel time in peak periods is likely to remain unchanged during construction.

Where road shoulders would be used to accommodate realigned traffic lanes, there is the potential for extended delays as a result of incidents such as breakdowns or accidents.

Monitoring of the motorway and work sites would be undertaken using CCTV and mobile patrols to assist management of incidents.

8.7.2 Impacts on local roads

Road users may choose to take an alternative route (diversion) due to the reduced benefit on the motorway as a result of reduced speed limits and lane closures. Diversion is expected predominantly in the off-peak periods and particularly at night when the most severe lane occupancies would occur. At times, the motorway would need to be closed to undertake certain works; however, the M5 East currently undergoes routine maintenance activities requiring its night time closure. A well-established detour is in place (including road signage) to support these closures. Works requiring the closure of the motorway would be timed to coincide with the routine closure periods for M5 East maintenance.

Table 8-6 outlines the proposed temporary road closures. During these periods, alternative routes would have sufficient spare capacity to accommodate additional traffic that has diverted from the motorway and therefore limited impact is anticipated for local roads.

8.7.3 Emergency services

The M5 Motorway is used by emergency service vehicles for travel to and from incidents. Therefore, the emergency services could potentially be delayed in general traffic when responding to incidents. In off-peak periods travel time delays would be related to the speed limit reduction and therefore the impact on emergency services would be minimal.

The potential removal of road shoulders would restrict access to incidents on the motorway by emergency service vehicles. Management plans for incident response would be developed in consultation with the emergency services

Emergency services would be regularly informed on the staging and progress of works through briefings from the construction team.

8.8 Impact on other road users

8.8.1 Pedestrians and cyclists

Specific pedestrian and cyclist facilities that would be impacted by construction activities are detailed in **Table 8-7**. Where there is possible interaction between construction traffic and pedestrians (eg at work site/compound access points) traffic controllers would be employed to ensure that adequate protection is given. Measures to reduce the impact on pedestrians would be addressed in the TMPs that are developed for the planning and staging of works.

Table 8-7: Construction impact on pedestrians and cyclists

Location	Facility type	Description of impact
Between between King Georges Road and Kindilan underpass	Shared path	Temporary closure of the shared path on the northern side of the motorway – pedestrians and cyclists would be directed onto the shared path of the southern side of the motorway during this time. This would enable construction to occur within the existing shared path corridor (north of the motorway).

Location	Facility type	Description of impact
Between between King Georges Road and Kindilan underpass	Shared path	Temporary closure of the shared path on the southern side of the motorway between King Georges Road and Kindilan underpass – pedestrians and cyclists would be directed onto the shared path of the northern side of the motorway during this time. This would enable construction to occur within the existing shared path corridor (south of the motorway).
M5 East Motorway shoulders	Shared path	The M5 motorway would be closed to cyclists between Belmore Road and Bexley Road. Cyclists would be directed onto the shared paths or local roads for the duration of the construction works on the motorway carriageways. Following completion of the works, cyclists would not be returned to the motorway between King Georges Road and Bexley Road.

8.8.2 Buses

No regular bus services use the M5 East Freeway or M5 South Western Motorway. However, intercity coach services, such as those operated by Murrays or Greyhound, do use the M5 East Freeway or M5 South Western Motorway. These intercity coach services would experience the same minor delays as general traffic

There are eight daytime bus routes which use King Georges Road between Canterbury Road and Stoney Creek Road. However, none of the work involved in the King Georges Road Interchange Upgrade will have an adverse impact on King Georges Road, therefore, no impact on bus services is anticipated.

8.9 Traffic management and mitigation during construction

8.9.1 Traffic Management Plans

The construction contractor would be responsible for the development of all TMPs for all aspects of construction that would require temporary changes to the motorway and local roads using barriers or lane occupancies. These changes would be undertaken in accordance with the *RMS Road Design Guide*, the *RMS Traffic Control at Work Sites* manual and *AS1742.3: Manual of Uniform Traffic Control Devices – Traffic control for works on roads*, and any other relevant standard, guide or manual. Consultation with relevant stakeholders would be managed through the Traffic and Transport Liaison Group.

TMPs provide the overall staging for the traffic management and the detail of how sub-plans are managed. The content of the TMPs would include:

- Traffic Control Plans showing the detail of signs and devices required for each configuration.
- Vehicle Management Plans showing access to work sites and direction of travel.
- Pedestrian and Cyclist Control Plans.
- Management strategy for other road users.
- Management strategy for access to adjacent properties.

Communication of the proposed changes would vary depending on the nature and extent of the management scheme. The options and processes for advising road users and the general public of the changes would be included in the Community and Stakeholder Consultation Plan and coordinated by the Traffic and Transport Liaison Group to include:

- Portable and permanent variable message signs.
- Other project signage as required to direct traffic
- Project-specific and Roads and Maritime web sites.
- Radio advertising.
- Metropolitan and local newspaper advertising.

8.9.2 Other mitigation strategies

It is expected that the construction contractor would take all reasonable measures to ensure that road user delays are kept to an absolute minimum and that access is maintained for all road users.

In addition to development of the TMPs, the following mitigation strategies would be implemented to manage and control traffic during construction:

- Identify potential road user delays during the planning and consultation phases.
- During the detailed design stage, develop construction staging and temporary works that avoid conflicts with the existing road network and maximises spatial separation between work areas and travel lanes.
- Maintain existing road network capacity during construction.
- Isolate work areas from general traffic using temporary safety barriers.
- Promote public transport and car pooling to personnel to reduce work site-related vehicle movements and parking on local roads.
- Develop alternative work methods to minimise impacts, for example utilising more efficient plant and equipment, and applying different design solutions.
- During construction, WDA to work with TMC to observe traffic flows and incidents from CCTV footage.
- Provide a mechanism for the community to report incidents and delays, for example a project phone number.
- Plan all lane occupancies with the aim to minimise the actual work area, limit obstructions and restrictions, maximise road capacity and avoid peak traffic periods.
- Analyse traffic volume data to identify capacity requirements, assess the potential impact of lane occupancies on traffic flows, and identify the best time to minimise inconvenience to road users.
- Provide clear and concise guidance and support amongst key stakeholders involved in the Traffic and Transport Liaison Group.
- Minimise impacts on the shared path and keep it operational during construction where practical and safe to do so.

9 Conclusion

9.1 Introduction

The principal objective of the King Georges Road Interchange Upgrade is to facilitate the possible future delivery of WestConnex M5 and reduce congestion on King Georges Road and the M5 Motorway in the vicinity of the interchange.

9.2 Operational benefits

9.2.1 Improve network operational performance

Overall demand on the study road network is set to continue to grow strongly. It also shows that without the project, network performance will continue to decrease with average speeds in 2027 falling to approximately 10km/h in both the AM and PM do minimum scenarios.

With the King Georges Road Interchange Upgrade, average speeds on the network are maintained at a higher level. Furthermore, the performance of the network in 2027 with the fully completed WestConnex is better than the ‘do minimum’ scenario in 2017 despite the increased traffic demand expected over the preceding 10 year period.

The travel time results for 2017 show improvement for all routes under the Project scenario compared to the ‘do minimum’ scenario. Eastbound M5 Motorway travel times in the AM peak show the most improvement, demonstrating decreased congestion for this route with the project implemented.

The travel time results for the fully completed WestConnex in 2027 also show significant improvement compared to the Future ‘do minimum’ scenario. King Georges Road northbound travel times decrease by approximately 3 minutes in both the AM and PM peak periods.

With the project and WestConnex implemented, King Georges Road southbound traffic would experience travel time savings of approximately 4 minutes in the AM and 5 minutes in the PM.

The operational performance of intersections along King Georges Road remains generally consistent across both the ‘do minimum’ and Project scenarios. Under project conditions, improvements are observed at the M5 Motorway interchange with average delays decreasing slightly in both the AM and PM peaks.

The operational performance of intersections along King Georges Road is generally improved with the fully completed WestConnex in 2027 compared to the ‘do minimum’ scenarios. The M5 Motorway interchange experiences significant improvement in the PM peak. Some increased performance is also observed in the AM peak. These improvements occur despite the increased traffic demand that will arise under the Full WestConnex scenario.

9.2.2 Improve the freight network

WestConnex provides a significant opportunity to address freight and commercial business vehicle needs along the M5 Motorway and M4 Motorway corridors, the requirement for high quality links to the Port Botany/Sydney Airport and the connectivity of the broader strategic freight network of which it would form a critical part.

WestConnex would provide significant freight benefits by providing more efficient and higher standard access between critical freight generators. In addition to the step change in freight efficiency and accessibility that WestConnex would provide, there are also a range of complementary initiatives that would enhance the freight network more broadly post implementation, including:

- Better connectivity of the strategic freight network for restricted access vehicles such as higher productivity vehicles, higher mass limit vehicles and over-height vehicles.
- ‘Last-mile’ access to freight generators located close to WestConnex
- Priority freight access to strategic freight generators such as Port Botany, Sydney Airport and intermodal terminals.

In meeting these needs, the King Georges Road Interchange Upgrade project would assist WestConnex to contribute to the broader strategic objectives of the *NSW Long Term Transport Master Plan* (LTTMP) (Transport for NSW (TfNSW) 2012) and strategic action areas in the *NSW Freight and Ports Strategy* (TfNSW 2013).

The King Georges Road Interchange Upgrade project would provide improved travel times for freight vehicles using the M5 Motorway in line with the improvement in operational performance of the motorway and contributes to the overall benefit once the rest of WestConnex is operational.

9.3 Construction impacts

The King Georges Road Interchange Upgrade project would tie into the completed M5 South West Motorway Widening project in the west. Minor treatment would be required to the existing M5 dual carriageways to retain two through lanes in each direction and accommodate the possible future construction of WestConnex M5. The eastern end of the project would tie into the existing M5 East Motorway, near Kooemba Road, Beverly Hills.
The proposed construction methodology and program indicates that the proposed works can be completed by the first quarter of 2017.

Construction activities would have a temporary impact on existing traffic flows along the M5 Motorway, arterial roads and various local roads in close proximity to the motorway corridor. Those arterial and local roads that would experience some additional traffic during the construction period are the same roads that are expected to experience long-term benefits as a result of the project. These are identified in **section 8.6.2**.

During construction, the motorway between Penshurst Street and Kooemba Road, Beverly Hills would generally have a reduced daytime speed limit of 80 kilometres per hour with some sections reduced to 60 kilometres per hour during night works. The speed limit reductions are required to facilitate reduced lane widths, works in the median and other works that would be undertaken in close proximity to travel lanes. Lane and shoulder widths would be consistent with *AS1742.3: Manual of Uniform Traffic Control Devices – Traffic control for works on roads.* The implementation of an 80 kilometres per hour roadwork speed limit through the works area would increase travel times on the M5 Motorway by less than one minute in free-flow conditions.

Routes for construction vehicles to and from compounds and work sites would be developed in the context of minimising impacts on local roads and maximising use of arterial roads. Based on the existing volumes and proportion of heavy vehicles it is expected that only the residential streets would have a noticeable increase in vehicle movements due to construction traffic accessing the work areas. Assessment of suitable routes and access points would be made as part of the Construction Environment Management Plan (CEMP) and associated Traffic Management Plans (TMPs) developed to limit the impact.

TMPs would be developed by the contractor to allow safe work sites to be created along the motorway and local roads. These work sites would be protected by temporary concrete barriers where applicable while maintaining the lane capacity on the road with the potential for changes to lane widths and realignment of lanes. The TMPs would consider the convenience and safety of all road users, including public transport, pedestrians and cyclists.

In some cases, works may be required to be undertaken at night or on weekends, subject to approval by Roads and Maritime and agencies if the impacts on traffic flow as a result of daytime activities are considered unacceptable by WDA.

9.4 Summary

The Traffic and Transport Assessment of the King Georges Road Interchange Upgrade project has found that the project would meet its stated objectives and would:

- Enable integration with the subsequent stages of WestConnex while minimising impacts on the surrounding environment in the interim period.
- Relieve road congestion so as to improve the travel time and safety of travel in the M5 Motorway in the vicinity of the King Georges Road Interchange.
- Improve road safety on the M5 Motorway in the vicinity of the King Georges Road Interchange.

Further, the Traffic and Transport Assessment has found that:

- The project is consistent with NSW Government and Transport for NSW (TfNSW) policy in respect to the LTTMP, NSW 2021: A plan to make NSW number one (NSW Department of Premier and Cabinet 2011) and the State Infrastructure Strategy (Infrastructure NSW 2012).
- The project is an integral component of WestConnex as outlined in the WestConnex Business Case (Sydney Motorways Project Office 2013).
- On traffic operational grounds, the existing M5 Motorway peak traffic volumes are at capacity and traffic growth is being constrained and peak periods extended. The King Georges Road Interchange Upgrade project would cater for diverse travel demands (such as freight and associated services) by providing the capacity required to service the new motorway corridors ,WestConnex M5 and M5 East, then onto St Peters and at Sydney Airport. These corridors would improve accessibility by providing new routes for through traffic and connection to a high standard road network for adjoining areas. The reduction in arterial traffic would improve accessibility for local journeys.
- Road freight operations in the corridor, especially the long distance heavy vehicle movements on the network to and from Port Botany/Sydney Airport from Western Sydney experience increasing trip delay and unreliability as a result of the general traffic congestion. The King Georges Road Interchange Upgrade project would provide reductions in travel time along the M5 Motorway and would contribute to the overall benefit once the rest of WestConnex is operational
- Construction activity would largely be confined to the M5 Motorway corridor itself and during normal working hours the existing number of trafficable lanes would be maintained. Some minor delays are anticipated as a result of reduced road works speed limits. Some local residential streets are anticipated to experience a noticeable increase

in vehicle movements due to construction traffic accessing the work areas however these are expected to be minor.

- Overall, the impact of the construction of the King Georges Road Interchange Upgrade project is anticipated to be minor and appropriate management plans would be applied to mitigate the impact.

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10 References

Australian and NSW Governments (2012). *Joint Study on Aviation Capacity for Sydney Region*, Sydney, NSW.

Austroads (2010). *Guide to Road Design (Part 1 to Part 8)* with the *RTA Supplements* to the Austroads - Guide to Road Design Road Design Guide.

Australian Standard (2009). *AS1742.3, Manual of uniform traffic control devices – Traffic control for works on roads*.

Bureau of Transport Statistics (BTS) (2012a). *2010/11 Household Travel Survey,* Sydney, NSW.

Bureau of Transport Statistics (BTS) (2012b). *Compendium of Sydney Rail Travel Statistics*, Sydney, NSW.

Bureau of Transport Statistics (BTS) (2012c). *Employment Forecasts 2006-2046*, Sydney, NSW.

Bureau of Transport Statistics (BTS) (2012d).*Train Loads Database*, Sydney, NSW.

Bureau of Transport Statistics (BTS) (2012e). *Strategic Travel Model assumptions*, Sydney, NSW.

Department of Planning and Environment (2013a). *(Draft) Metropolitan Strategy for Sydney to 2031*, Sydney, NSW.

Department of Planning and Environment (2013b). *Urban Activation Carter Street, Lidcombe*, Sydney, NSW.

Department of Planning and Environment (2013c). *Wentworth Point Urban Activation Precinct Proposal*, Sydney, NSW.

Department of Premier and Cabinet (2011). *NSW 2021*: *A plan to make NSW number one* Sydney, NSW.

Department of Main Roads (1987). *Roads 2000*, Sydney, NSW.

Infrastructure NSW (2012). *State Infrastructure Strategy*, Sydney, NSW.

NSW Government (2014). *Bicycle information for NSW Cycleway Finder v2.0*, Sydney, NSW.

Parramatta City Council (2013). *Western Sydney Light Rail Network Part 2: Feasibility Report*, Parramatta, NSW.

Roads and Maritime Services [formerly the NSW Roads and Traffic Authority] (RMS) (2010) *Guide to Traffic Control at Work Sites, Version 4*: Sydney, NSW.

Roads and Maritime Services [formerly the NSW Roads and Traffic Authority] (RMS) (2002) *Guide to Traffic Generating Developments*, Sydney, NSW.

Sydney Airport Corporation Limited (SACL) (2014). *Sydney Airport Master Plan 2033*, Sydney, NSW.

Sydney Motorways Project Office (SMPO) (2013a). *WestConnex Business Case Executive Summary*, Sydney, NSW.

Sydney Motorways Project Office (SMPO) (2013b). *WestConnex Business Case*, Sydney, NSW.

Sydney Ports Corporation (2012). *Trade and Logistics Report 2011-12*, Sydney, NSW.

Transport for NSW (TfNSW) (2011), Metropolitan Road Freight Hierarchy on the State Road Network Practice Note, Sydney, NSW.

Transport for NSW (TfNSW) (2012a). *NSW Long Term Transport Master Plan*, Sydney, NSW.

Transport for NSW (TfNSW) (2012b). *Sydney's Rail Future: Modernising Sydney's Trains*, Sydney, NSW.

Transport for NSW (TfNSW) (2012c). *North West Rail Link Project Overview,* Sydney, NSW.

Transport for NSW (TfNSW) (2012d). *South West Rail Link Project Overview,* Sydney, NSW.

Transport for NSW (TfNSW) (2013a). *NSW Freight and Ports Strategy*, Sydney, NSW.

Transport for NSW (TfNSW) (2013b). *Sydney's Bus Future*, Sydney, NSW.

Transport for NSW (TfNSW) (2014). *Sydney Metropolitan Bus Service Contract*, Sydney, NSW.

Transurban (2014*). NorthConnex Community Presentation*, Sydney, Nsw.

WestConnex Delivery Authority (WDA) (2013). *WestConnex Assumptions Book version 1.4*, Sydney, NSW.