City of Melbourne

City Road Microsimulation
Options testing report

July 2015

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Executive summary

Overview

The City of Melbourne is currently developing a masterplan for the redevelopment of City Road in Southbank. The aim of the masterplan is to enhance City Road to make it friendlier to pedestrians and cyclists, to reduce the dominance of the carriageway and generally to improve the amenity of the area for local residents and traders. Some of the proposed scenarios involve changes to the road infrastructure which are likely to impact on traffic movements along City Road. City Road is an arterial road under the management of VicRoads. Under the Smart Roads scheme it is designated as a Traffic Route, meaning that its primary function is the movement of traffic. The proposed changes are therefore of interest to VicRoads.

Council has engaged GHD to develop two-hour AM and PM peak VISSIM microsimulation models of the City Road/Alexandra Avenue corridor between Cecil Street at the western end and Linlithgow Avenue at the eastern end.

Prior to carrying out option testing, the model was submitted to VicRoads together with a model validation report for review. Following a round of comments the base (existing conditions) model was accepted as being suitable for options testing in February 2015.

Base model calibration and validation

The first stage was to build and validate a base model. The purpose of this is to have a model which replicates existing traffic conditions well enough that it is suitable for forecasting future traffic conditions and to provide a benchmark against which statistical comparisons can be made.

Existing traffic conditions are established by conducting extensive surveys. These were carried out over one day in November 2014 and comprised of turning movement counts at all signalised intersections in the study area, journey time surveys along six routes and queue length surveys at all signalised intersections. These were then validated against industry standards to achieve compliance. The base model was reviewed by VicRoads and adjusted in response to comments. In February 2015 VicRoads approved the base model for use in options testing.

Options testing

The City of Melbourne has developed several concept designs to be tested in the model. Each design (or layout) is made up of a number of discrete engineering treatments (such as a new pedestrian crossing). In order to know the impacts of each of these treatments, each has been tested by adding one at a time to the base case (existing conditions). Three treatments combine to produce the *City Road East and Alexandra Avenue improvements scenario* and further treatments have been tested against this scenario.

During early testing, it became apparent that the initial concepts would produce impacts that were not acceptable. Generally, this means that journey time increases were too great or queues became too long. Therefore, the model has been used to refine the options such that their impacts are minimised. The process of option refinement is detailed in the main body of this report.

The *preferred layout* and the *alternate layout* build on the City Road East and Alexandra Avenue improvements scenario by making changes to mid-block sections at the western end of City Road between Power Street and Clarendon Street. Generally these improvements comprise of bike lanes, footpath widening, removal of on-street parking, signalising existing priority-controlled intersections and other miscellaneous changes.

Finally, sensitivity tests have been undertaken on the preferred layout. These tests reduce the speed limit on City Road to determine the impact on journey times.

The options that have been tested are as follows:

The City Road East and Alexandra Avenue improvements scenario which is made up of:

- New pedestrian crossing on Alexandra Avenue;
- Removal of slip lanes at Southbank Boulevard and Southgate Avenue intersections; and
- Removal of double slip lane at Queensbridge Street intersection.

The City Road West improvement scenarios which are made up of:

- The preferred layout; and
- The alternate layout.

The sensitivity tests which are made up of:

- 50 km/h speed limit on City Road; and
- 40 km/h speed limit on City Road.

For each test, results comprise of journey time changes and level of service changes at intersections.

Results of options testing

Journey time results for each option model are compared to the equivalent result for the base case (existing conditions) model. Table E.1 shows results for Routes 1 and 2 while Table E.2 shows results for Routes 3 and 4.

In general, the analysis indicates that the City Road East and Alexandra Avenue improvements scenario has little impact on journey times. The preferred and alternate scenarios do increase journey times, but the preferred scenario has less of an impact than the alternate scenario. (Where a smaller change is reported for the alternate scenario, this is due to vehicles being unable to enter the model in this scenario. This artificially improves results as there are fewer vehicles in the network. This phenomenon is explained fully in the main report.)

Generally, impacts in the westbound direction are greater than in the eastbound direction. This is primarily due to congestion experienced in the Southgate area as vehicles arrive from the relatively free-flowing Alexandra Avenue and is particularly bad in the PM peak.

Table E.1 – Summary journey time impacts for Routes 1 and 2

Scenario	Change in journey time compared to existing			
	Route 1 (eastbound)		Route 2 (westbound)	
	AM peak	PM peak	AM peak	PM peak
Pedestrian crossing on Alexandra Avenue	-6%	+2%	+7%	+5%
Remove slip lanes at SBB and SGA*	-2%	-6%	-5%	+2%
Remove slip lane at Queensbridge Street	-2%	-4%	-3%	+1%
Preferred layout (60 km/h)	-3%	-2%	+22%	+11%
Alternate layout (60 km/h)	-10%	-21%	+55%	+5%
Preferred layout (50 km/h)	+4%	+3%	+20%	+25%
Preferred layout (40 km/h)	+17%	+49%	+28%	+53%

* SGA = Southgate Avenue

Table E.2 – Summary journey time impacts for Routes 3 and 4

Scenario	Change in journey time compared to existing			
	Route 3 (eastbound)		Route 4 (westbound)	
	AM peak	PM peak	AM peak	PM peak
Pedestrian crossing on Alexandra Avenue	-2%	+1%	+8%	0%
Remove slip lanes at SBB and SGA*	+5%	-3%	-12%	0%
Remove slip lane at Queensbridge Street	+8%	-4%	-11%	-8%
Preferred layout (60 km/h)	+10%	+22%	+34%	+11%
Alternate layout (60 km/h)	+54%	+31%	+146%	+27%
Preferred layout (50 km/h)	+13%	+27%	+25%	+22%
Preferred layout (40 km/h)	+31%	+74%	+51%	+45%

* SGA = Southgate Avenue

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1. Introduction

1.1 Project background

In 2013 GHD was engaged by the City of Melbourne ("Council") to provide traffic engineering and transport planning inputs to the City Road Masterplan study being undertaken by Council.

The aim of the masterplan is to enhance City Road to make it friendlier to pedestrians and cyclists, to reduce the dominance of the carriageway and generally to improve the amenity of the area for local residents and traders. Some of the proposed scenarios involve changes to the road infrastructure which are likely to impact on traffic movements along City Road. City Road is an arterial road under the management of VicRoads. Under the Smart Roads scheme it is designated as a Traffic Route, meaning that its primary function is the movement of traffic. The proposed changes are therefore of interest to VicRoads.

As part of the master plan work, GHD tested a number of scenarios using SIDRA Intersection software. One such change was the removal of one traffic lane in each direction along City Road. The SIDRA analysis indicated that this was likely not to be feasible, but it was noted at the time that SIDRA may not be the best tool to use, as its ability to accurately represent the progression of traffic along a corridor of closely spaced traffic signals is limited. It was agreed that microsimulation modelling would be a more robust way of testing this option.

Council has now engaged GHD to develop two-hour AM and PM peak VISSIM microsimulation models of the City Road/Alexandra Avenue corridor between Cecil Street at the western end and Linlithgow Avenue at the eastern end.

Subsequently, and as part of a separate project, Council requested that Southbank Boulevard be included in the microsimulation model. The model validation report therefore includes Southbank Boulevard between Freshwater Place and Linlithgow Avenue, but as that is a separate project, the results of the option tests are not included in this report. A separate options testing report for the Southbank Boulevard project will be produced after the completion of the City Road option testing.

Prior to carrying out option testing, the model was submitted to VicRoads together with a model validation report for review. Following a round of comments the base (existing conditions) model was accepted as being suitable for options testing in February 2015.

1.2 Purpose of this report

The purpose of this report is to:

- Present the results of scenario testing which represents different options for improving City Road to make it friendlier to pedestrians and cyclists. The purpose of this is to determine the impacts to vehicle, and where necessary, public transport travel times and other network performance statistics.
- Present the results of the analysis with commentary to enable Council and VicRoads to make a decision on which option to take forward.

1.3 Assumptions

This report assumes the following:

- Traffic data collected during the base (existing conditions) model calibration and validation is accurate and reliable;
- Traffic data used in the model is representative of a typical weekday in the study area; and
- There will be no redistribution of traffic as a result of the proposed changes. This means that the reduced capacity network must cope with existing traffic volumes, which in reality are likely to find an alternative route or to cause a switch to another mode of travel. While this could be addressed by assuming a lower volume of traffic in the modelled network, it would be better addressed by undertaking strategic modelling using the Victorian Integrated Transport Model (or similar) but that is beyond the scope of this study. The impact of this assumption is that results may be worse than would be experienced in reality due to the additional volume of traffic in the network.

1.4 Scope and limitations

The focus of this study has been the modelled area only. The impacts of any potential traffic redistribution as a result of the proposed changes have not been considered. Any redistribution has the potential to affect journey time results along City Road and Southbank Boulevard.

2. Model network development

2.1 Modelled time periods

The AM peak and PM peak periods originally required by VicRoads and subsequently modelled are as follows:

- AM peak: 0730 – 0930;
- PM peak: 1700 – 1900.

These time periods represent the evaluation periods within the models. It should be noted that a one-hour warm-up period has been applied to each of these models prior to the commencement of evaluation.

2.2 User classes

The following user classes have been incorporated within the model:

- Light vehicles;
- Heavy vehicles;
- Bus services;
- Tram services; and
- Pedestrians.

2.3 Model time steps

The model runs at a definition of five time steps per simulation second. The value of this parameter affects the interval at which drivers make decisions within the simulation and therefore a higher value implies a more accurate model output.

2.4 Model seed values

The base (existing conditions) model is simulated using five variable ‘seed values’. The seed value affects the generation of the random numbers that influence the model operation and variability. Therefore each time the model is run with a different seed value a slightly different set of outputs is generated. The use of seed values therefore provides confidence that the model results are not based upon a single outlying model run, but the result of a larger sample of model runs.

2.5 Model assignment

The model has been assigned as a dynamic assignment with a single iteration. The study area network developed for the VISSIM modelling has very little route choice, and this has been constrained with the use of edge closures. Therefore further iterations within the microsimulation are not required. The benefit of using a dynamic assignment is to permit the use of traditional square matrices.

2.6 Trip matrices

Base (existing conditions) model trip matrices developed during the calibration and validation of the base (existing conditions) models have been used in option testing. These matrices have been profiled in 15 minute intervals to reflect the high degree of variability in peak traffic demand across each time period. The original trip matrices have been used rather than develop

matrices that assumed re-routing of traffic onto parallel routes. This represents a worst case scenario, as it could reasonably be expected that some of the treatments applied to the network would reduce capacity and cause some re-routing of traffic to alternate routes.

2.7 Links and connectors

Links and connectors have been coded using a scaled background aerial photograph of the study area provided by Council. The majority of traffic links have been coded as 'urban' behaviour type while pedestrian footpaths have been coded as 'footpath' behaviour type. Where links and connectors have been coded in this way the default behavioural values have not been changed.

2.8 Priority intersections

Priority intersections have been coded using several different methods dependent upon location and complexity. For simple priority decisions (such as left turns) the standard conflict area coding has been used. Conflict areas have also been used at diverge points in order to correctly simulate the blocking of some movements by traffic queuing back from storage lanes.

In locations where priority intersections are more complex (such as right turning traffic giving way to opposing traffic and pedestrians) priority rule coding has been used. This allows the use of more detailed headway distance, gap time and speed criteria to be adopted to improve driver behaviour at these locations.

2.9 Signalised intersections

GHD has requested and received a significant volume of signal control data from VicRoads. This data has allowed the development of a signal control system within the models that accurately simulates the operation and timings of on-site controllers.

VISSIM provides a number of methods for simulating signal operation in any given network. These methods include fixed time signals, vehicle actuated programming (VAP) and an interface with external simulation software (such as SCATSIM). While all of the signal controllers in the study area operate using SCATS, this study has not used SCATSIM; rather, the controllers have been coded using VAP, which allows detailed signal logic programming, including public transport priority.

2.10 Travel speeds

Travel speed has been coded at the posted on-site speed limits for the study area. These are primarily 60 km/h for City Road and Southbank Boulevard and 50 km/h for feeder routes. The standard VISSIM default distributions have been adjusted to allow for a normal distribution of up to 10% around the mean.

Options which alter the speed limit have been coded by adjusting the speed distribution profile of the relevant speed limits to avoid the need to code every speed limit individually.

2.11 Public transport

There is a moderate amount of public transport activity within the study area and this has been simulated within the model.

Tram routes 1, 12 and 55 have been modelled to operate along their prescribed routes using actual timetabled arrival and departure times. Due to the large number of services, all other tram routes along St Kilda Road have been modelled using an average service rate. This is considered adequate as St Kilda Road is not part of the core model area and is included

primarily to allow queueing to be modelled at the Southbank Boulevard intersection. Tram dwell times are not available and have been estimated based on previous experience.

Bus movements have been coded to represent each of the services operating within the study area in the peak periods. Other bus details such as the use of the tram reservation on Queensbridge Street have also been included. Dwell time data is not available and has been estimated based on previous work undertaken in the central Melbourne area.

2.12 Saturation flows

In order to simulate the reduction in saturation flow due to turn geometry, reduced speed areas have been coded for left and right turns throughout the network or where conditions dictate that traffic consistently reduces speed. The values assigned to each turn are categorised based upon a combination of a number of factors. These include:

- Turn radius;
- Lane width;
- Visibility; and
- Gradient.

2.13 Pedestrian activity

Pedestrian count data was collected as part of the turning movement counts at signalised intersections and have been replicated in the model. The exception to this is at Clarke Street and Balston Street where pedestrians cross City Road without priority. While pedestrian crossing data has been collected at these locations, they have not been modelled due to the complexity of accurately replicating the observed pedestrian behaviour. For example, pedestrians have been observed crossing to the centre of the road where there is no median in order to stage their crossing. The approach taken is considered adequate for validation purposes, as pedestrians generally do not obstruct traffic at these intersections.

Observations were made on site regarding the speed of pedestrians walking across the road and the subsequent blocking of left turning and right turning vehicles. These have been replicated in the model.

3. Base (existing conditions) model calibration and validation

3.1 Introduction

This section sets out the key calibration and validation statistics from the preparation of the base (existing conditions) model. The calibration and validation of a base model is important to ensure a robust base from which to test options and provide statistical comparisons of existing layouts against options. Full calibration and validation statistics are presented in a separate model validation report (GHD doc ref 238683).

3.2 Calibration results

A turning count calibration was used to compare observed on-site traffic volumes with equivalent outputs from the model. A turning count calibration was undertaken for each of the major intersections and the purpose of this calibration was to check the traffic volumes collected from the models were representative of traffic volume observed on site for each traffic movement at each intersection. The following criteria were used during the turning counts calibration process:

- 85% of GEH statistics for individual junction turning-movement total volumes should be less than 5
- R2 statistic should be between 0.9 and 1.0 for a flow plot of observed vs. modelled turn volumes (where R^2 = 1.0 is a perfect correlation)

Table 3.1 demonstrates that the modelled turning volumes exceed the target GEH criteria.

Table 3.1 – Turning count calibration – GEH comparison

	Number of turning counts with GEH < 5			
	AM peak		PM peak	
	0730 – 0830	0830 – 0930	1700 – 1800	1800 – 1900
Target	85%	85%	85%	85%
Modelled	96%	97%	94%	93%
Passed?	Yes	Yes	Yes	Yes

Figure 3.1 and Figure 3.2 present these results in a scatter graph format comparing modelled volumes against surveyed volumes for the AM peak and PM peak periods respectively. It can be seen in both graphs that there is an excellent fit between modelled and observed turning movements.

Figure 3.1 – AM peak VISSIM model observed vs modelled turning volume scatter plot

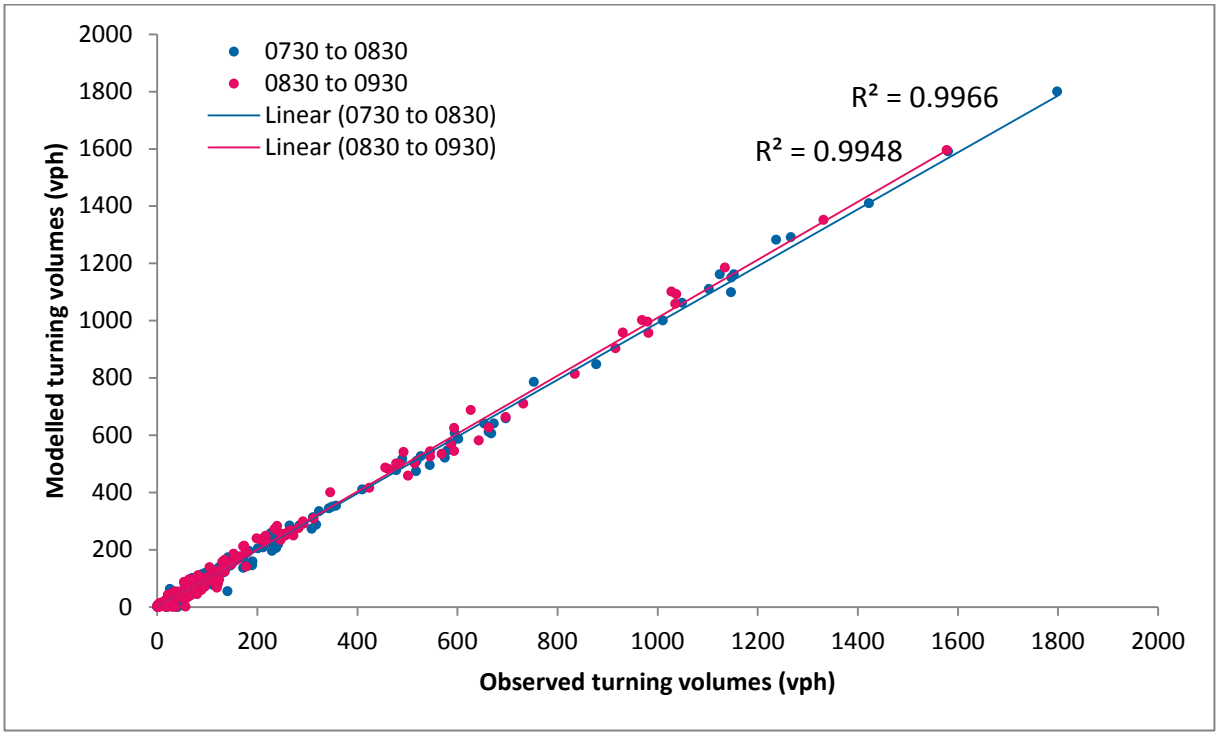
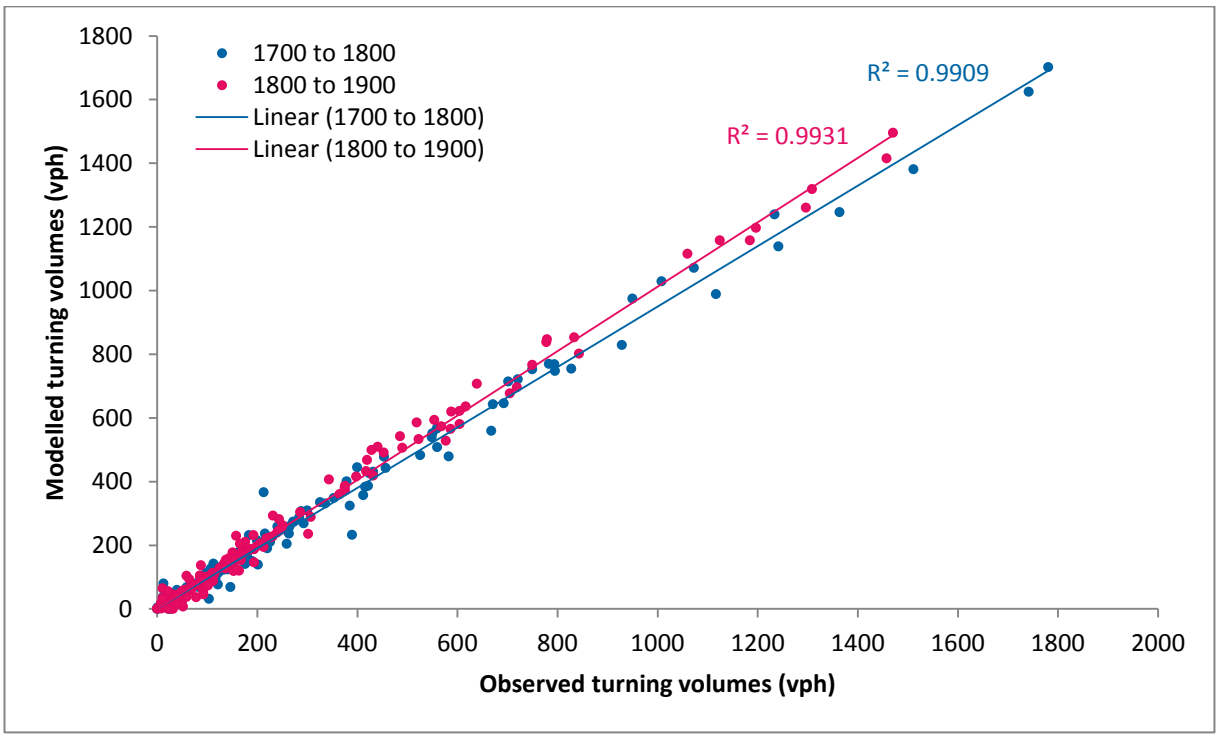


Figure 3.2 – PM peak VISSIM model observed vs modelled turning volume scatter plot



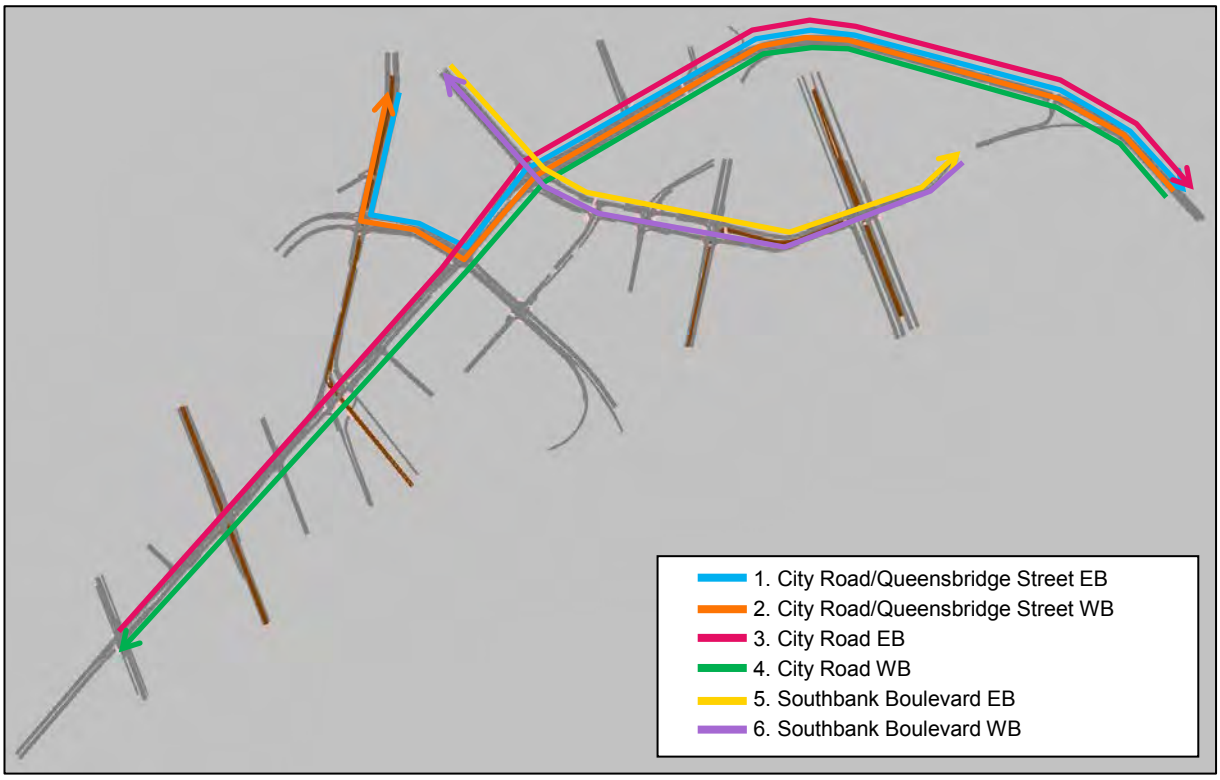
3.3 Validation results

3.3.1 Validation criteria

A generally accepted criterion within the industry when validating microscopic models to travel time data is that the modelled median travel time (from five individual model runs) should be within 15% or one minute (whichever is the greater) of the observed median travel time value. A journey time within these bounds is deemed to be representative of actual journey times.

The journey times routes are shown in Figure 3.1. They were decided in conjunction with VicRoads for the purposes of validating the most important routes through the network and for ensuring that the validation would be sufficiently representative of observed conditions.

Figure 3.1 – Journey time routes



3.3.2 AM peak

Travel time validation results are presented in Table 3.1 for the AM peak period. It shows that for all vehicle types an acceptable level of validation has been achieved for this peak period.

Table 1.1 – VISSIM model travel time comparison (AM peak)

Route	Median journey time (secs)		Difference (secs)	Difference (%)	Meets criteria?
	Observed	Modelled			
1. Queensbridge Street/City Road – EB	197	175	-28	-9%	Yes
2. Queensbridge Street/City Road – WB	385	393	+8	+2%	Yes
3. City Road – EB	298	270	-28	-9%	Yes
4. City Road – WB	278	314	+36	+13%	Yes
5. Southbank Boulevard – EB	202	165	-37	-18%	Yes
6. Southbank Boulevard – WB	186	199	+13	+7%	Yes

AM peak journey time results for the six runs are shown in Figure 1.2 to Figure 1.7.

Figure 1.2 – Route 1 journey time validation – Queensbridge Street/City Road (eastbound, AM peak)

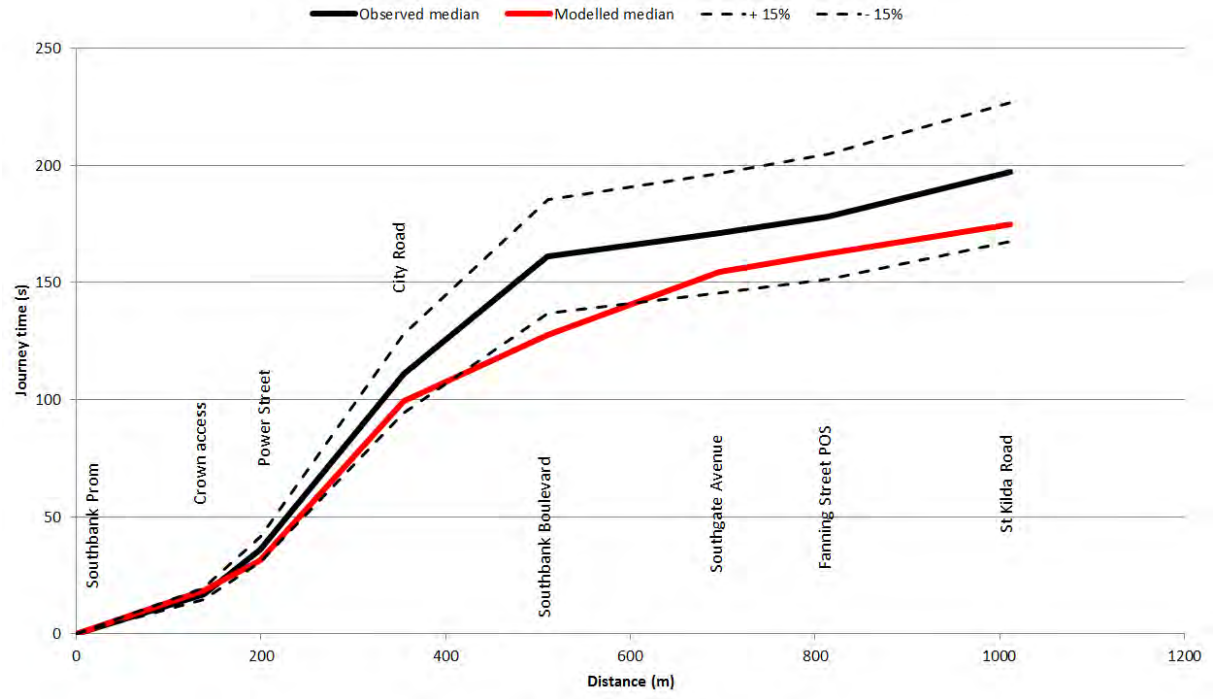


Figure 1.3 – Route 2 journey time validation – Queensbridge Street/City Road (westbound, AM peak)

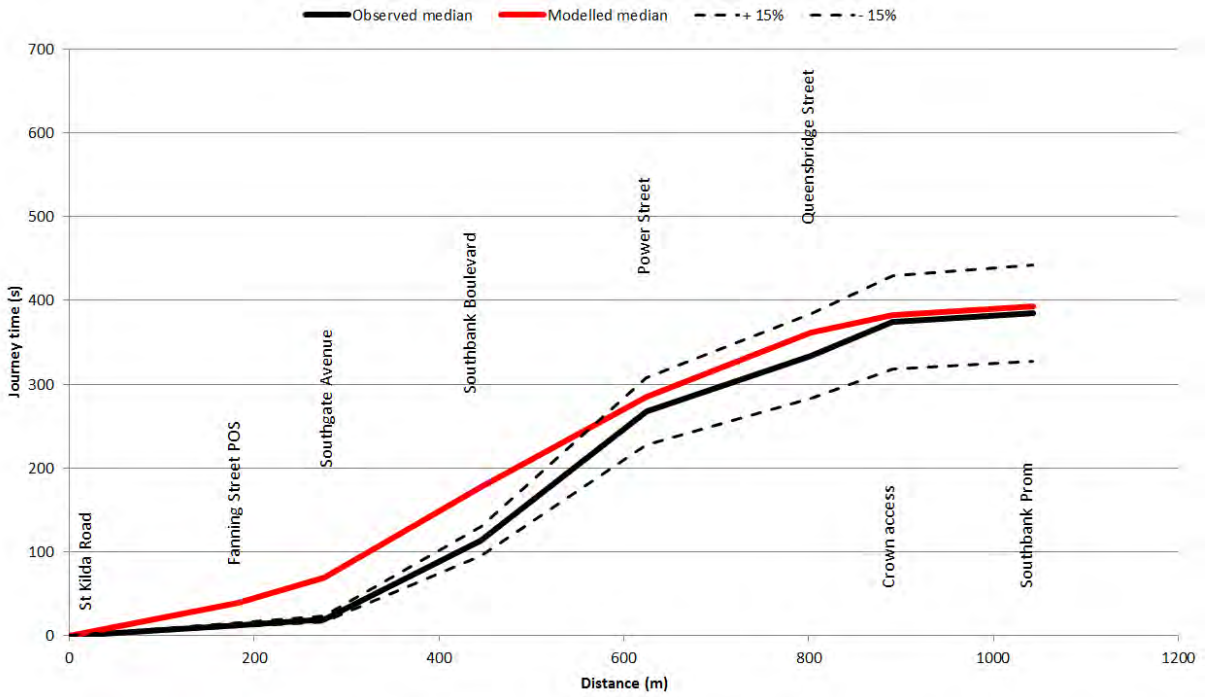


Figure 1.4 – Route 3 journey time validation – City Road (eastbound, AM peak)

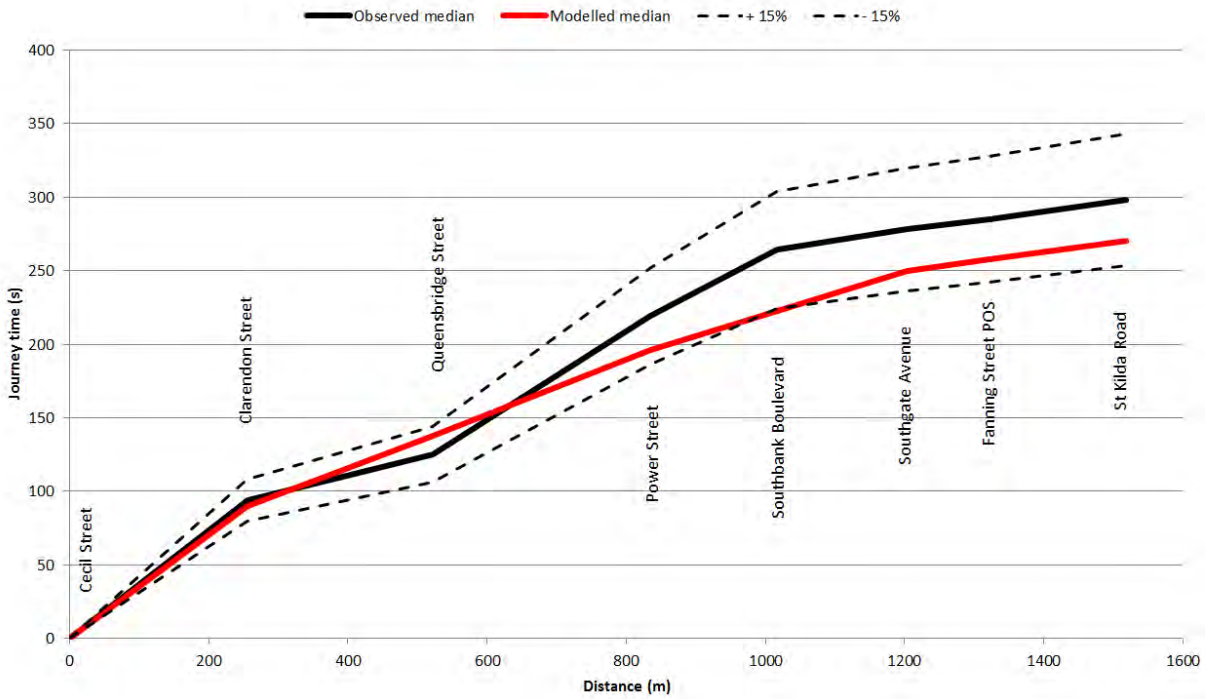


Figure 1.5 – Route 4 journey time validation – City Road (westbound, AM peak)

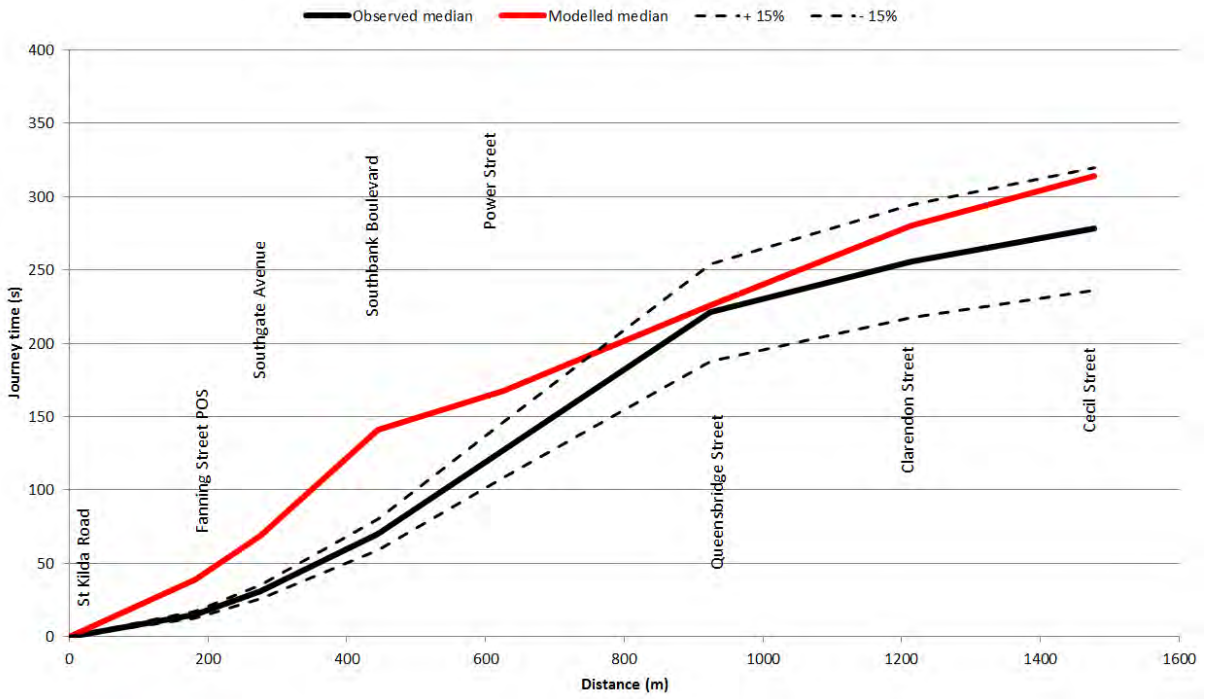


Figure 1.6 – Route 5 journey time validation – Southbank Boulevard (eastbound, AM peak)

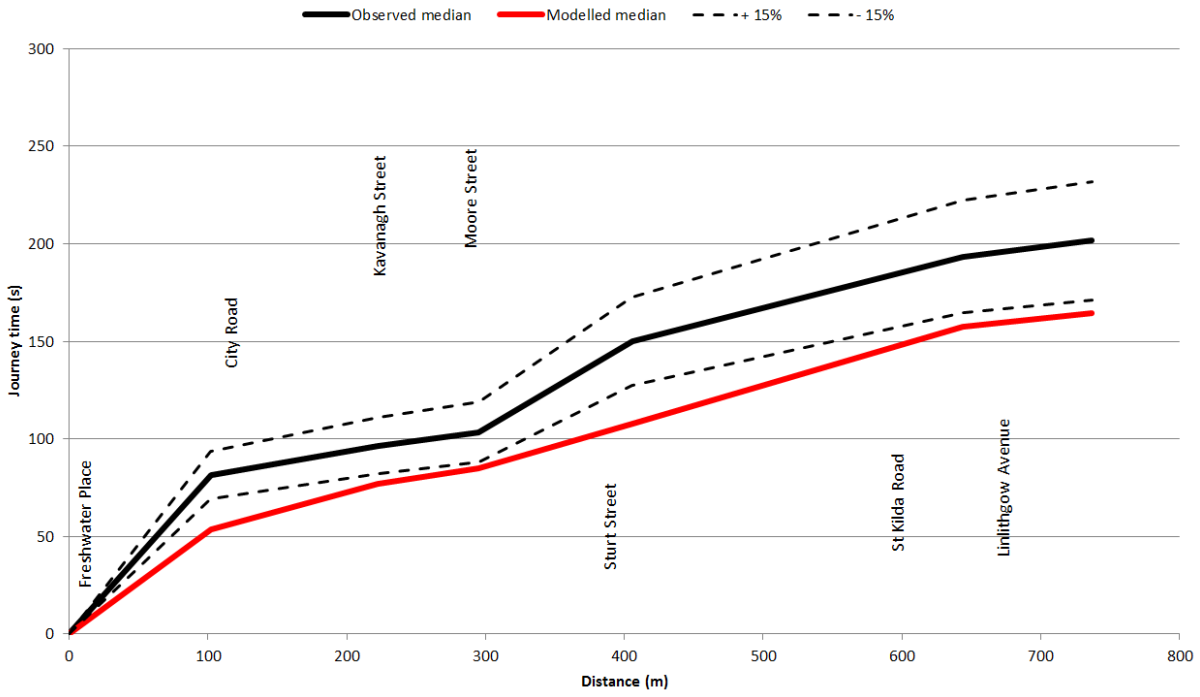
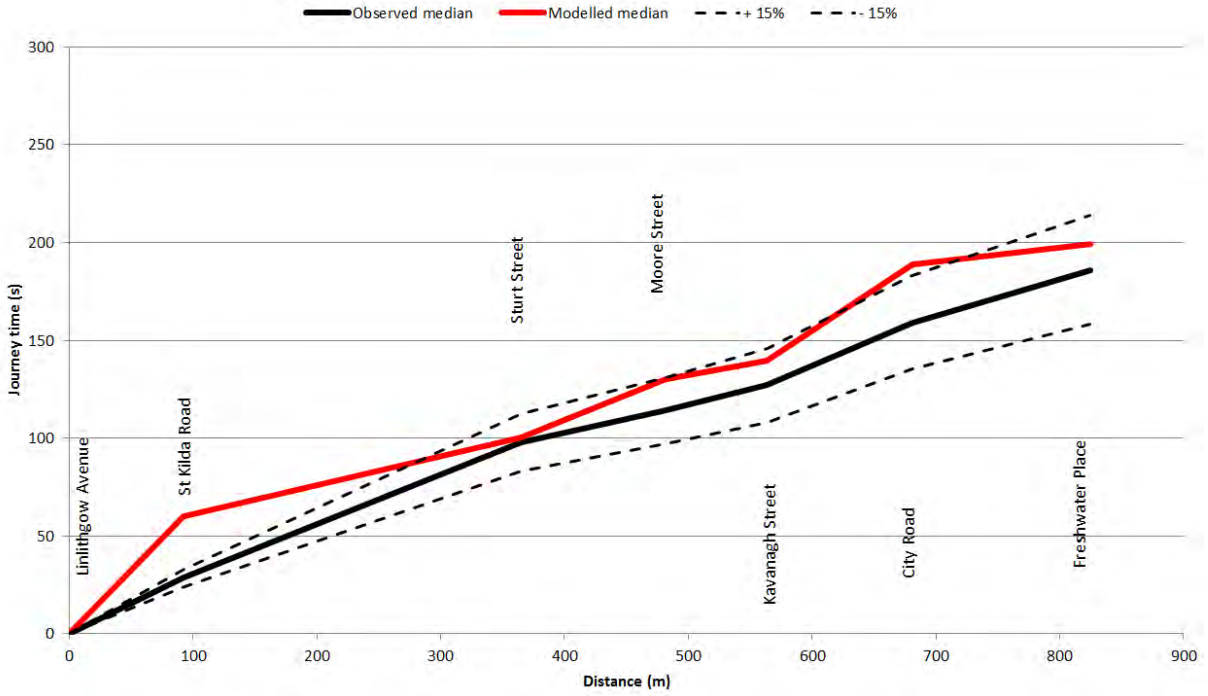


Figure 1.7 – Route 6 journey time validation – Southbank Boulevard (westbound, AM peak)



3.3.3 PM peak

Travel time validation results are presented in Table 1.2 for the PM peak period. It shows that for all vehicle types that an acceptable level of validation has been achieved for this peak period with the exception of Route 4. Despite not meeting the journey time validation criteria for one route, the model has been deemed acceptable for use in options testing by VicRoads.

Table 1.2 – VISSIM model travel time comparison (PM peak)

Route	Median journey time (secs)		Difference (secs)	Difference (%)	Meets criteria?
	Observed	Modelled			
1. Queensbridge Street/City Road – EB	250	212	-39	-15%	Yes
2. Queensbridge Street/City Road – WB	275	255	-20	-7%	Yes
3. City Road – EB	303	294	-9	-3%	Yes
4. City Road – WB	417	309	-108	-26%	No
5. Southbank Boulevard – EB	201	180	-21	-10%	Yes
6. Southbank Boulevard – WB	172	208	+36	+21%	Yes

PM peak journey time results for the six runs are shown in Figure 1.8 to Figure 1.13.

Figure 1.8 – Route 1 journey time validation – Queensbridge Street/City Road (eastbound, PM peak)

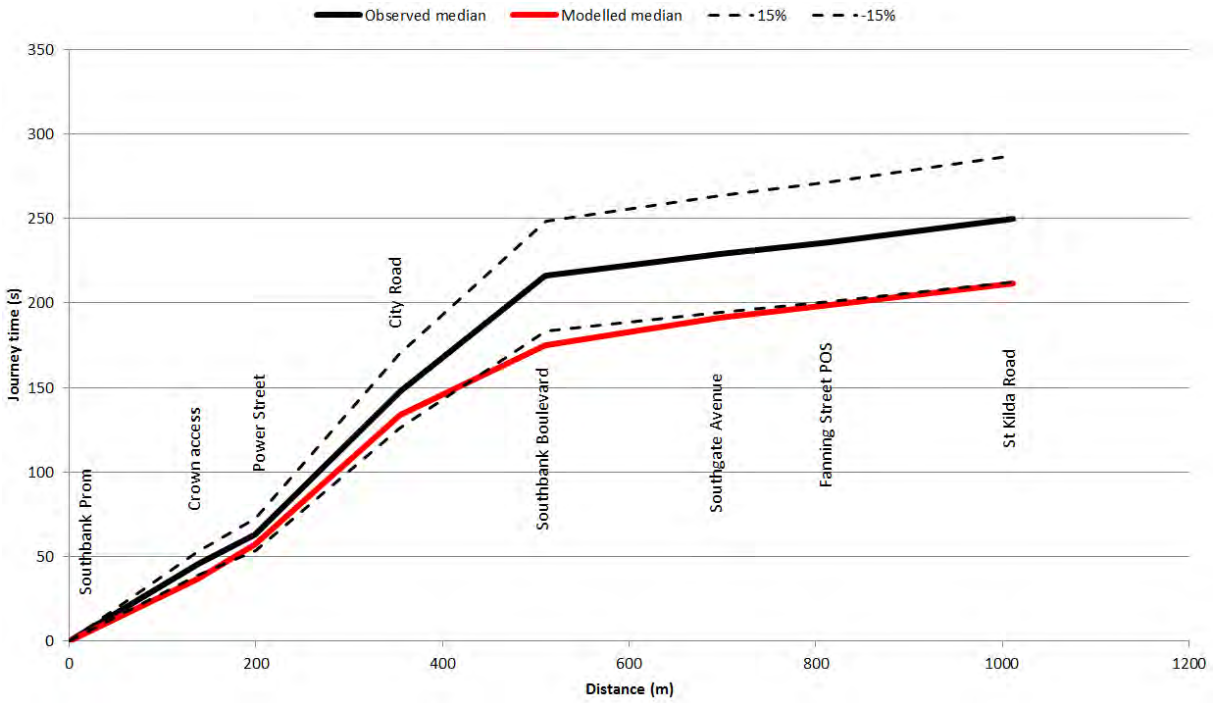


Figure 1.9 – Route 2 journey time validation – Queensbridge Street/City Road (westbound, PM peak)

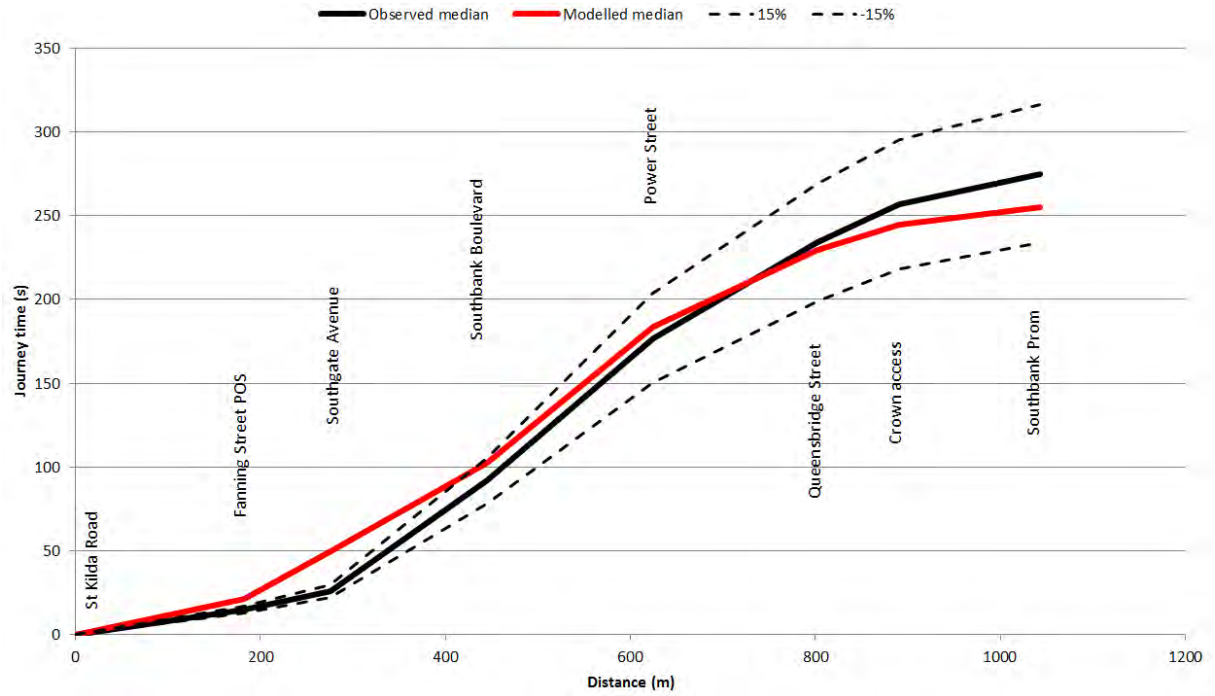


Figure 1.10 – Route 3 journey time validation – City Road (eastbound, PM peak)

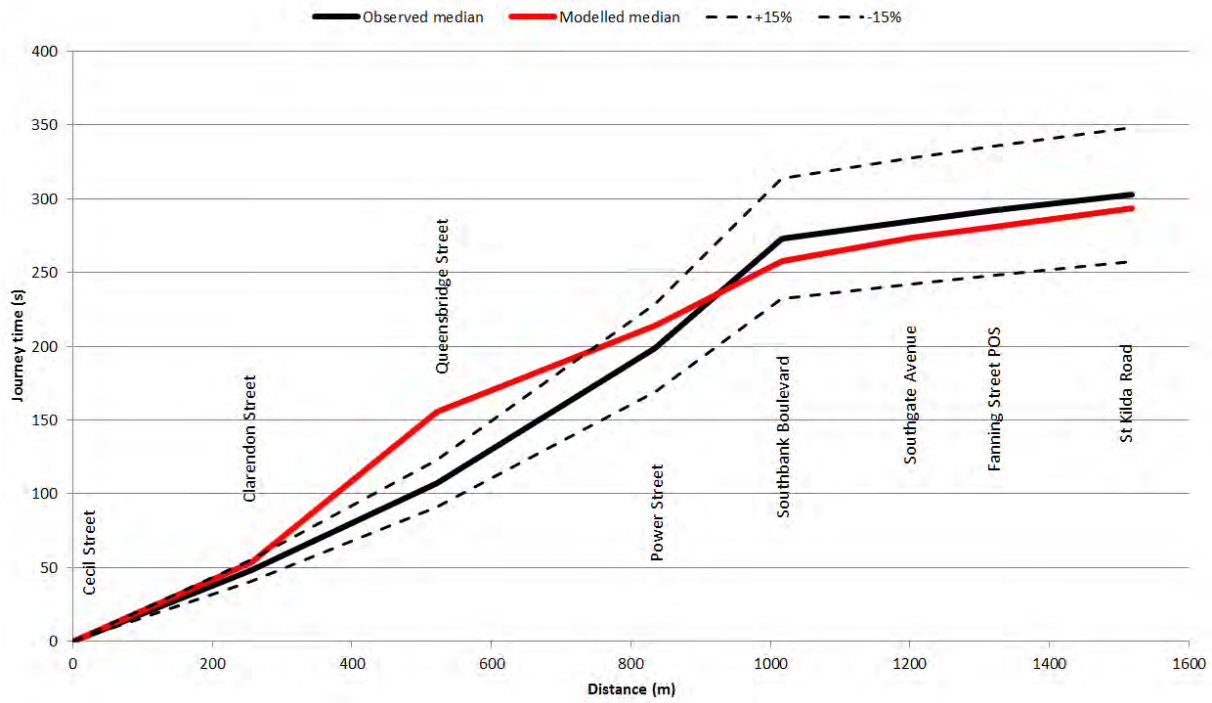


Figure 1.11 – Route 4 journey time validation – City Road (westbound, PM peak)

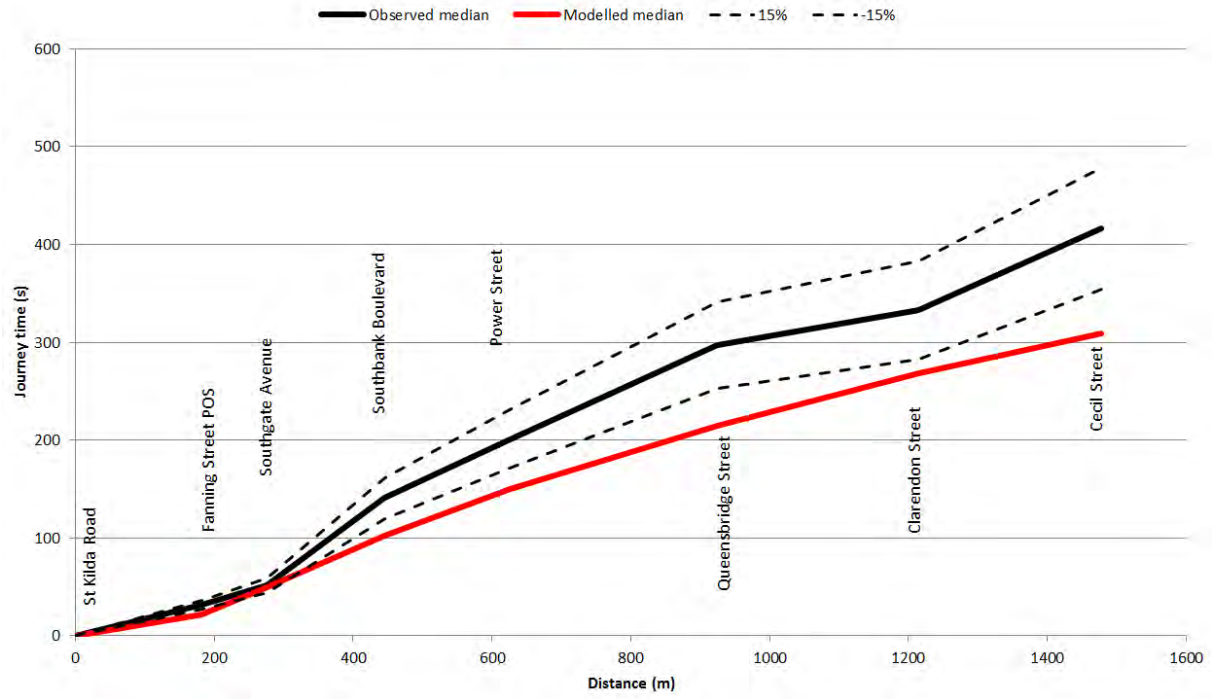


Figure 1.12 – Route 5 journey time validation – Southbank Boulevard (eastbound, PM peak)

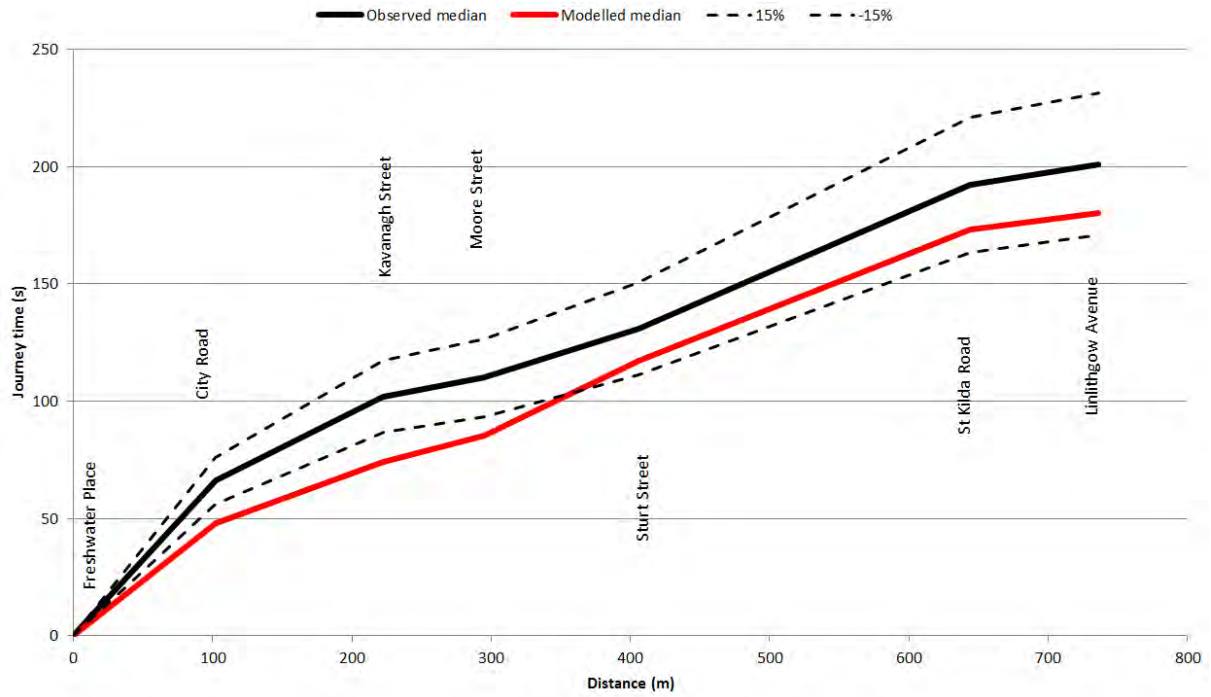
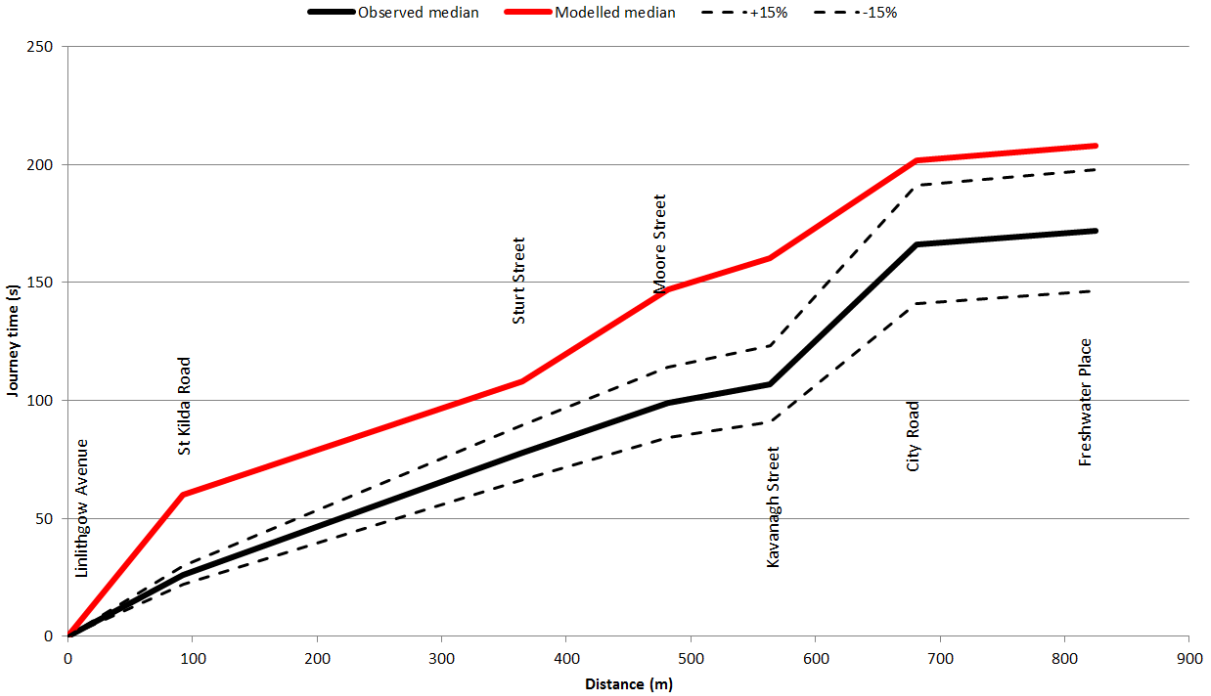


Figure 1.13 – Route 6 journey time validation – Southbank Boulevard (westbound, PM peak)



4. Overview of initial options

4.1 Introduction

Council has developed a number of concept designs (options) which make up various scenarios. A relatively large number of options need testing in various combinations to develop the preferred scenario. As these options can (and will) exist in combination, a bottom-up approach has been adopted whereby the first option has been added to the base case (existing conditions) and each subsequent option has been added to the previous option. In this way it is possible to see the impacts of each option incrementally, rather than as a whole, which would mask the individual impacts.

4.2 Options tested in all scenarios

There are a number of options which will be common to all scenarios. These are:

- New pedestrian crossing on Alexandra Avenue
- Removal of slip lanes at Southbank Boulevard and Southgate Avenue intersections
- Removal of slip lanes and Moray Street underpass at the Queensbridge Street/Moray Street intersection

Collectively, these options are called the *City Road East and Alexandra Avenue improvements scenario*, which forms an interim base against which all subsequent options will be tested.

The options testing process has addressed each of these options in a cumulative manner. For example, the removal of slip lanes in the Southbank Boulevard and Southgate Avenue scenario also includes the pedestrian crossing on Alexandra Avenue. In this way, it is possible to see the impact of each treatment incrementally.

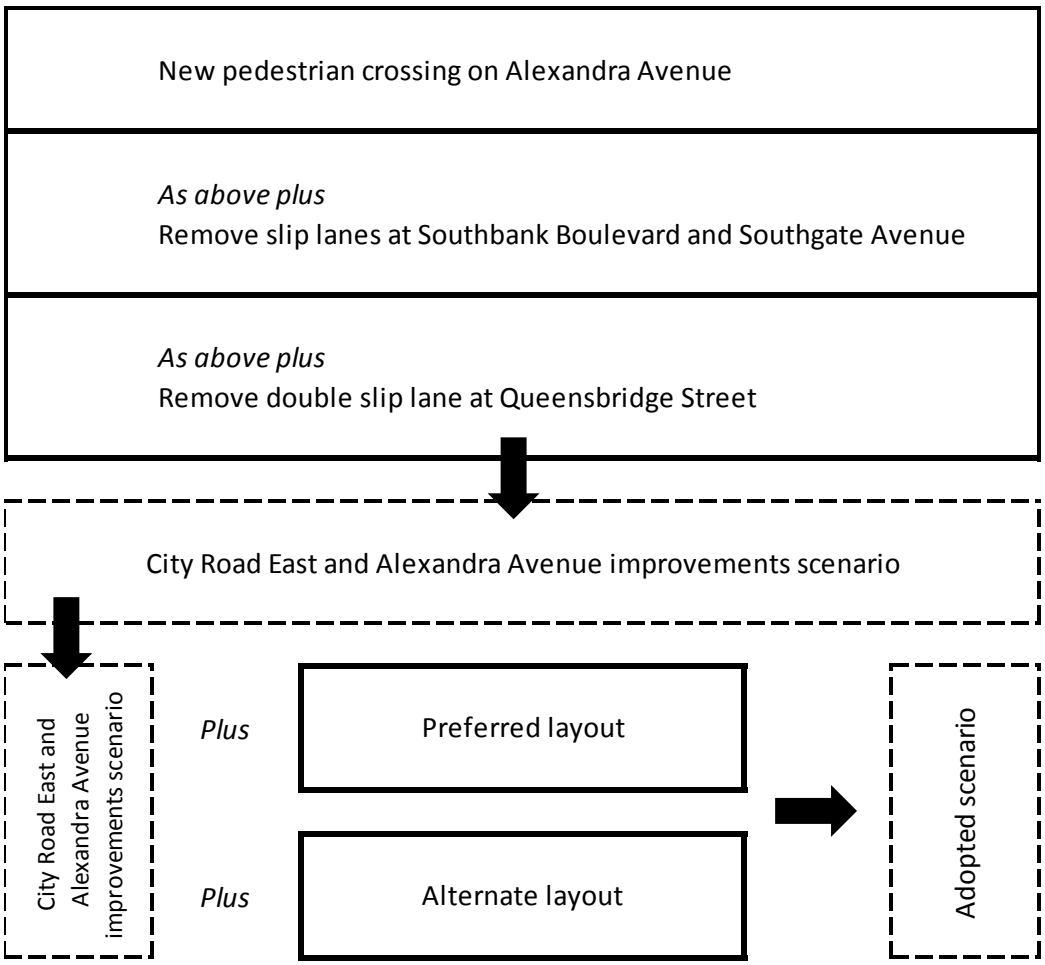
4.3 City Road West improvements

Two layouts have been tested: a preferred layout and an alternate layout. These designs generally involve changes to mid-block lane configurations and some intersection treatments on City Road between Clarendon Street and Power Street. These options are known as the *City Road West improvements*. The changes generally facilitate bus and bike lanes and footpath widening. The concept designs for these improvements are shown in Appendix A.

The City Road West improvements are in addition to the City Road East and Alexandra Avenue improvements.

The options testing process is summarised in Figure 4.1.

Figure 4.1 – Summary of options testing process



5. Option refinement

5.1 Introduction

During the testing of each common option it became apparent that some would not work as presented in the concept designs. The reasons for this generally involve unacceptable increases to journey times or intersection delays. The model has been used to refine the options so that the negative impacts are minimised. This section details the changes that have been made to the options. The results of these refined options are presented in Section 6.

5.2 New pedestrian crossing

This option consists of a new pedestrian crossing on Alexandra Avenue. No changes to the concept design have been made.

The crossing has been added to the model approximately half way between Linlithgow Avenue and where the St Kilda Road underpass cutting flattens out. The crossing has been linked to the Linlithgow Avenue signals. The system detects a pedestrian push button call and provides a pedestrian green phase after the main City Road pivot phase ends at the Linlithgow Avenue intersection. This has been set up to minimise the chances of westbound vehicles being stopped by the pedestrian crossing

On advice from the City of Melbourne, it has been assumed that 25 pedestrians will cross per hour in each direction in the AM peak, and 30 pedestrians will cross per hour in each direction in the PM peak. These have been split equally into 15 minute periods.

5.3 Removal of slip lanes at Southbank Boulevard and Southgate Avenue

This option consists of the removal of slip lanes at Southbank Boulevard and Southgate Avenue. At Southbank Boulevard the left turn movement will take place from the adjacent through lane (which becomes a shared left/through lane). At Southgate Avenue the lane configuration consists of one left and one right turn lane, both of which are at the stop line.

During early tests it became apparent that removing the slip lane on the south-east corner of the Southbank Boulevard intersection (i.e. the south to west movement) would substantially increase journey times and queues on the south approach. This was for two reasons:

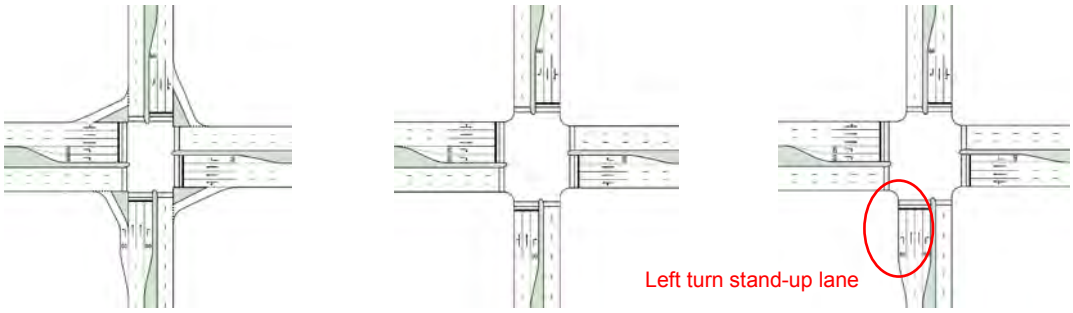
- The shared movement results in a loss of through capacity in the left lane; and
- The left turners are now delayed by pedestrians crossing City Road. This further exacerbates delays for through traffic.

Following these tests, it was decided that the loss of the slip lane on the south-east corner of the Southbank Boulevard intersection would not work as proposed. An alternate option consisting of a standard left turn lane at the stop line (plus two through lanes and a right turn lane) has therefore been developed.

The changes to this option are shown in Figure 5.1.

Note that no changes have been made to the concept at Southgate Avenue.

Figure 5.1 – Refinement of the removal of slip lanes (Southbank Boulevard)



5.4 Queensbridge Street slip lane and Moray Street underpass

This option consists of the removal of the double left turn slip lane on the west approach to the Queensbridge Street intersection and the removal of the Moray Street underpass. Vehicles previously using the slip lane into Queensbridge Street will now turn at the stop line and will share the lane with through traffic. The removal of the Moray Street underpass requires two things:

- The existing one-way section of the northbound carriageway on Moray Street must be converted to two-way travel. To accommodate the new southbound lane, the number of northbound lanes must be reduced from three to two.
- Southbound traffic from Queensbridge Street currently crosses City Road and turns right under Kings Way. In the new layout this traffic must turn right into City Road, then left into Moray Street onto the new southbound lane.

Testing the above lane configuration resulted in large increases in journey time on Route 1 in the AM peak. This was due to the additional vehicles turning right into City Road to access Moray Street (which previously went straight ahead) causing a queue on Queensbridge Street which extended back past Power Street. Vehicles turning left into Power Street were therefore delayed by this queue.

Additionally, the northbound queue of traffic on Moray Street extended due to the loss of through capacity at the stop line. At the end of the simulation period approximately 150 vehicles were unable to enter the model, which means that the queue and delay are longer than results would suggest.

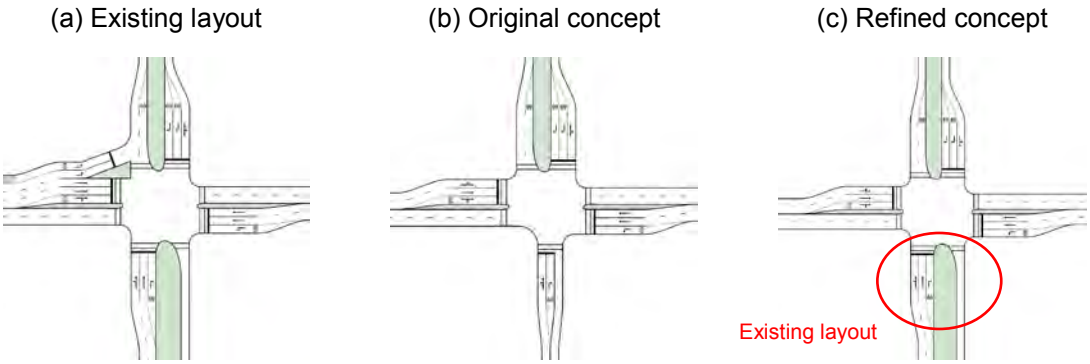
To alleviate the above issues, the following changes to this option have been tested:

- The lane configuration on the north approach has been altered so that the two right turn lanes occupy most of the road space while the left/through lane is a short lane.
- The lane configuration on the south approach has been altered to provide a left/through lane and through/right lane. This permits northbound traffic to travel through the intersection in two lanes before merging on the departure side. This lane configuration requires a change in signal operation, as the through and right turn movements can no longer operate separately. (Currently, the through movement runs during tram phases and provides additional capacity for that movement.) Additionally, extra green time has been allocated to the Moray Street phase (at the expense of City Road) to compensate for the loss of stop line capacity.

The above changes do alleviate the queuing issue on Queensbridge Street, which brings journey times on Route 1 back in line with those for the removal of slip lanes at Southbank Boulevard and Southgate Avenue scenario (i.e. no net change). However, while the changes to the Moray Street approach do improve queueing on that road, up to 100 vehicles are still unable to enter the network.

Given the above, it has been decided that the removal of the Moray Street underpass should be excluded from the Queensbridge Street/Moray Street layout changes. This is shown in Figure 5.2.

Figure 5.2 – Refinement of Option 4



6. Option test results

6.1 Introduction

This section presents a summary of the option test results and provides explanations of how each option compares. The results presented are for the refined options as described in Section 5.

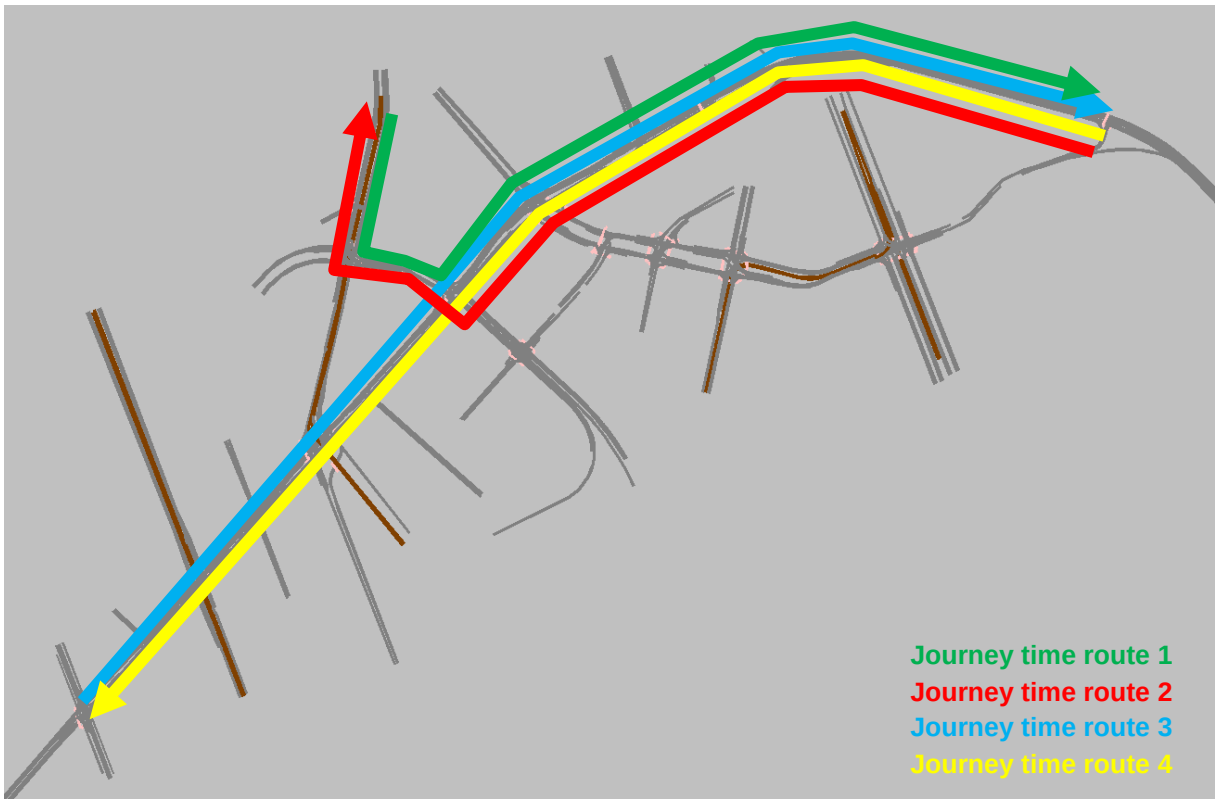
Journey times are presented for all options, while intersection delays are presented only for the City Road East and Alexandra Avenue improvements scenario and the City Road West layouts.

The journey time routes are as follows:

1. Queensbridge Street/City Road between Southbank Promenade and Linlithgow Avenue
2. Queensbridge Street/City Road between Linlithgow Avenue and Southbank Promenade
3. City Road between Cecil Street and Linlithgow Avenue
4. City Road between Linlithgow Avenue and Cecil Street

These are shown in Figure 6.1.

Figure 6.1 – Journey time routes



6.2 Journey time results

6.2.1 City Road East and Alexandra Avenue improvements scenario (AM peak)

This scenario is made up of the new pedestrian crossing on Alexandra Avenue and the removal of the slip lanes at Southbank Boulevard, Southgate Avenue and Queensbridge Street intersections. This scenario is therefore the base against which the City Road West layouts will be tested. This section presents the results of the options which make up the City Road East and Alexandra Avenue improvements scenario compared to the base case (existing conditions). In subsequent sections, the City Road West layout will be compared to the City Road East and Alexandra Avenue improvements scenario and the base case (existing conditions).

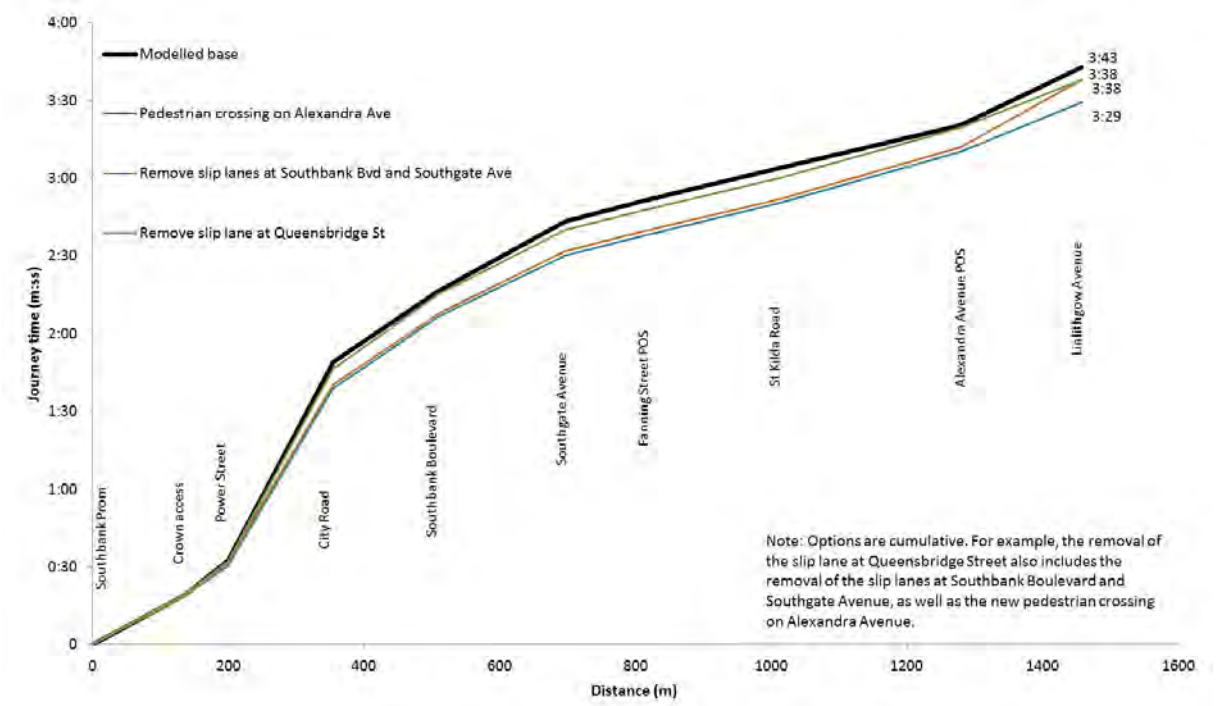
Routes 1 and 2

These routes travel between Queensbridge Street at Southbank Promenade to Alexandra Avenue at Linlithgow Avenue in the eastbound and westbound directions respectively. The results of the option tests are shown in Figure 6.2, Figure 6.3, Table 6.1 and Table 6.2.

The analysis indicates that:

- For Route 1, there is very little difference in overall travel times with some very minor improvements in travel time with some of the options. However, these minor improvements should be viewed as being well within the typical variation experienced within urban locations on a day to day basis.
- For Route 2 there are also some minor differences in travel time relative to the base model. Again, these minor changes should be viewed as being well within the typical variation experienced within urban locations on a day to day basis.

Figure 6.2 – Results of journey time tests for Route 1 (AM peak)



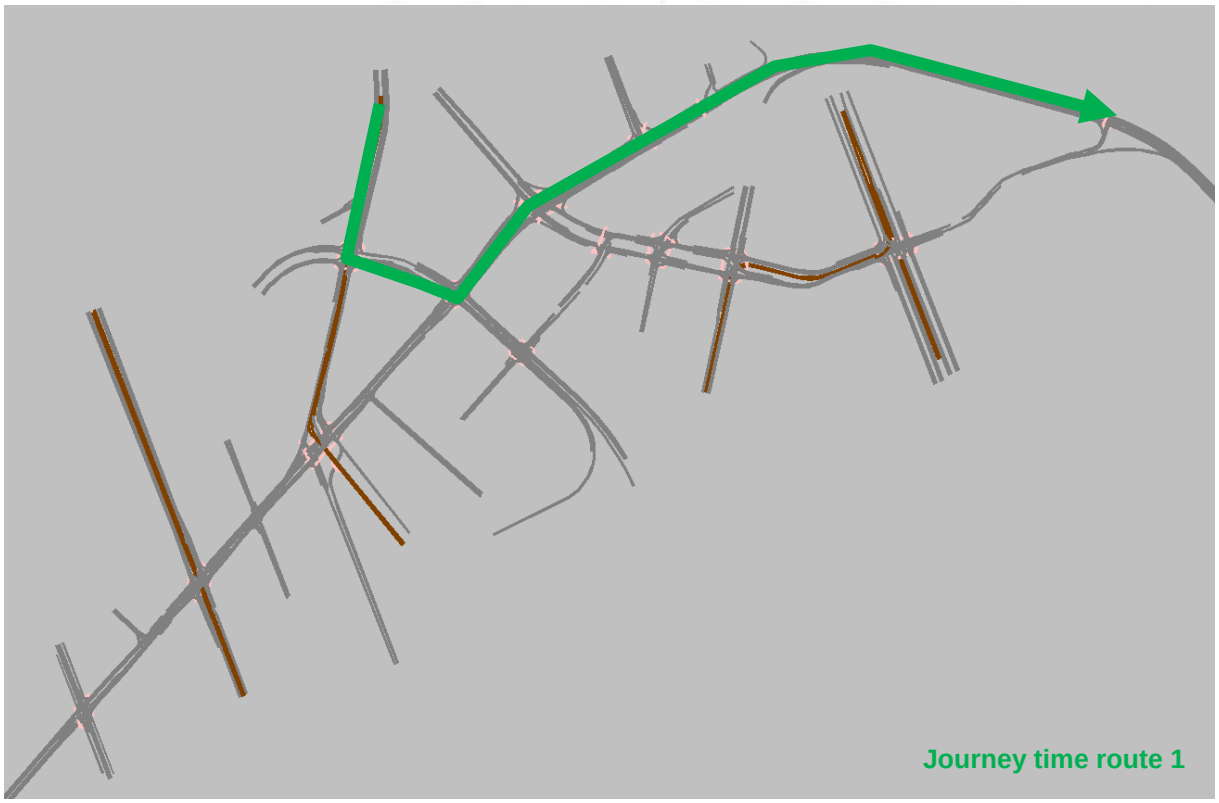
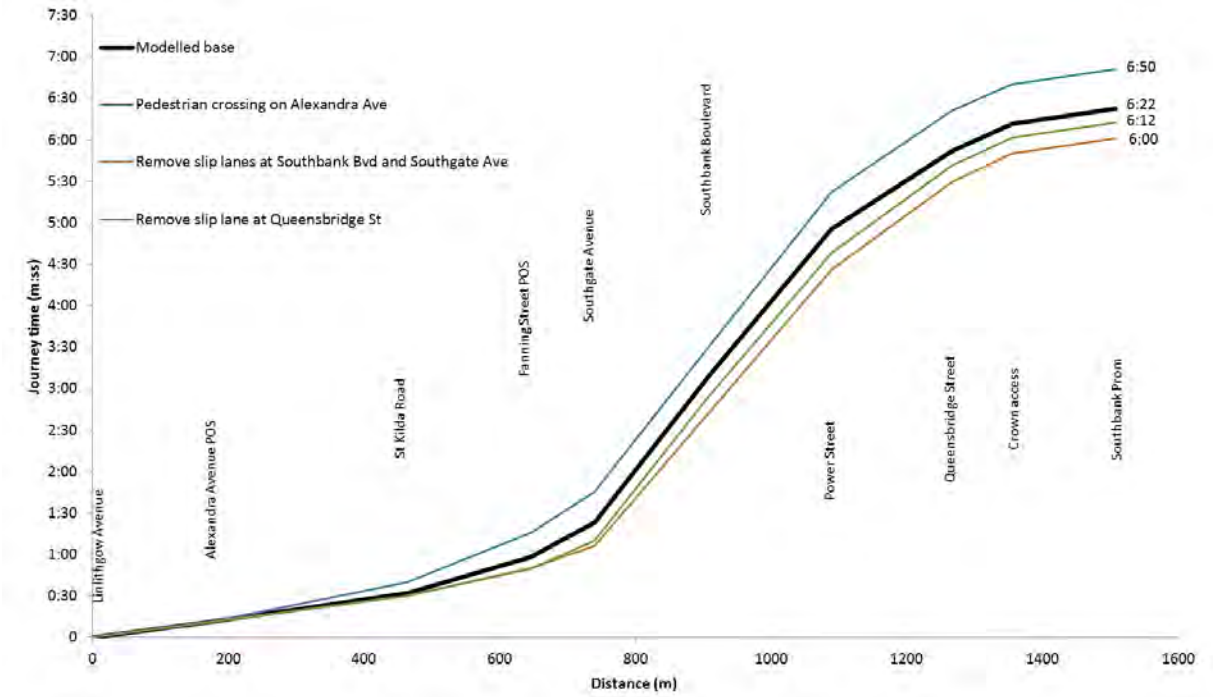


Figure 6.3 – Results of journey time tests for Route 2 (AM peak)



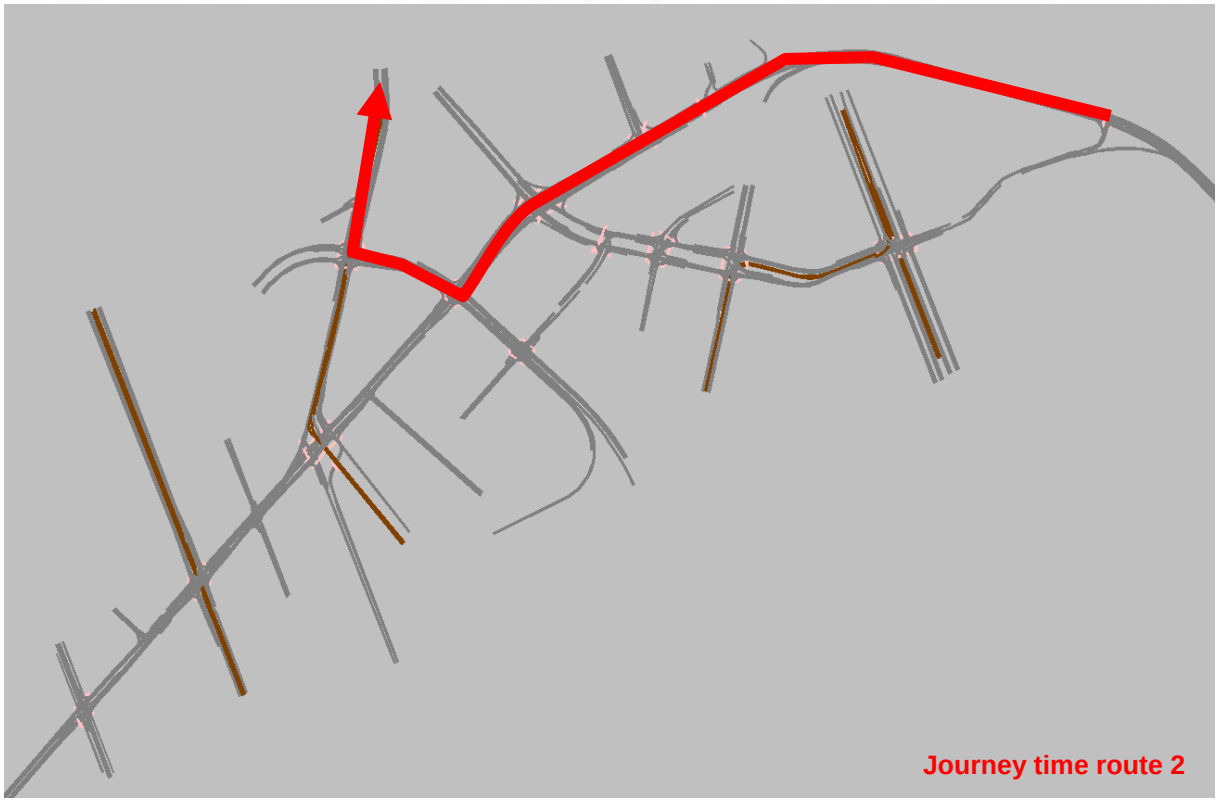


Table 6.1 – Journey time results by section for Route 1 (AM peak)

Section ending	Existing	Ped crossing	Remove slips Southbank & Southgate	Remove slip Queensbridge
Crown access	0:20	0:19	0:19	0:20
Power Street	0:13	0:11	0:13	0:12
City Road	1:16	1:08	1:09	1:14
Southbank Boulevard	0:28	0:28	0:28	0:29
Southgate Avenue	0:27	0:23	0:24	0:25
Fanning Street POS	0:08	0:08	0:08	0:08
St Kilda Road	0:12	0:12	0:12	0:12
Alexandra Avenue POS	0:17	0:20	0:20	0:19
Linlithgow Avenue	0:22	0:19	0:26	0:19
TOTAL	**3:43**	**3:29**	**3:38**	**3:38**
Per cent change from base		-6%	-2%	-2%

Note: options above are cumulative.

Table 6.2 – Journey time results by section for Route 2 (AM peak)

Section ending	Existing	Ped crossing	Remove slips Southbank & Southgate	Remove slip Queensbridge
Alexandra Avenue POS	0:12	0:12	0:12	0:12
St Kilda Road	0:20	0:28	0:19	0:18
Fanning Street POS	0:26	0:36	0:20	0:20
Southgate Avenue	0:25	0:30	0:16	0:20
Southbank Boulevard	1:47	1:45	1:37	1:45
Power Street	1:45	1:51	1:43	1:43
Queensbridge Street	0:57	0:59	1:03	1:03
Crown access	0:20	0:19	0:21	0:20
Southbank Prom	0:11	0:11	0:11	0:11
TOTAL	**6:22**	**6:50**	**6:01**	**6:12**
Per cent change from base		7%	-5%	-3%

Note: options above are cumulative.

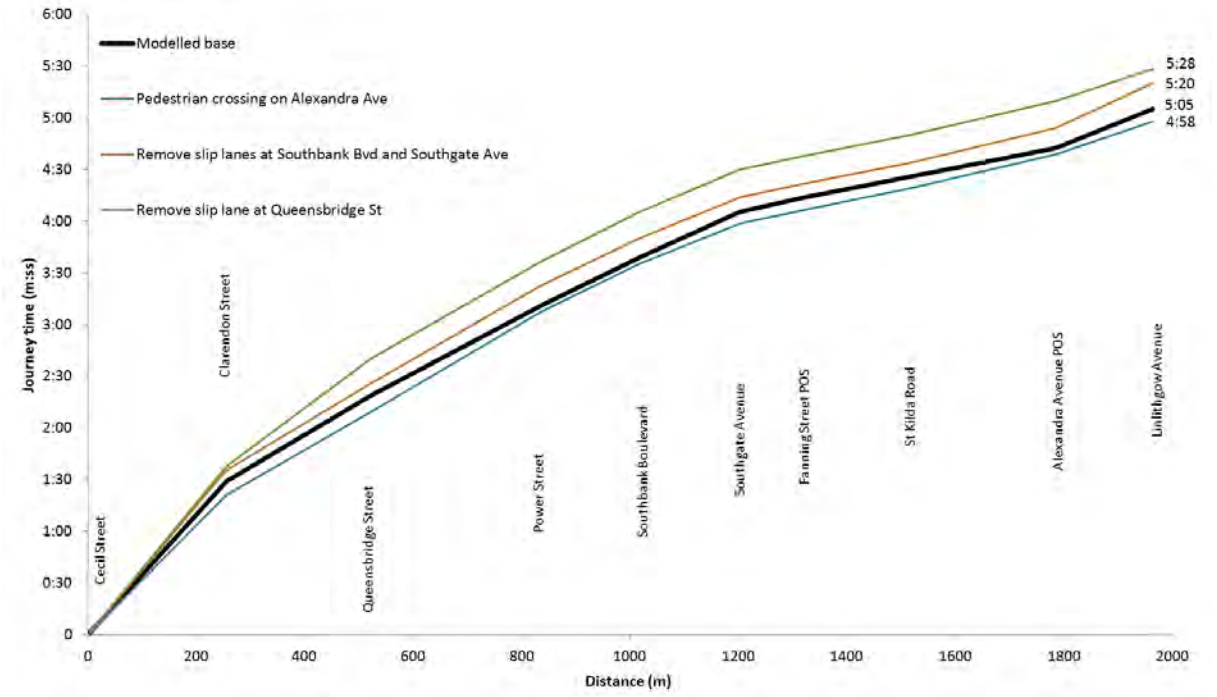
Routes 3 and 4

These routes travel along City Road/Alexandra Avenue between Cecil Street and Linlithgow Avenue in the eastbound and westbound directions respectively. The results of the option tests are shown in Figure 6.4, Figure 6.5, Table 6.3 and Table 6.4.

The analysis indicates that:

- For Route 3 there is very little difference in overall travel times with some very minor improvements in travel time with some of the options. However, these minor improvements should be viewed as being well within the typical variation experienced within urban locations on a day to day basis.
- For Route 4 there is some variation in overall travel time caused mainly on the approach to Southbank Boulevard:
  - There is a small increase in travel time on approach in the 'Pedestrian crossing on Alexandra Ave' option most likely due to small changes in arrival rates at the Southbank Boulevard and City Road intersection caused by the pedestrian crossing.
  - For the subsequent two options there is a small improvement in travel time which is due to the headways of vehicles on approach to the intersection decreasing slightly due to the removal of the slip lanes. This means that green signal times on the main east-west movement along City Road increase slightly leading to a minor improvement in travel time.

Figure 6.4 – Results of journey time tests for Route 3 (AM peak)



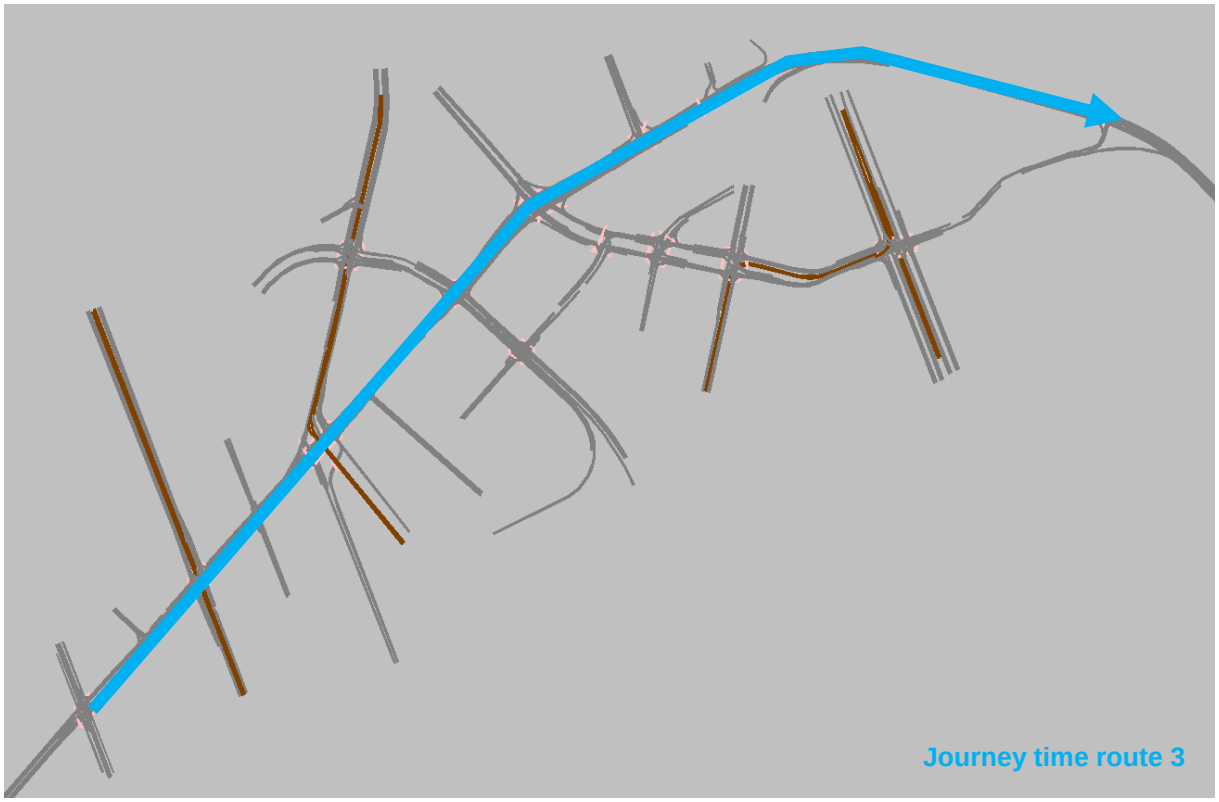
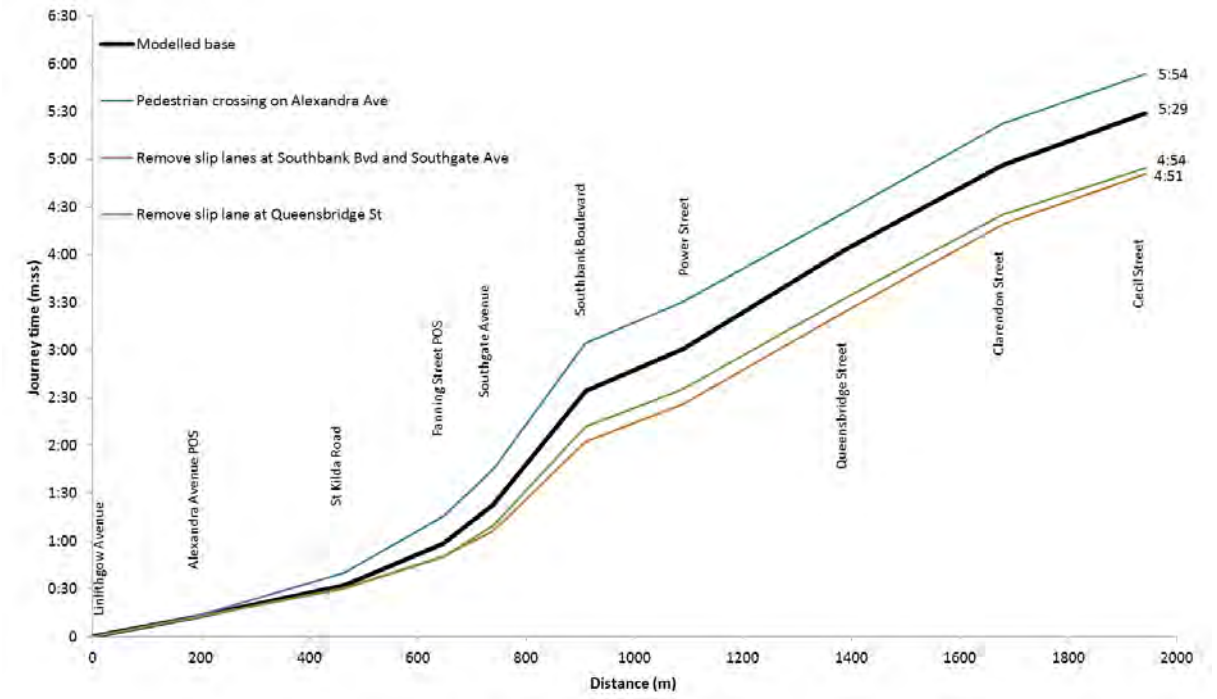


Figure 6.5 – Results of journey time tests for Route 4 (AM peak)



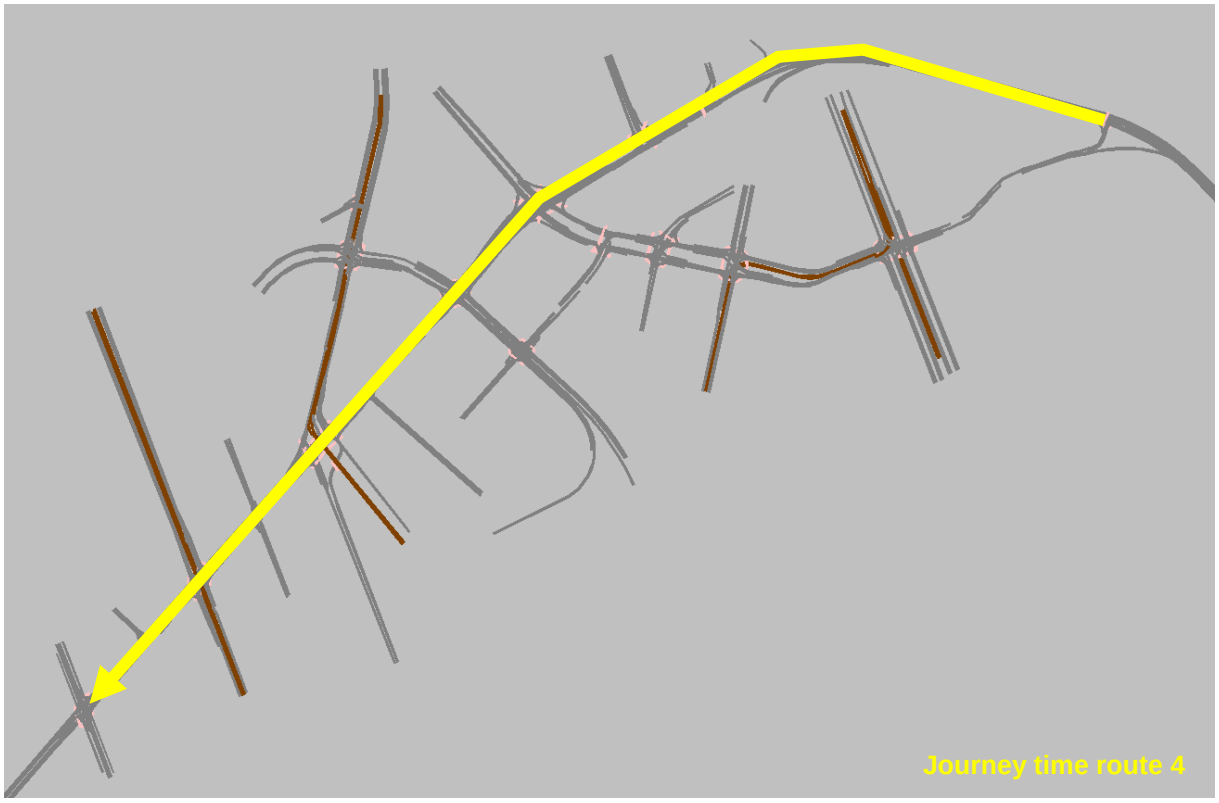


Table 6.3 – Journey time results by section for Route 3 (AM peak)

Section ending	Existing	Ped crossing	Remove slips Southbank & Southgate	Remove slip Queensbridge
Clarendon Street	1:29	1:21	1:35	1:38
Queensbridge Street	0:49	0:49	0:51	1:03
Power Street	0:53	0:58	0:56	0:56
Southbank Boulevard	0:28	0:28	0:28	0:29
Southgate Avenue	0:27	0:23	0:24	0:25
Fanning Street POS	0:08	0:08	0:08	0:08
St Kilda Road	0:12	0:12	0:12	0:12
Alexandra Avenue POS	0:17	0:20	0:20	0:19
Linlithgow Avenue	0:22	0:19	0:26	0:19
TOTAL	**5:05**	**4:58**	**5:20**	**5:28**
Per cent change from base		-2%	5%	8%

Note: options above are cumulative.

Table 6.4 – Journey time results by section for Route 4 (AM peak)

Section ending	Existing	Ped crossing	Remove slips Southbank & Southgate	Remove slip Queensbridge
Alexandra Avenue POS	0:12	0:12	0:12	0:12
St Kilda Road	0:20	0:28	0:19	0:18
Fanning Street POS	0:26	0:36	0:20	0:20
Southgate Avenue	0:25	0:30	0:16	0:20
Southbank Boulevard	1:11	1:19	0:56	1:02
Power Street	0:26	0:26	0:24	0:24
Queensbridge Street	1:03	0:56	0:59	0:57
Clarendon Street	0:53	0:56	0:55	0:53
Cecil Street	0:33	0:31	0:32	0:29
TOTAL	**5:29**	**5:54**	**4:51**	**4:54**
Per cent change from base		8%	-12%	-11%

Note: options above are cumulative.

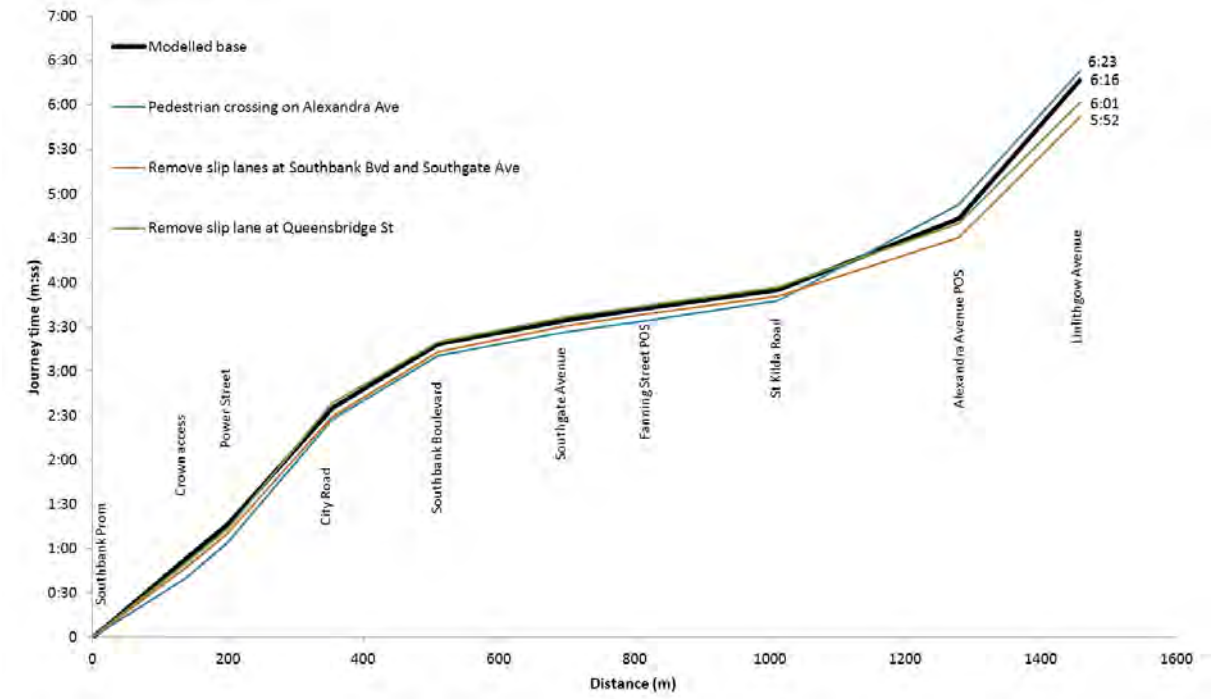
6.2.2 City Road East and Alexandra Avenue improvements scenario (PM peak)

Routes 1 and 2

The results of the option tests are shown in Figure 6.6, Figure 6.7, Table 6.5 and Table 6.6.

The analysis indicates that there is very little difference in overall travel times with some very minor changes in travel time with some of the options. As stated previously for the AM peak, these minor changes should be viewed as being well within the typical variation experienced within urban locations on a day to day basis.

Figure 6.6 – Results of journey time tests for Route 1 (PM peak)



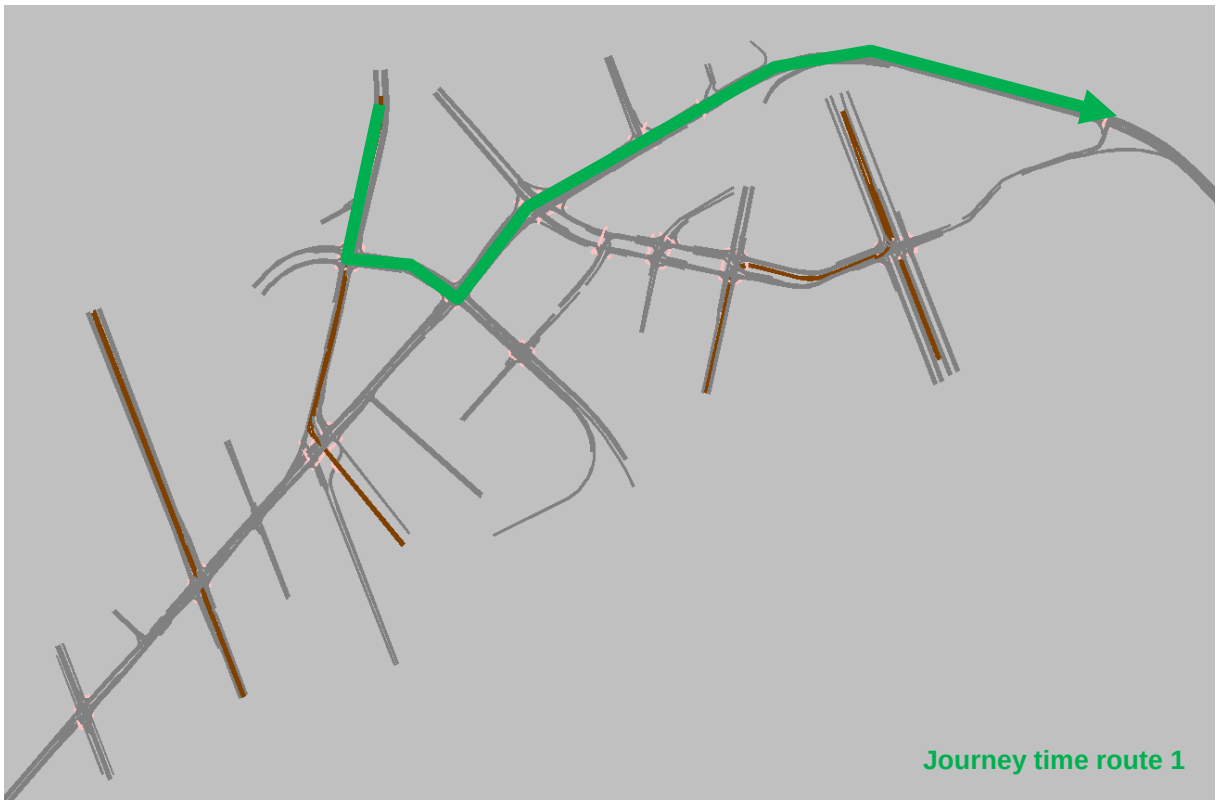
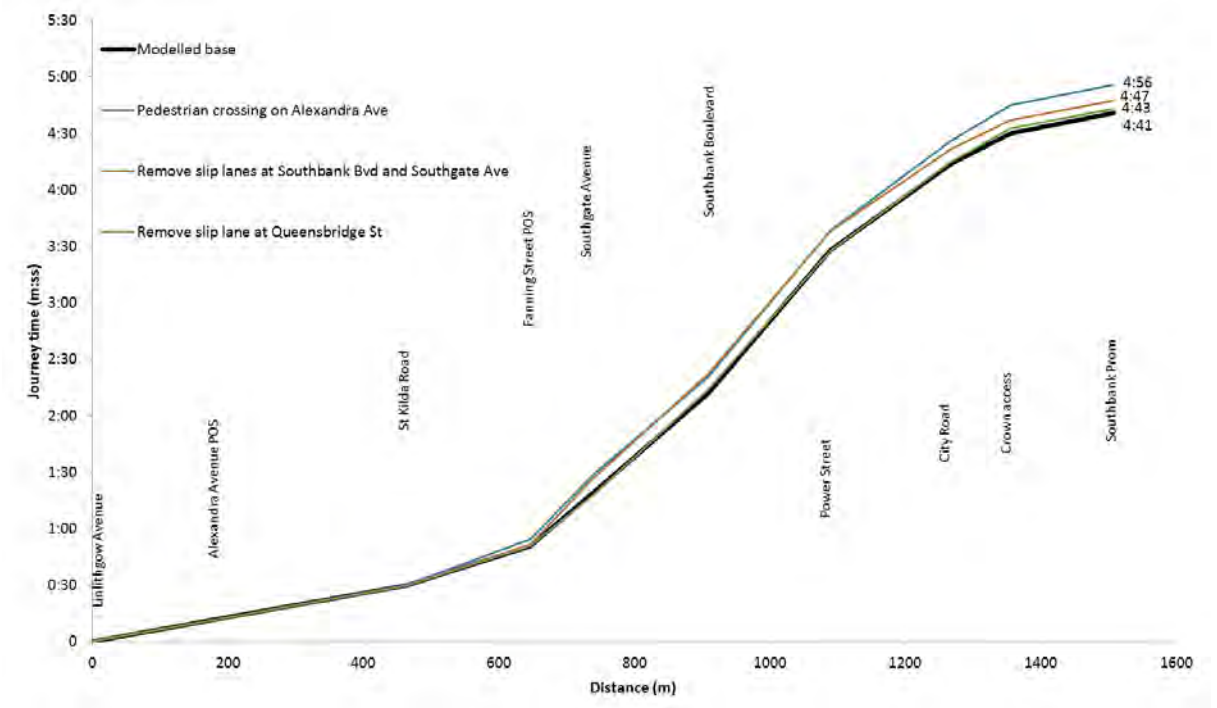


Figure 6.7 – Results of journey time tests for Route 2 (PM peak)



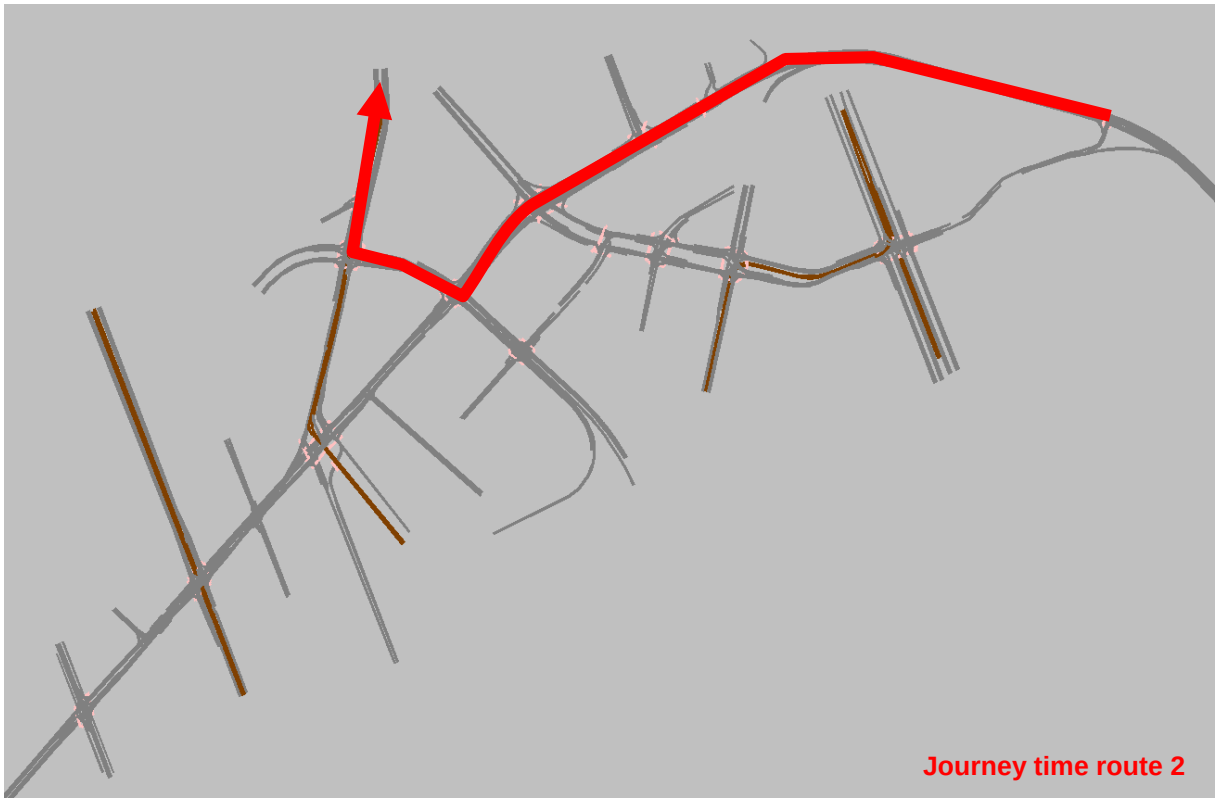


Table 6.5 – Journey time results by section for Route 1 (PM peak)

Section ending	Existing	Ped crossing	Remove slips Southbank & Southgate	Remove slip Queensbridge
Crown access	0:53	0:41	0:47	0:50
Power Street	0:23	0:24	0:23	0:23
City Road	1:19	1:23	1:19	1:25
Southbank Boulevard	0:43	0:43	0:44	0:41
Southgate Avenue	0:16	0:16	0:17	0:17
Fanning Street POS	0:08	0:08	0:08	0:08
St Kilda Road	0:13	0:13	0:12	0:12
Alexandra Avenue POS	0:49	1:05	0:40	0:43
Linlithgow Avenue	1:33	1:30	1:22	1:21
TOTAL	**6:16**	**6:23**	**5:52**	**6:01**
Per cent change from base		2%	-6%	-4%

Note: options above are cumulative.

Table 6.6 – Journey time results by section for Route 2 (PM peak)

Section ending	Existing	Ped crossing	Remove slips Southbank & Southgate	Remove slip Queensbridge
Alexandra Avenue POS	0:12	0:12	0:12	0:12
St Kilda Road	0:18	0:18	0:18	0:18
Fanning Street POS	0:21	0:24	0:22	0:21
Southgate Avenue	0:29	0:34	0:35	0:27
Southbank Boulevard	0:53	0:52	0:55	0:56
Power Street	1:16	1:18	1:16	1:14
Queensbridge Street	0:46	0:47	0:43	0:47
Crown access	0:16	0:19	0:16	0:18
Southbank Prom	0:11	0:11	0:11	0:11
TOTAL	**4:41**	**4:56**	**4:47**	**4:43**
Per cent change from base		5%	2%	1%

Note: options above are cumulative.

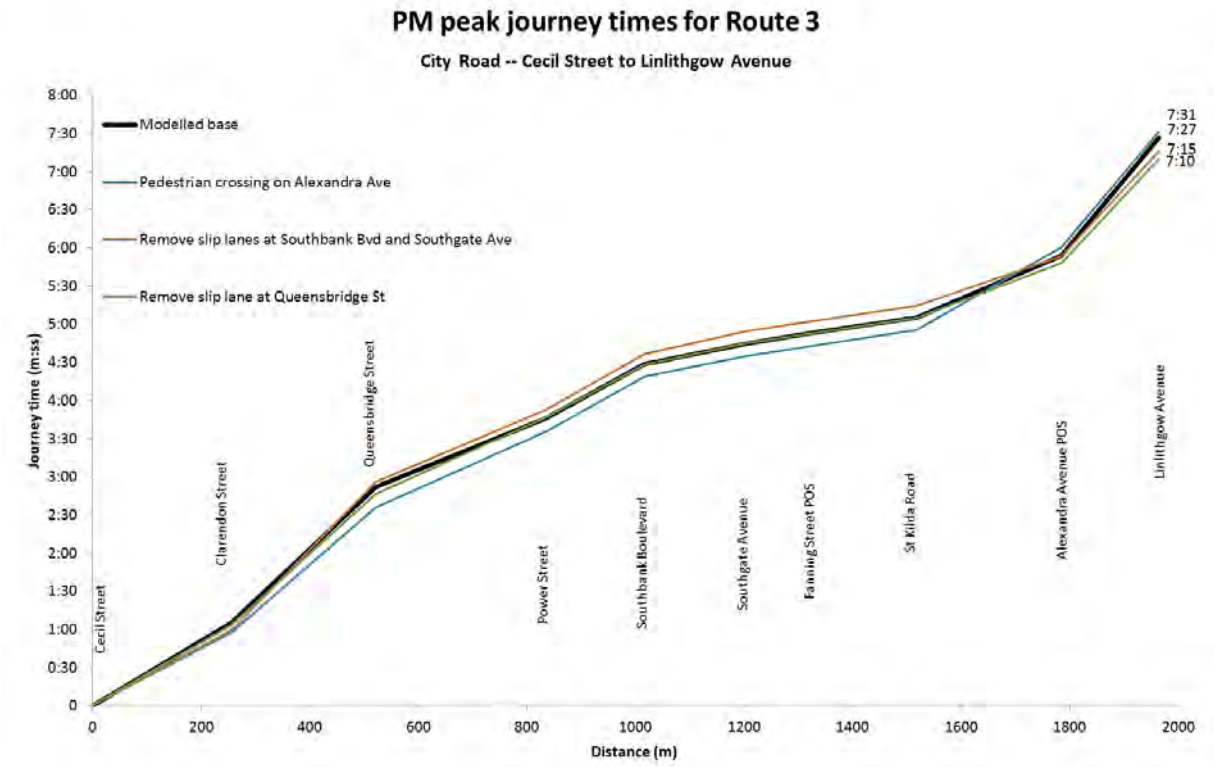
Routes 3 and 4

The results of the option tests are shown in Figure 6.4, Figure 6.5, Table 6.3 and Table 6.4.

The analysis indicates that—

- On Route 3 there are very minor overall differences in travel time across each of the options, which would be almost imperceptible to motorists travelling on this route.
- On Route 4 there are again very minor overall differences in travel time for most options. For the 'Remove slip lane at Queensbridge St' option there is a small improvement in travel time on approach to Southbank Boulevard due to a slight increase in green signal time on the east-west movement at this intersection.

Figure 6.8 – Results of journey time tests for Route 3 (PM peak)



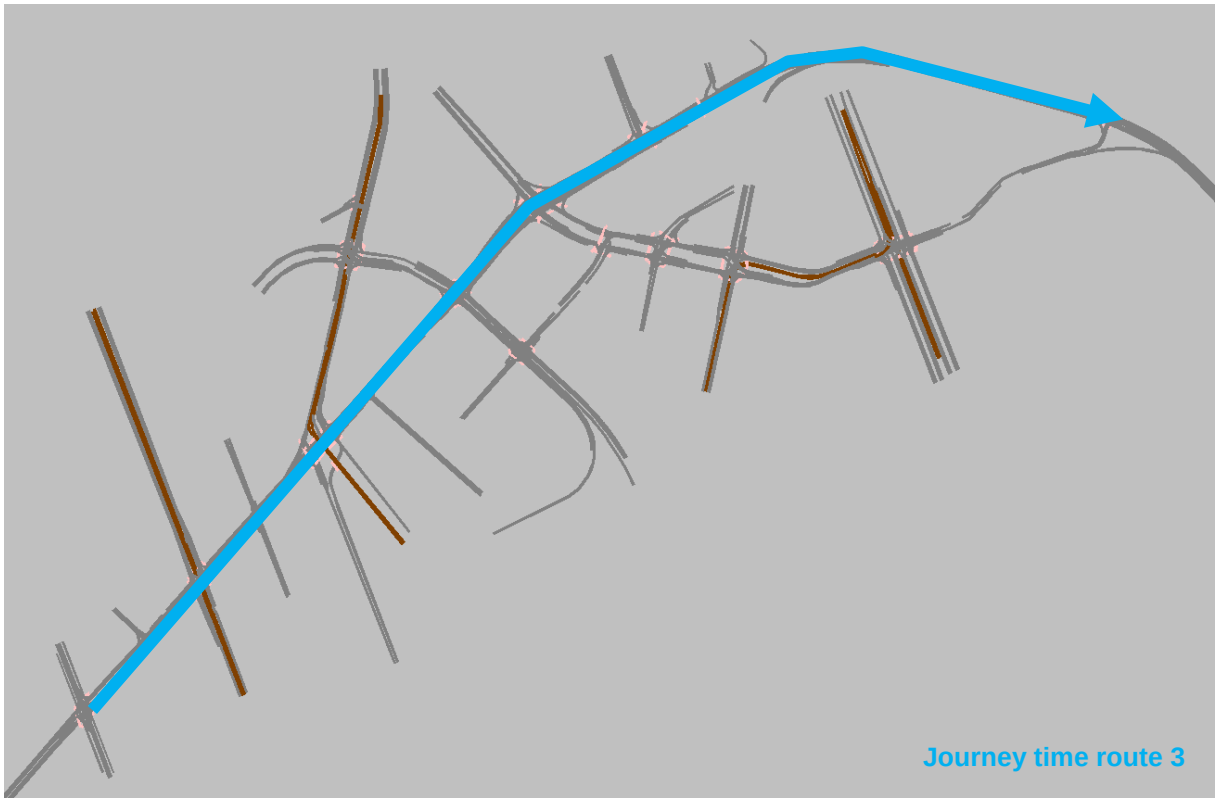
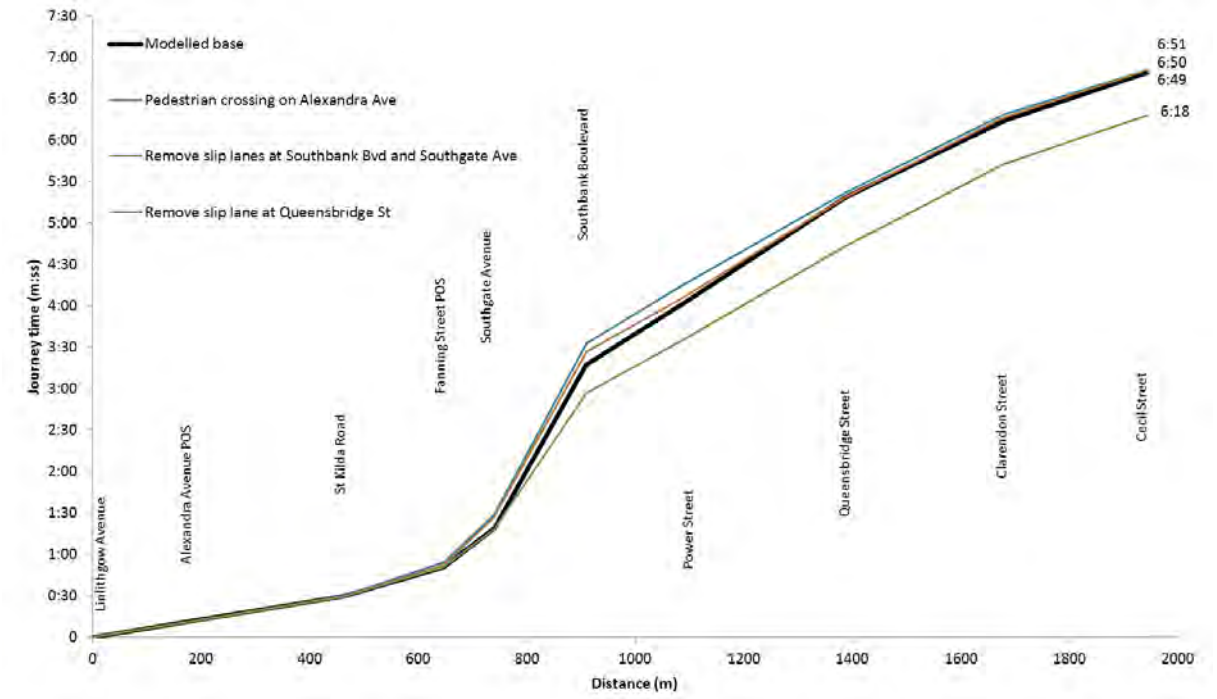


Figure 6.9 – Results of journey time tests for Route 4 (PM peak)



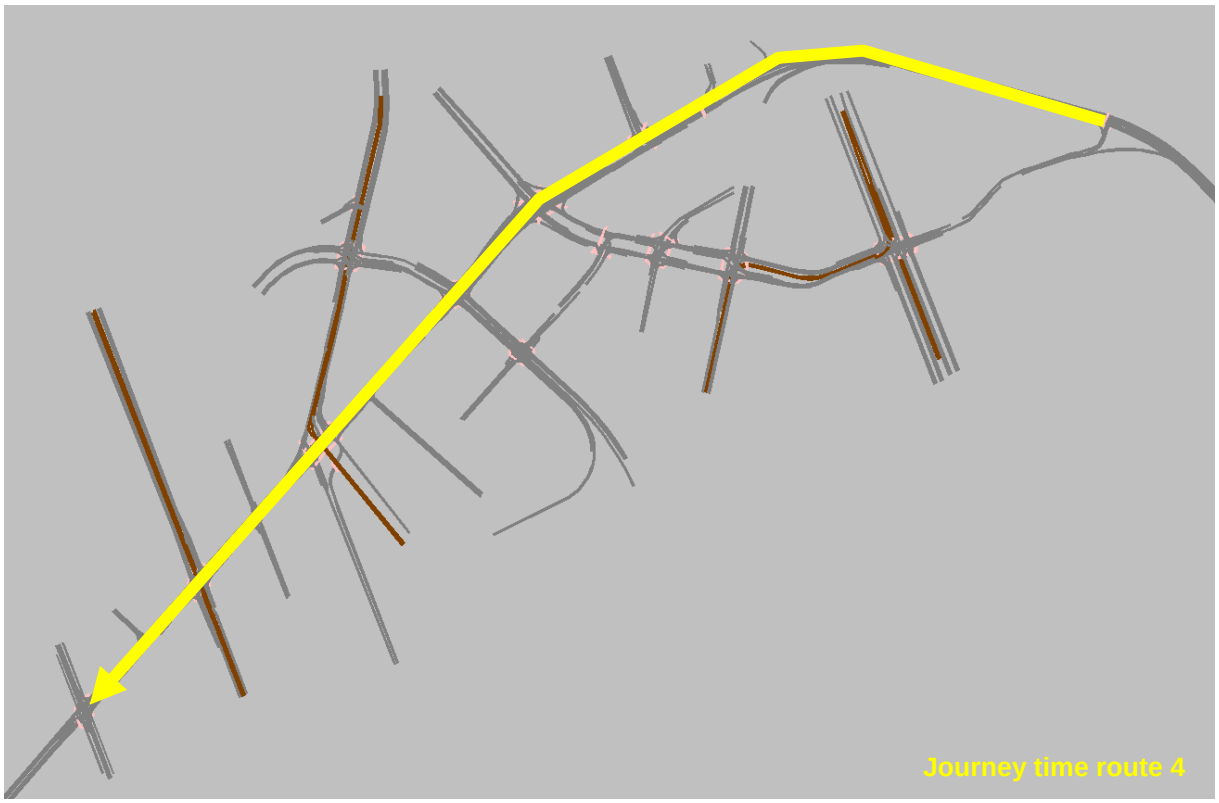


Table 6.7 – Journey time results by section for Route 3 (PM peak)

Section ending	Existing	Ped crossing	Remove slips Southbank & Southgate	Remove slip Queensbridge
Clarendon Street	1:05	0:58	0:59	1:04
Queensbridge Street	1:47	1:38	1:57	1:43
Power Street	0:54	0:59	0:57	1:00
Southbank Boulevard	0:43	0:43	0:44	0:41
Southgate Avenue	0:16	0:16	0:17	0:17
Fanning Street POS	0:08	0:08	0:08	0:08
St Kilda Road	0:13	0:13	0:12	0:12
Alexandra Avenue POS	0:49	1:05	0:40	0:43
Linlithgow Avenue	1:33	1:30	1:22	1:21
TOTAL	**7:27**	**7:31**	**7:15**	**7:10**
Per cent change from base		1%	-3%	-4%

Note: options above are cumulative.

Table 6.8 – Journey time results by section for Route 4 (PM peak)

Section ending	Existing	Ped crossing	Remove slips Southbank & Southgate	Remove slip Queensbridge
Alexandra Avenue POS	0:12	0:12	0:12	0:12
St Kilda Road	0:18	0:18	0:18	0:18
Fanning Street POS	0:21	0:24	0:22	0:21
Southgate Avenue	0:29	0:34	0:35	0:27
Southbank Boulevard	1:58	2:04	2:00	1:39
Power Street	0:45	0:43	0:40	0:39
Queensbridge Street	1:17	1:07	1:13	1:08
Clarendon Street	0:55	0:56	0:57	0:59
Cecil Street	0:35	0:32	0:34	0:36
TOTAL	**6:49**	**6:50**	**6:51**	**6:18**
Per cent change from base		0%	0%	-8%

Note: options above are cumulative.

6.2.3 City Road West improvements (AM peak)

The City Road West improvements consist of the preferred scenario and the alternate scenario.

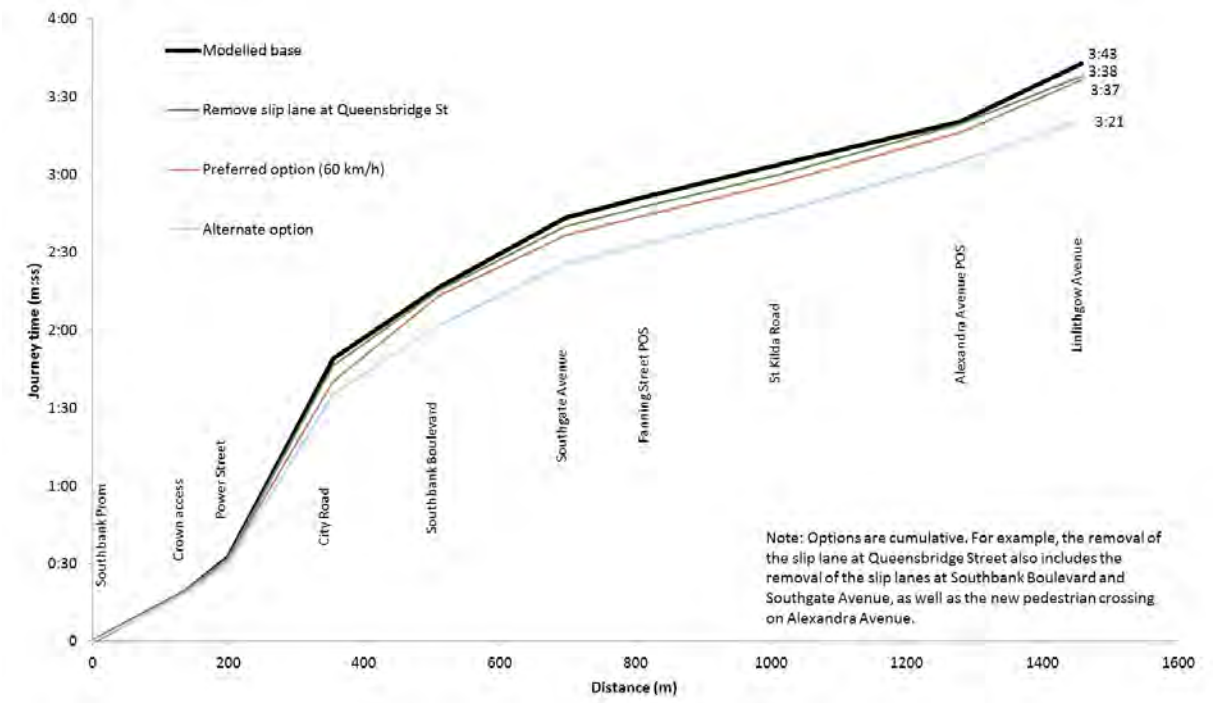
Routes 1 and 2

These routes travel between Queensbridge Street at Southbank Promenade to Alexandra Avenue at Linlithgow Avenue in the eastbound and westbound directions respectively. The results of the option tests are shown in Figure 6.10, Figure 6.11, Table 6.9 and Table 6.10.

The analysis indicates that—

- The preferred layout marginally increases journey times compared to the City Road East and Alexandra Avenue improvements scenario eastbound due to the loss of capacity on the west approaches to Queensbridge and Power streets. In the westbound direction there is a more pronounced increase in journey time which is primarily due to the loss of capacity on the east approach to Queensbridge Street combined with the new intersection at Balston Street. The short distance between these intersections creates a queue which propagates back to St Kilda Road.
- The alternate layout appears to have a reduced journey time compared to both the City Road East and Alexandra Avenue improvements scenario and the preferred scenario in the eastbound direction, but this is an artificial result caused by the inability of many vehicles to enter the network. This effectively reduces demand in the network, leading to less congestion and faster journey times. (See Section 6.4 for more details.) In the westbound direction the loss of one lane of capacity (due to a bus lane) increases journey times substantially.

Figure 6.10 – Results of journey time tests for Route 1 (AM peak)



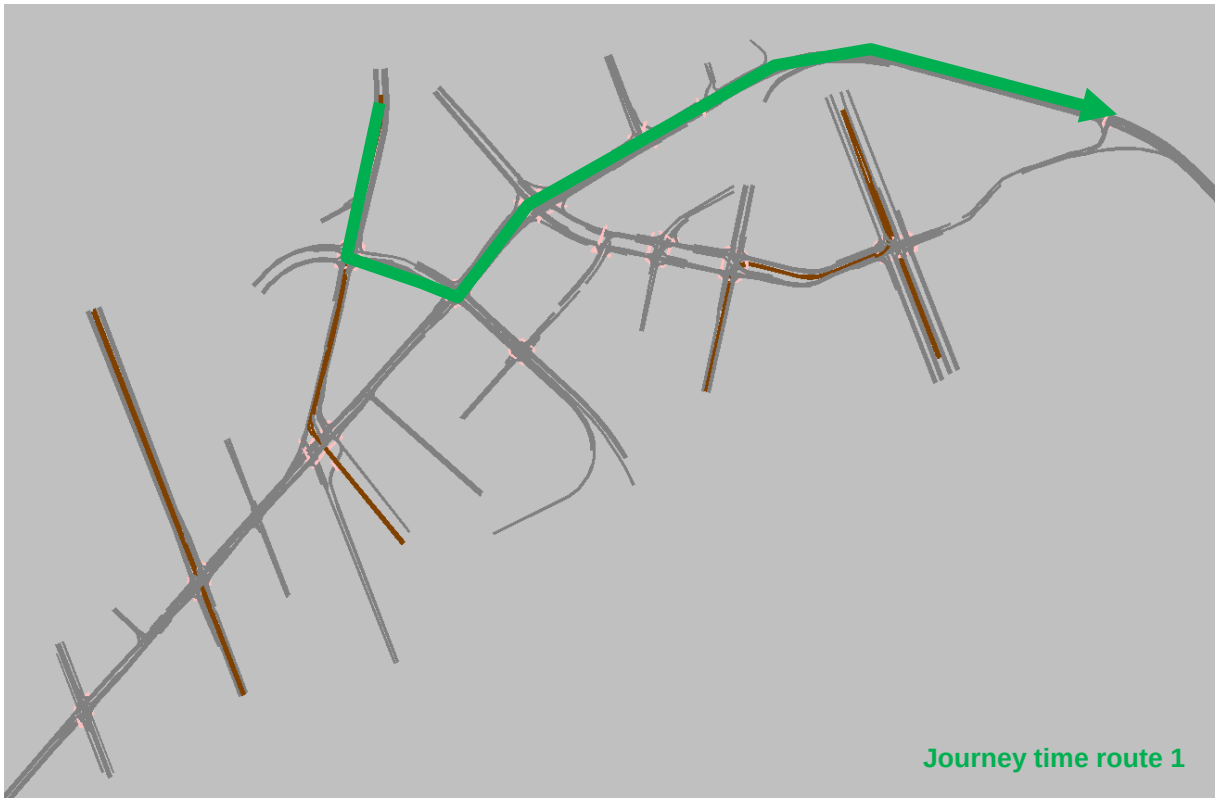
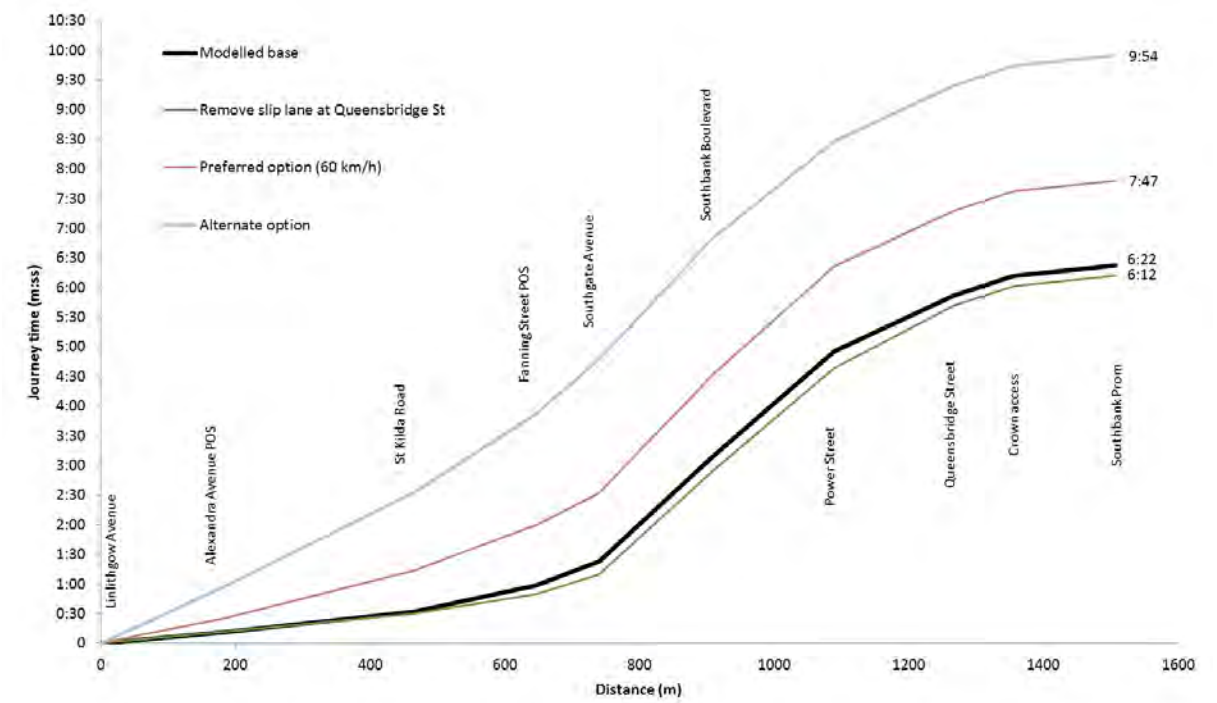


Figure 6.11 – Results of journey time tests for Route 2 (AM peak)



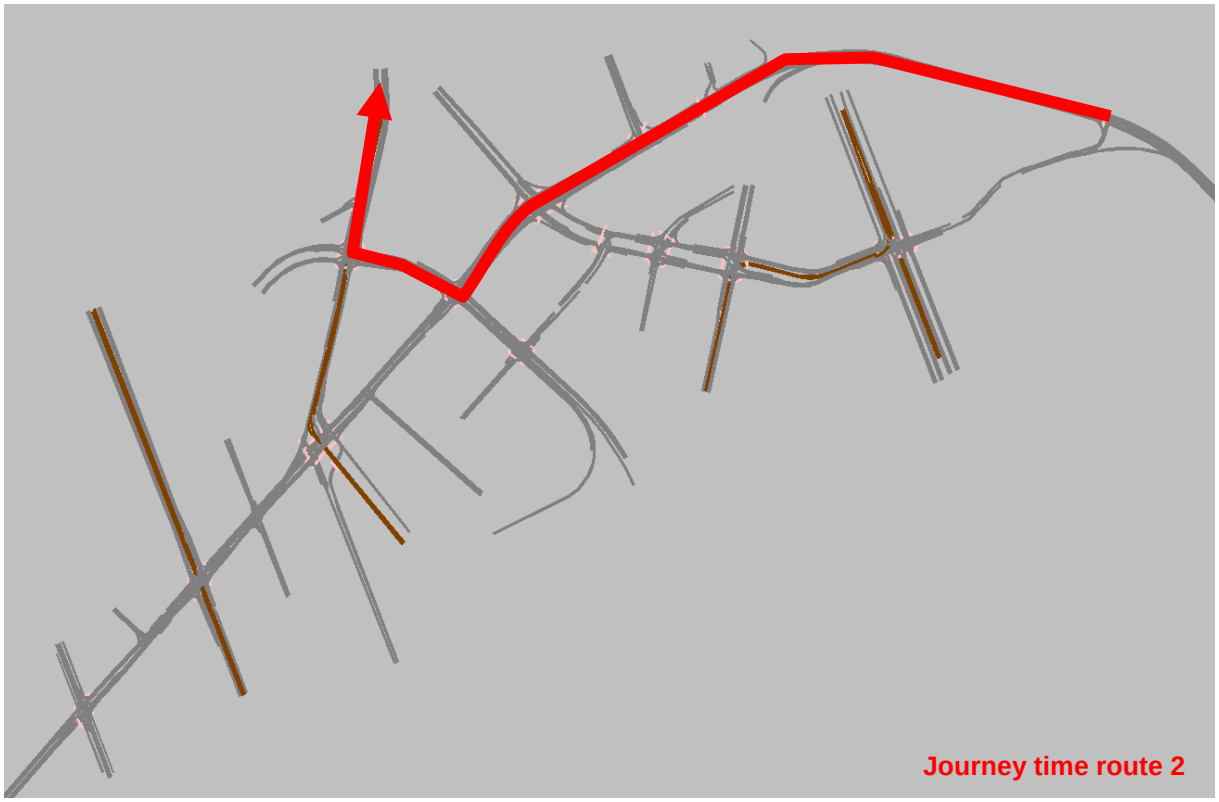


Table 6.9 – Journey time results by section for Route 1 (AM peak)

Section ending	Existing	Remove slip Queensbridge	Preferred option	Alternate option
Crown access	0:20	0:20	0:20	0:19
Power Street	0:13	0:12	0:12	0:11
City Road	1:16	1:14	1:09	1:05
Southbank Boulevard	0:28	0:29	0:33	0:27
Southgate Avenue	0:27	0:25	0:23	0:23
Fanning Street POS	0:08	0:08	0:08	0:08
St Kilda Road	0:12	0:12	0:12	0:12
Alexandra Avenue POS	0:17	0:19	0:20	0:20
Linlithgow Avenue	0:22	0:19	0:20	0:15
TOTAL	**3:43**	**3:38**	**3:37**	**3:21**
Per cent change from base		-2%	-3%	-10%

Note: options above are cumulative.

Table 6.10 – Journey time results by section for Route 2 (AM peak)

Section ending	Existing	Remove slip Queensbridge	Preferred option	Alternate option
Alexandra Avenue POS	0:12	0:12	0:26	0:58
St Kilda Road	0:20	0:18	0:48	1:35
Fanning Street POS	0:26	0:20	0:47	1:19
Southgate Avenue	0:25	0:20	0:31	0:55
Southbank Boulevard	1:47	1:45	2:01	2:03
Power Street	1:45	1:43	1:49	1:37
Queensbridge Street	0:57	1:03	0:56	0:57
Crown access	0:20	0:20	0:20	0:20
Southbank Prom	0:11	0:11	0:11	0:11
TOTAL	**6:22**	**6:12**	**7:47**	**9:54**
Per cent change from base		-3%	22%	55%

Note: options above are cumulative.

Routes 3 and 4

These routes travel along City Road/Alexandra Avenue between Cecil Street and Linlithgow Avenue in the eastbound and westbound directions respectively. The results of the option tests are shown in Figure 6.12, Figure 6.13, Table 6.11 and Table 6.12.

The analysis indicates that—

- The preferred layout has negligible impact in the eastbound direction, but increases journey times in the westbound direction. The lack of change in the eastbound direction is because there is little change to capacity other than the new intersections at Clarke and Balston streets, but the turning volumes at those locations are low enough that they do not materially impact on flows on City Road. There is also slightly less capacity at Power Street (loss of one right turn lane) but again the turning volumes are low enough not to impact adversely on City Road.
- In the westbound direction the preferred layout increases journey times. This is due to the loss of the left and right turn lanes on the east approach to Queensbridge Street and Clarendon Street respectively. As on Route 2, the combination of loss of capacity at Queensbridge Street and the new intersection at Balston Street increases queuing which extends back past Power Street and impacts on congestion and journey times in the Southgate area (see Screenshot 1).
- The alternate layout increases journey times substantially in both directions. This is primarily due to the loss of one lane in each direction as a result of the footpath widening and the westbound bus lane between Clarendon and Queensbridge streets. In both directions the queue of traffic extends to the edges of the model, where many vehicles cannot enter at the end of the analysis period. This means that the results shown in the charts do not take account of suppressed demand unable to enter the network.

Screenshot 1 – Westbound delays at Power Street in the preferred scenario (AM peak)

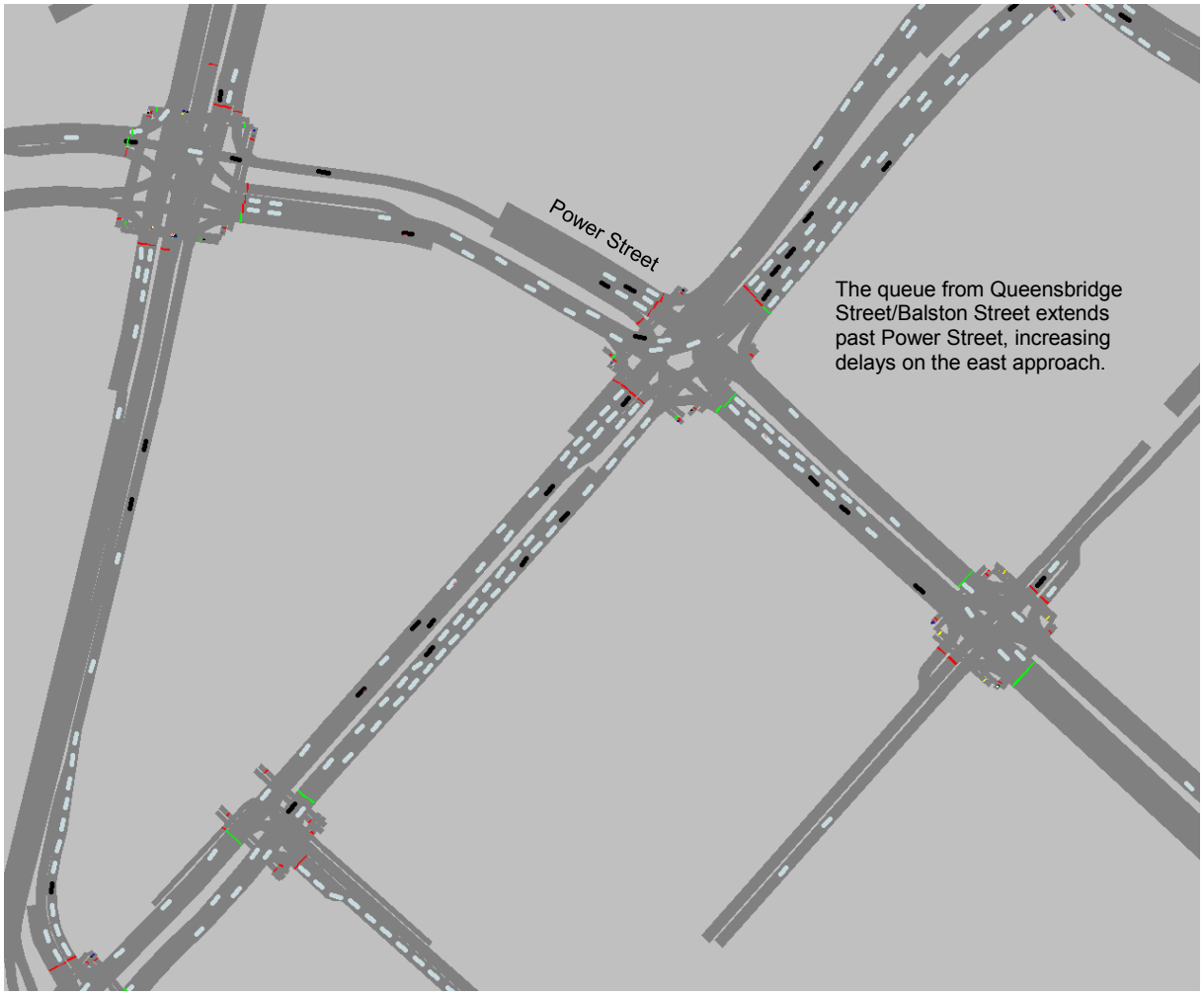
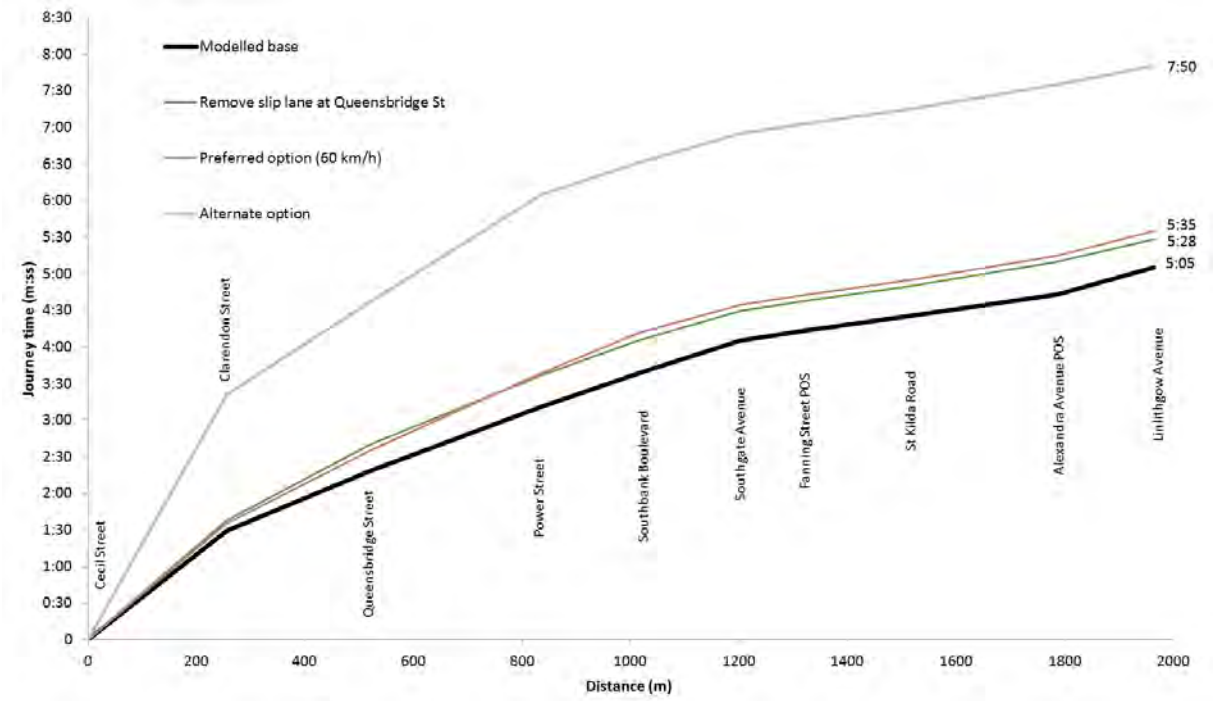


Figure 6.12 – Results of journey time tests for Route 3 (AM peak)



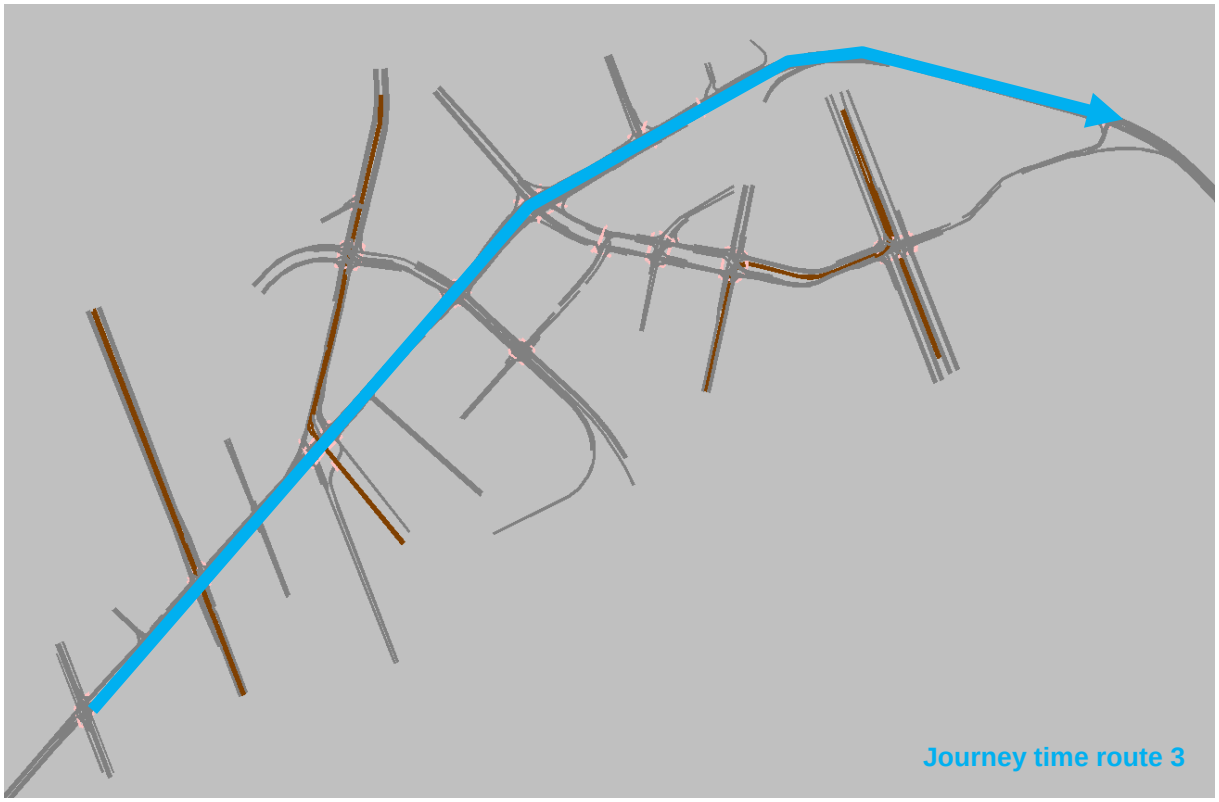
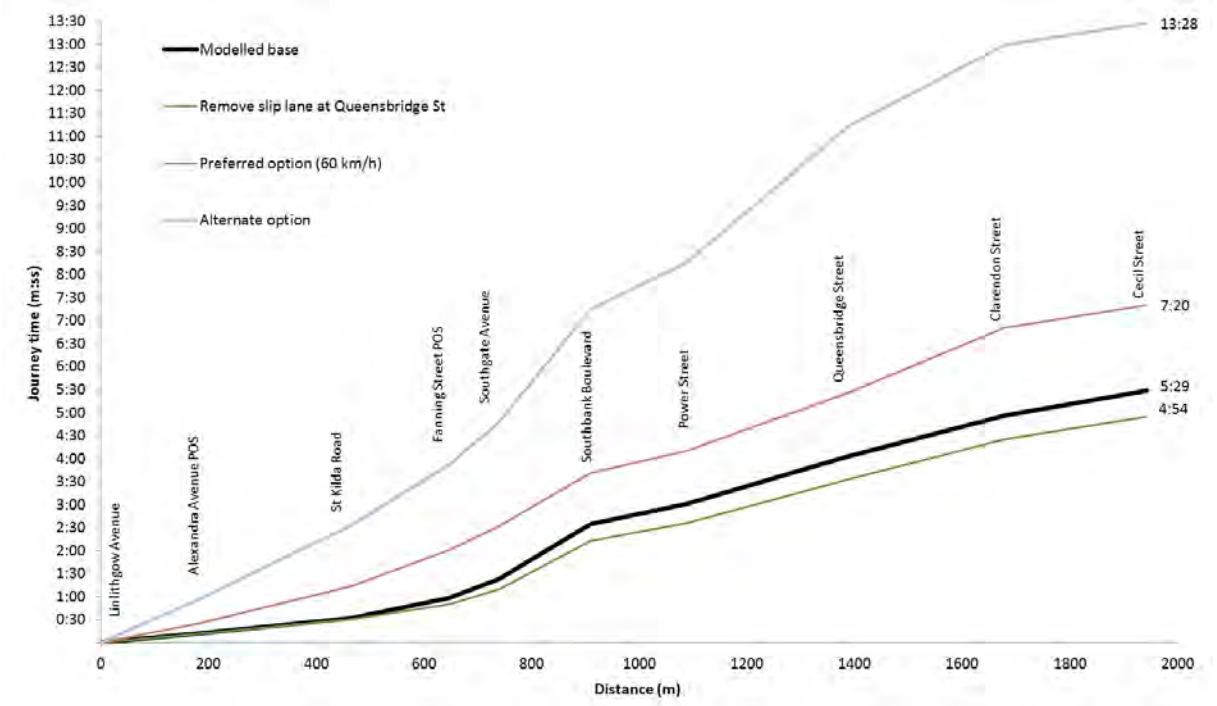


Figure 6.13 – Results of journey time tests for Route 4 (AM peak)



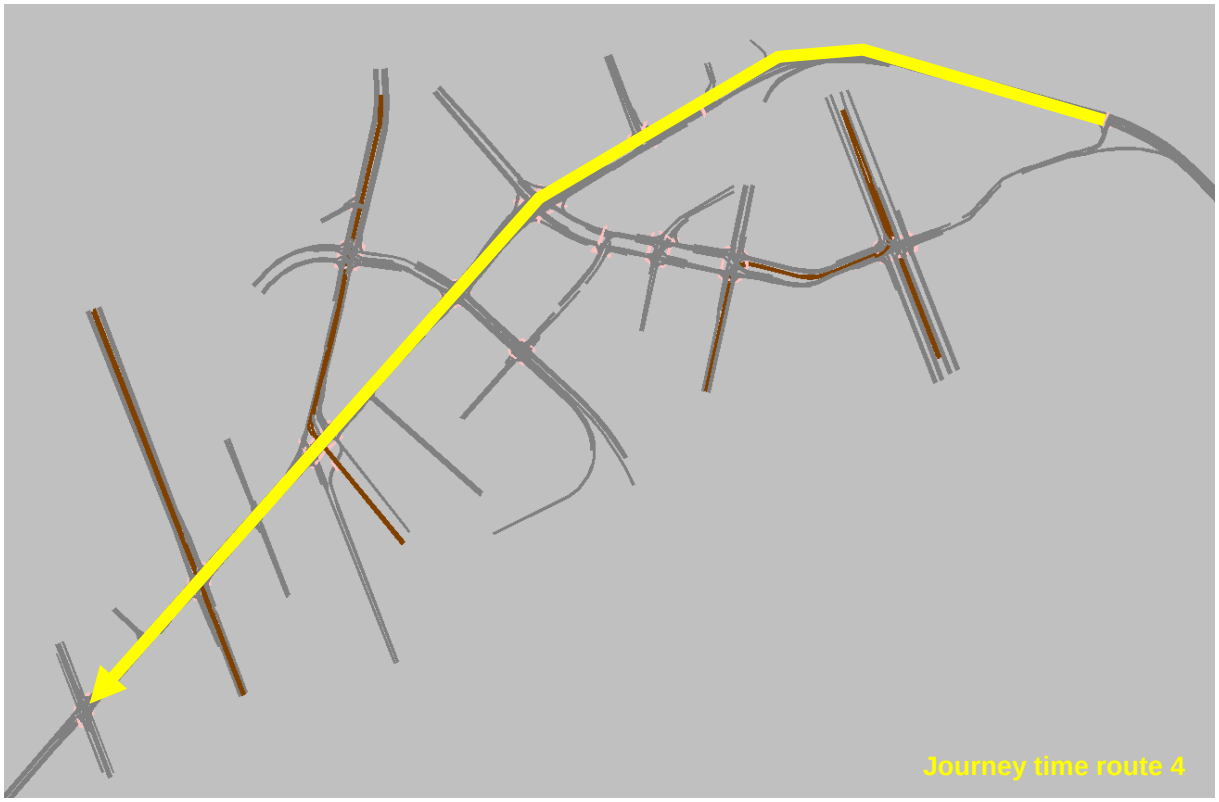


Table 6.11 – Journey time results by section for Route 3 (AM peak)

Section ending	Existing	Remove slip Queensbridge	Preferred option	Alternate option
Clarendon Street	1:29	1:38	1:35	3:21
Queensbridge Street	0:49	1:03	1:00	1:16
Power Street	0:53	0:56	1:03	1:27
Southbank Boulevard	0:28	0:29	0:33	0:27
Southgate Avenue	0:27	0:25	0:23	0:23
Fanning Street POS	0:08	0:08	0:08	0:08
St Kilda Road	0:12	0:12	0:12	0:12
Alexandra Avenue POS	0:17	0:19	0:20	0:20
Linlithgow Avenue	0:22	0:19	0:20	0:15
TOTAL	**5:05**	**5:28**	**5:35**	**7:50**
Per cent change from base		8%	10%	54%

Note: options above are cumulative.

Table 6.12 – Journey time results by section for Route 4 (AM peak)

Section ending	Existing	Remove slip Queensbridge	Preferred option	Alternate option
Alexandra Avenue POS	0:12	0:12	0:26	0:58
St Kilda Road	0:20	0:18	0:48	1:35
Fanning Street POS	0:26	0:20	0:47	1:19
Southgate Avenue	0:25	0:20	0:31	0:55
Southbank Boulevard	1:11	1:02	1:09	2:27
Power Street	0:26	0:24	0:30	1:02
Queensbridge Street	1:03	0:57	1:15	2:57
Clarendon Street	0:53	0:53	1:25	1:46
Cecil Street	0:33	0:29	0:29	0:29
TOTAL	**5:29**	**4:54**	**7:20**	**13:28**
Per cent change from base		-11%	34%	146%

Note: options above are cumulative.

6.2.4 City Road West improvements (PM peak)

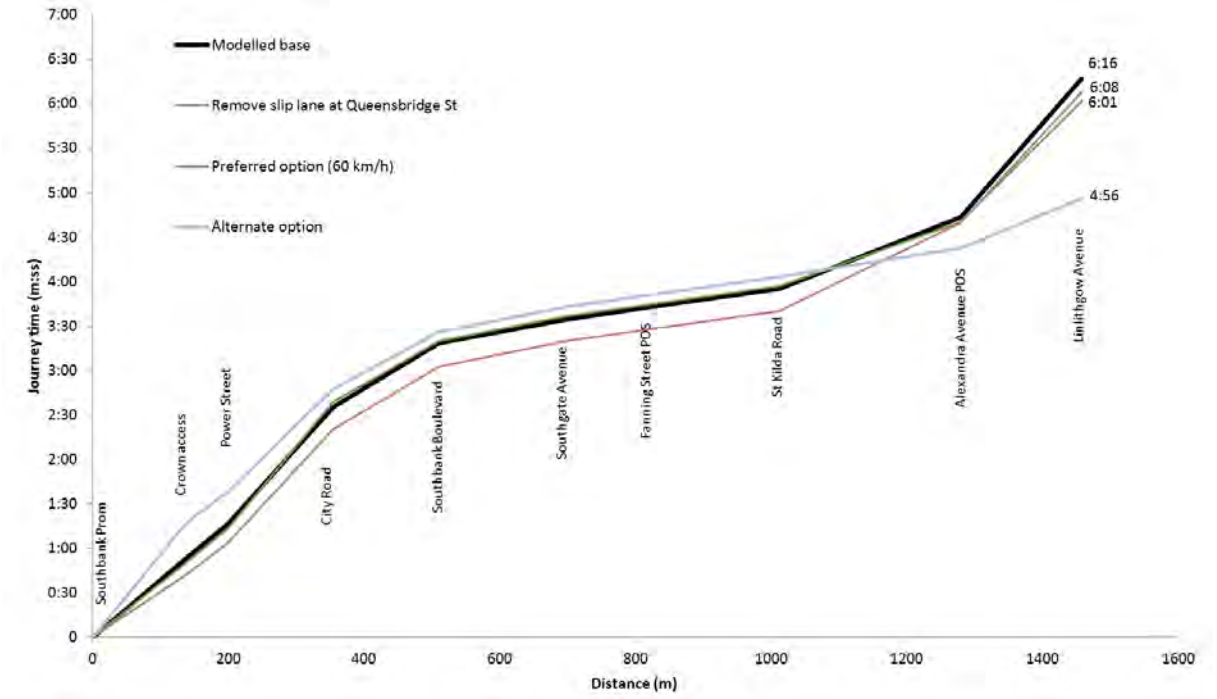
Routes 1 and 2

The results of the option tests are shown in Figure 6.14, Figure 6.15, Table 6.13 and Table 6.14.

The analysis indicates that—

- In the eastbound direction the overall trend is little to no change in journey times, although in the alternate layout the results are likely to be optimistic as many vehicles are unable to enter the network.
- In the westbound direction, there is negligible change in the preferred layout.
- The alternate layout shows a slightly reduced journey time compared to the preferred layout, but this is likely to be because many vehicles are unable to enter the model, which suppresses demand.

Figure 6.14 – Results of journey time tests for Route 1 (PM peak)



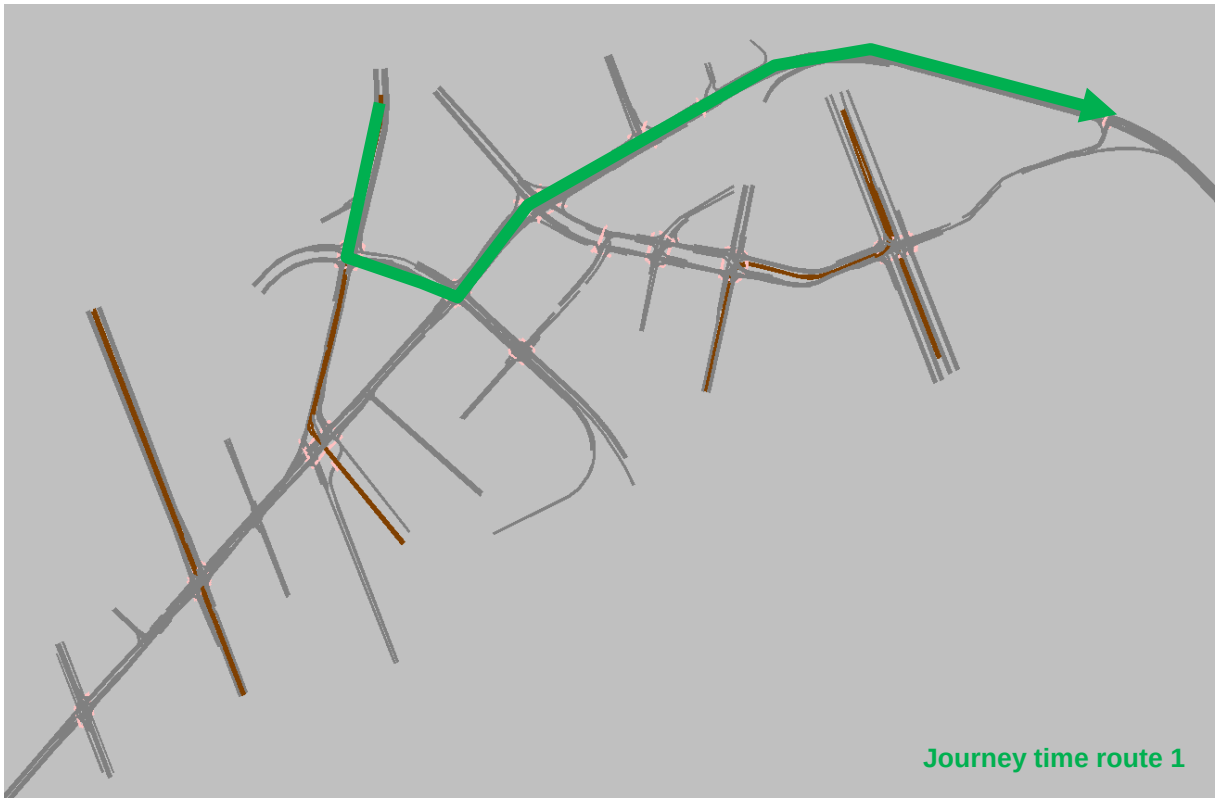
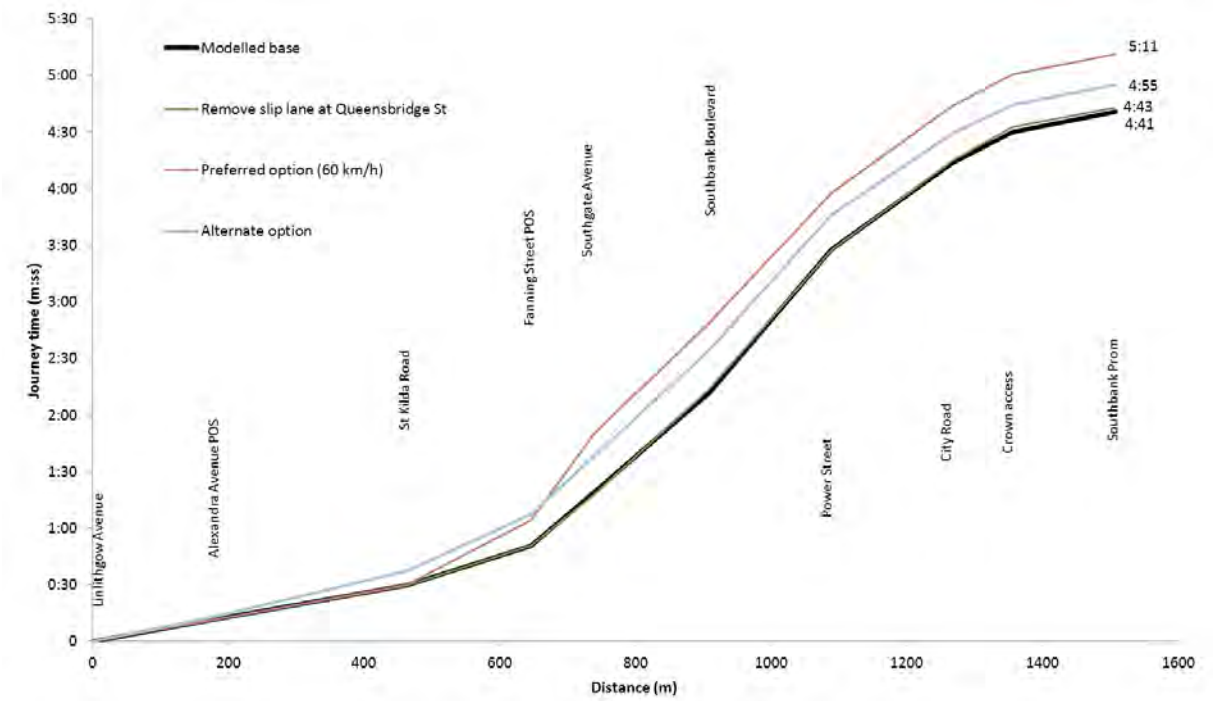


Figure 6.15 – Results of journey time tests for Route 2 (PM peak)



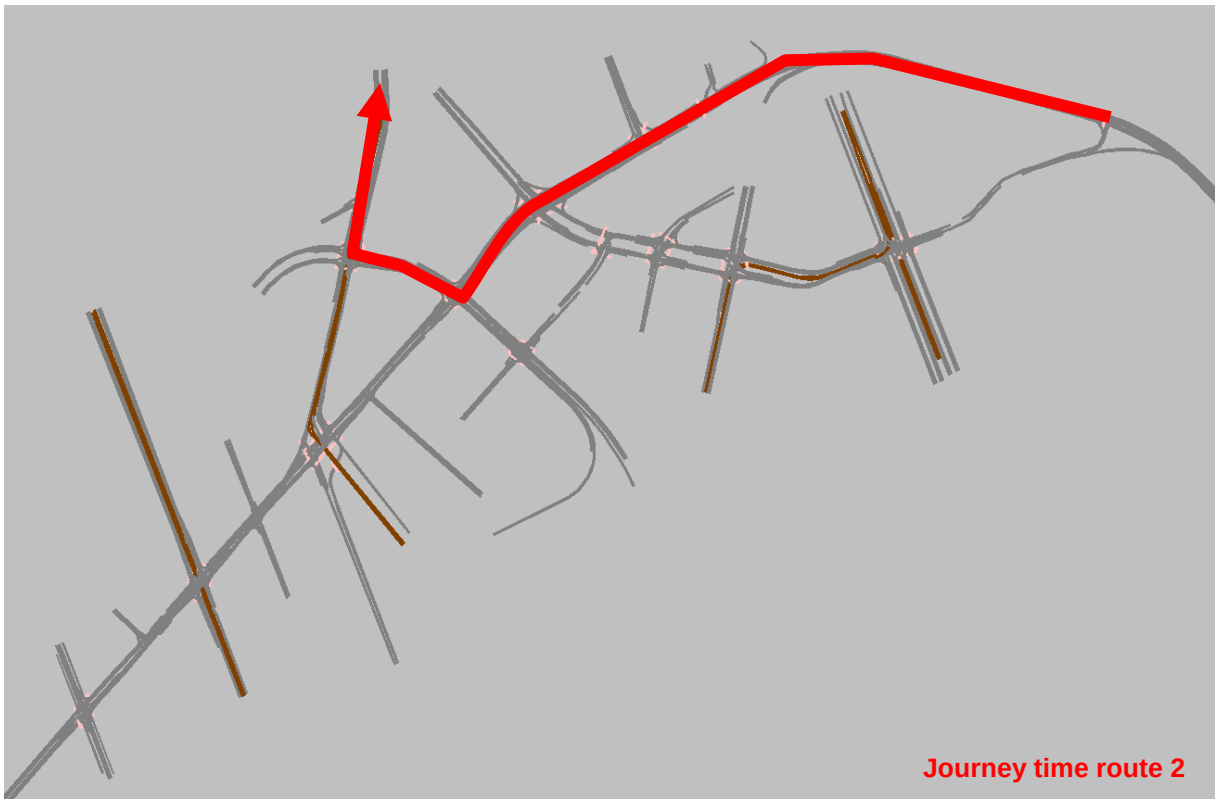


Table 6.13 – Journey time results by section for Route 1 (PM peak)

Section ending	Existing	Remove slip Queensbridge	Preferred option	Alternate option
Crown access	0:53	0:50	0:43	1:17
Power Street	0:23	0:23	0:21	0:22
City Road	1:19	1:25	1:17	1:09
Southbank Boulevard	0:43	0:41	0:42	0:39
Southgate Avenue	0:16	0:17	0:17	0:17
Fanning Street POS	0:08	0:08	0:08	0:08
St Kilda Road	0:13	0:12	0:13	0:12
Alexandra Avenue POS	0:49	0:43	0:59	0:20
Linlithgow Avenue	1:33	1:21	1:28	0:33
TOTAL	**6:16**	**6:01**	**6:08**	**4:56**
Per cent change from base		-4%	-2%	-21%

Note: options above are cumulative.

Table 6.14 – Journey time results by section for Route 2 (PM peak)

Section ending	Existing	Remove slip Queensbridge	Preferred option	Alternate option
Alexandra Avenue POS	0:12	0:12	0:12	0:13
St Kilda Road	0:18	0:18	0:18	0:24
Fanning Street POS	0:21	0:21	0:34	0:30
Southgate Avenue	0:29	0:27	0:46	0:31
Southbank Boulevard	0:53	0:56	0:59	0:56
Power Street	1:16	1:14	1:09	1:11
Queensbridge Street	0:46	0:47	0:46	0:43
Crown access	0:16	0:18	0:17	0:15
Southbank Prom	0:11	0:11	0:11	0:11
TOTAL	**4:41**	**4:43**	**5:11**	**4:55**
Per cent change form base		1%	11%	5%

Note: options above are cumulative.

Routes 3 and 4

The results of the option tests are shown in Figure 6.16, Figure 6.17, Table 6.15 and Table 6.16.

The analysis indicates that—

- In the eastbound direction the preferred layout produces little to no change in journey times, except for on the approach to Clarendon Street. This is due to vehicles being delayed at Clarke Street, which forms a queue that prevents vehicles from entering the Clarendon Street intersection (see Screenshot 2). In the westbound direction there is a slight increase in journey times on the approach to Clarendon Street which is due to the loss of the right turn lane.
- The alternate layout has a bigger impact on eastbound journey times than the preferred layout, which is primarily due to the loss of one lane mid-block between Clarendon Street and Queensbridge Street. Note that the results for the alternate layout are likely to be optimistic due to the large number of vehicles which cannot enter the network thereby reducing demand in the model. In the westbound direction the journey times are again increased compared to the preferred layout. This is due to the loss of a mid-block lane between Clarendon Street and Queensbridge Street.

Screenshot 2 – Eastbound delays at Clarendon Street in the preferred scenario (PM peak)

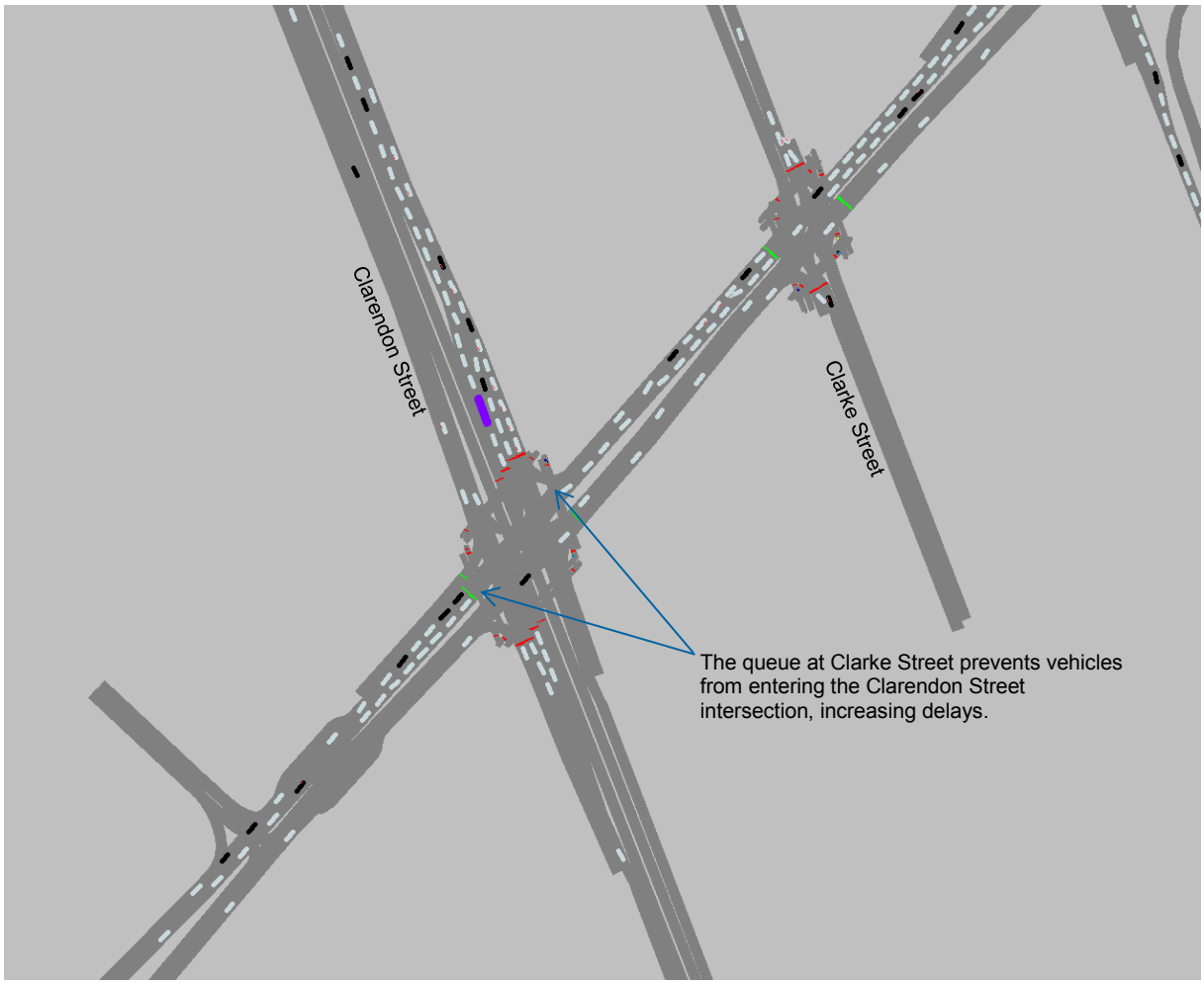
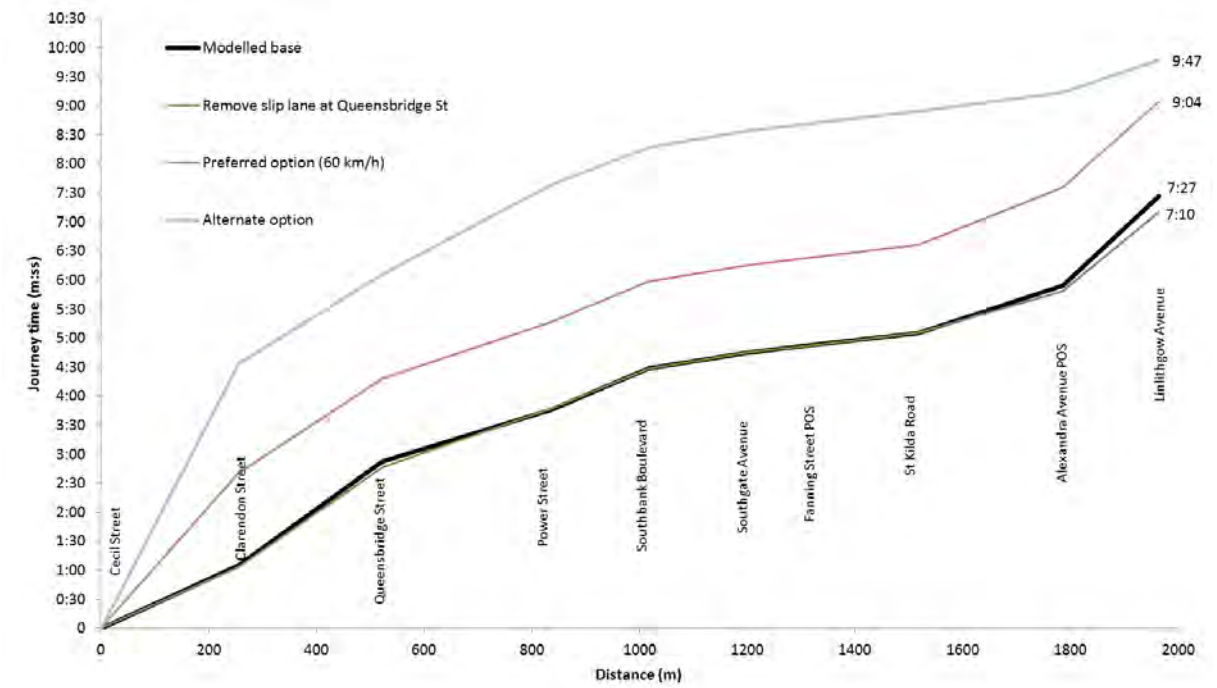


Figure 6.16 - Results of journey time tests for Route 3 (PM peak)



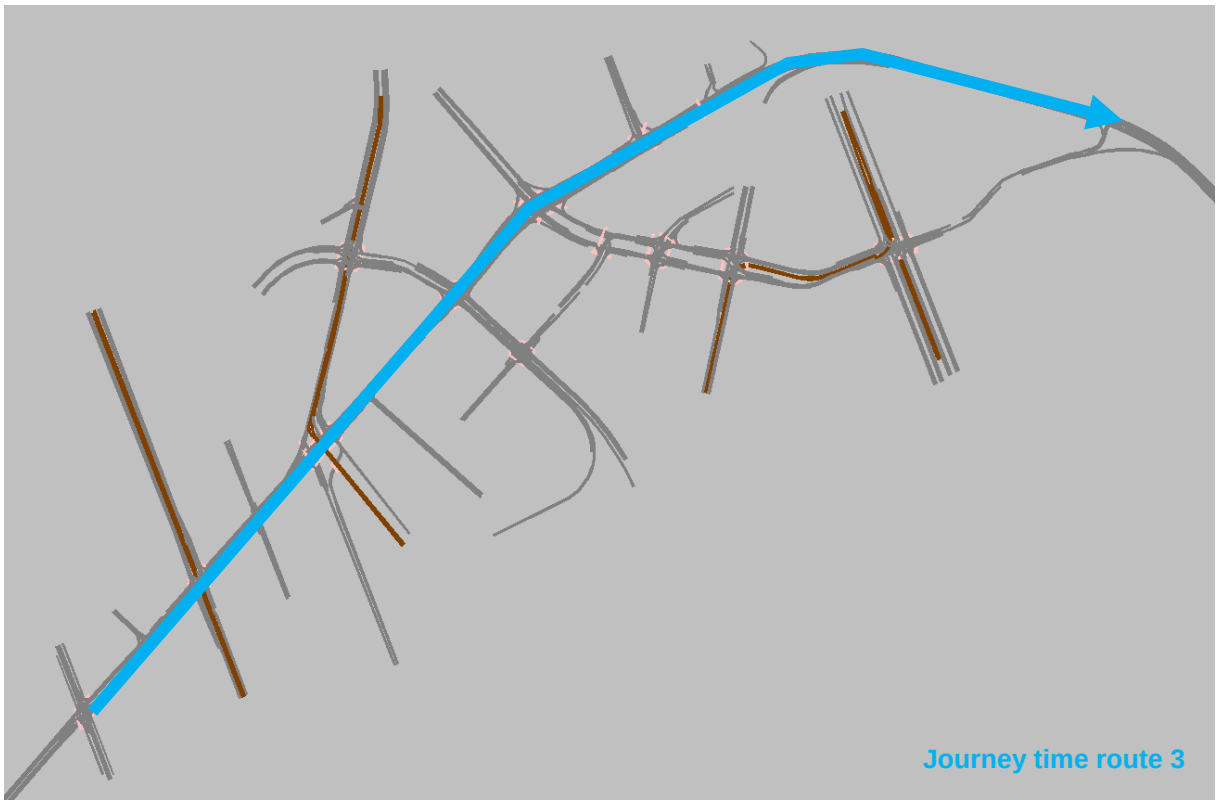
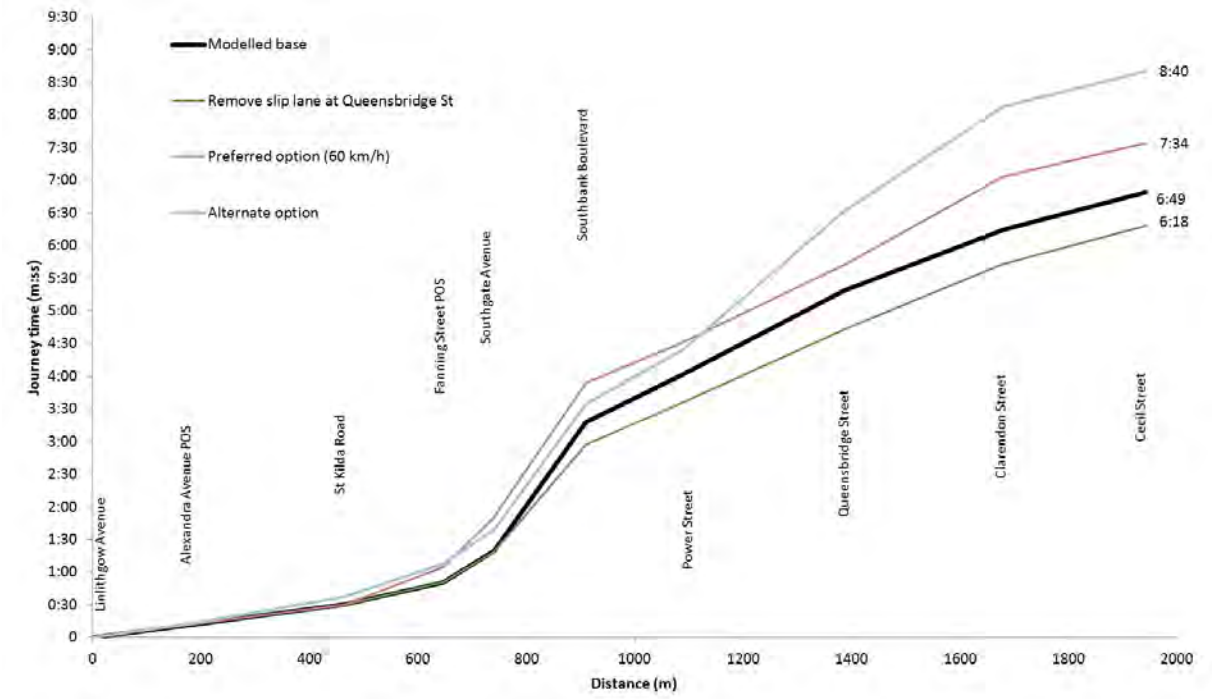


Figure 6.17 – Results of journey time tests for Route 4 (PM peak)



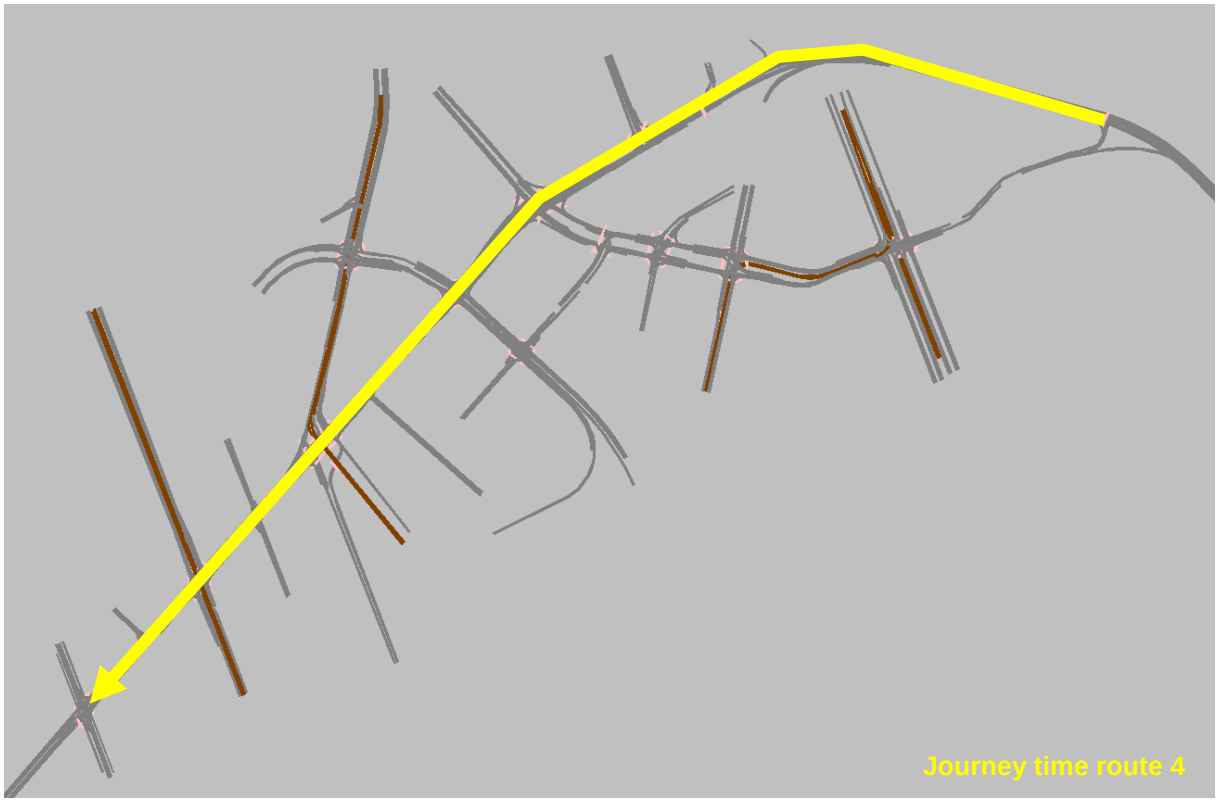


Table 6.15 – Journey time results by section for Route 3 (PM peak)

Section ending	Existing	Remove slip Queensbridge	Preferred option	Alternate Option
Clarendon Street	1:05	1:04	2:40	4:33
Queensbridge Street	1:47	1:43	1:38	1:33
Power Street	0:54	1:00	0:59	1:33
Southbank Boulevard	0:43	0:41	0:42	0:39
Southgate Avenue	0:16	0:17	0:17	0:16
Fanning Street POS	0:08	0:08	0:08	0:08
St Kilda Road	0:13	0:12	0:13	0:12
Alexandra Avenue POS	0:49	0:43	0:59	0:20
Linlithgow Avenue	1:33	1:21	1:28	0:33
TOTAL	**7:27**	**7:10**	**9:04**	**9:47**
Per cent change from base		-4%	22%	31%

Note: options above are cumulative.

Table 6.16 – Journey time results by section for Route 4 (PM peak)

Section ending	Existing	Remove slip Queensbridge	Preferred option	Alternate Option
Alexandra Avenue POS	0:12	0:12	0:12	0:13
St Kilda Road	0:18	0:18	0:18	0:24
Fanning Street POS	0:21	0:21	0:34	0:30
Southgate Avenue	0:29	0:27	0:46	0:31
Southbank Boulevard	1:58	1:39	2:03	1:56
Power Street	0:45	0:39	0:37	0:50
Queensbridge Street	1:17	1:08	1:12	2:08
Clarendon Street	0:55	0:59	1:20	1:35
Cecil Street	0:35	0:36	0:31	0:33
TOTAL	**6:49**	**6:18**	**7:34**	**8:40**
Per cent change from base		-8%	11%	27%

Note: options above are cumulative.

6.2.5 City Road preferred option sensitivity testing (AM peak)

Sensitivity tests for reduced speed limits have been carried out for the preferred scenario. Speed limits of 40 km/h and 50 km/h on City Road between Clarendon Street and Linlithgow Avenue have been tested. Results are presented below.

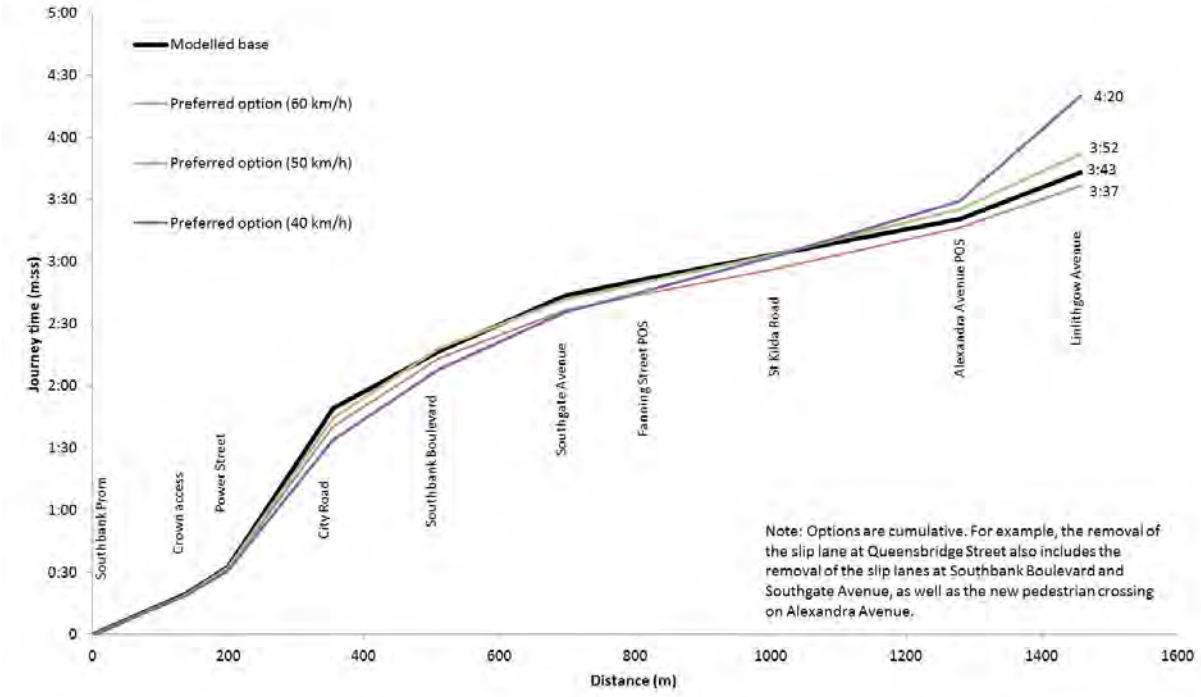
Routes 1 and 2

These routes travel between Queensbridge Street at Southbank Promenade to Alexandra Avenue at Linlithgow Avenue in the eastbound and westbound directions respectively. The results of the option tests are shown in Figure 6.18, Figure 6.19, Table 6.17 and Table 6.18.

The analysis indicates that—

- For Route 1 there is little overall difference in travel time with the exception of the 40 km/h sensitivity test where travel times increase between the proposed Alexandra Avenue pedestrian crossing and Linlithgow Avenue.
- For Route 2 there is little overall difference in travel time between each of the sensitivity tests. However all three tests show an increase in travel time relative to the base model particularly on approach to Southbank Avenue.

Figure 6.18 – Results of journey time tests for Route 1 (AM peak)



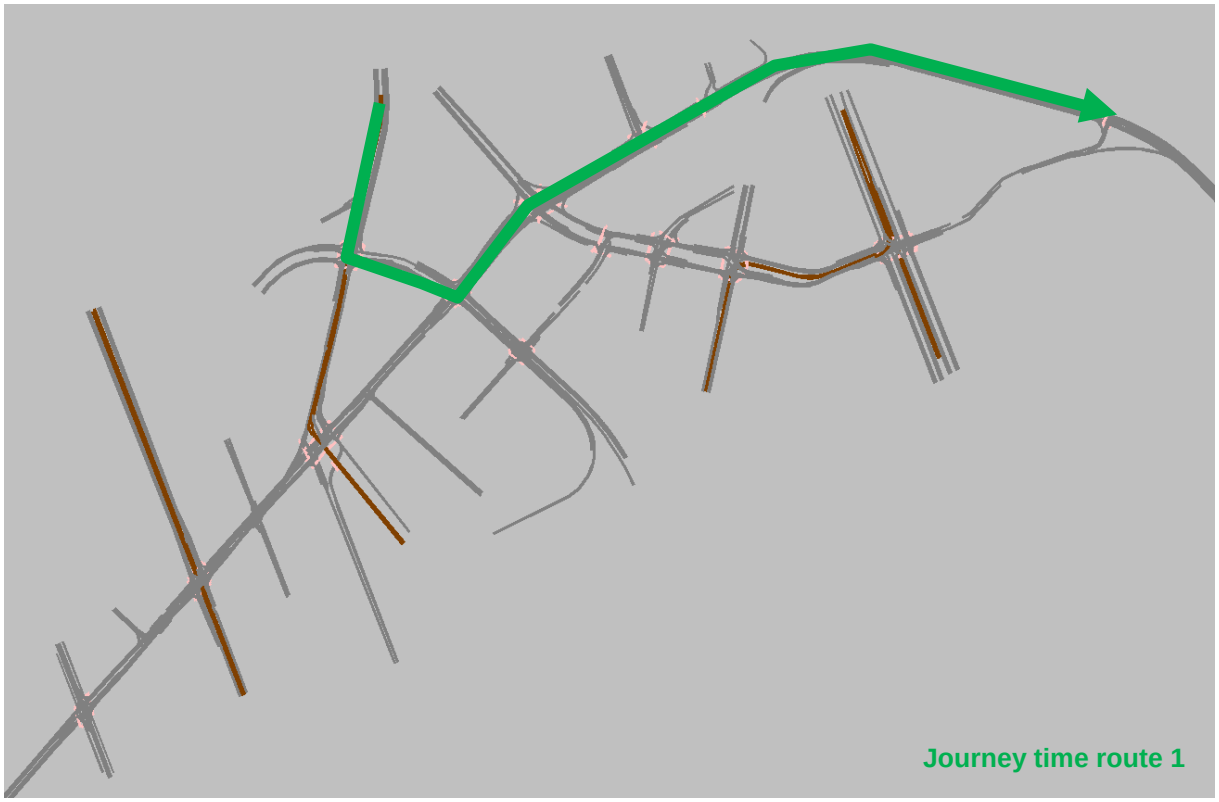
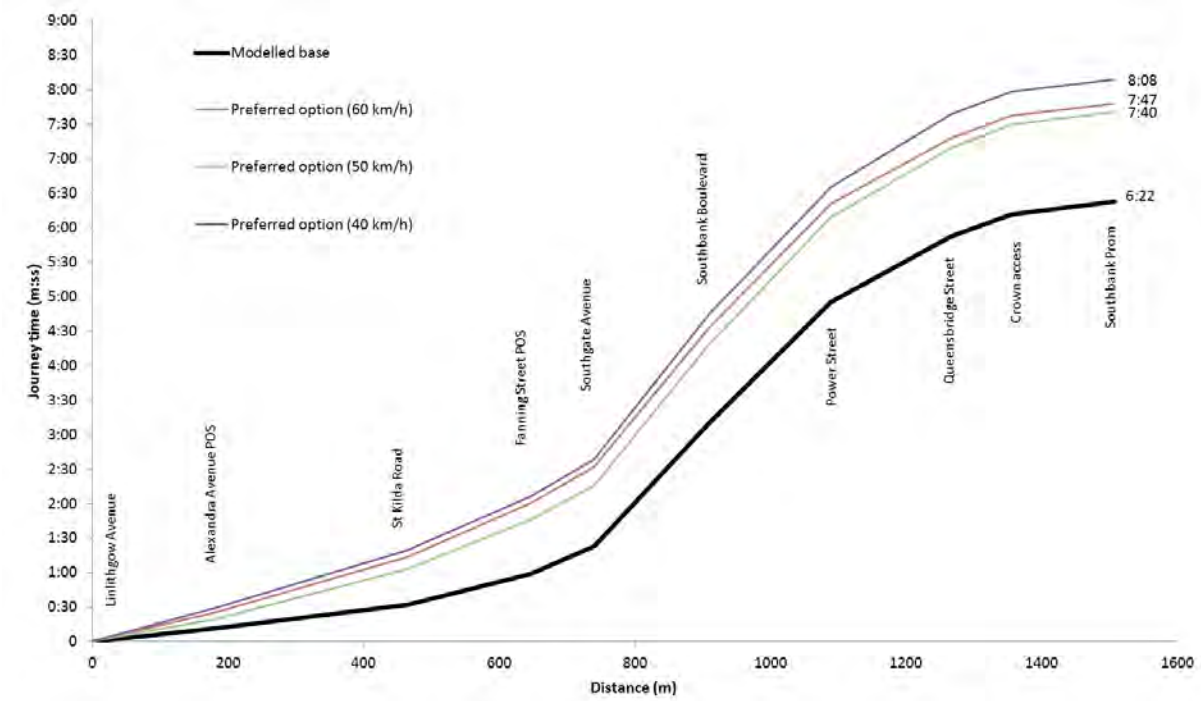


Figure 6.19 – Results of journey time tests for Route 2 (AM peak)



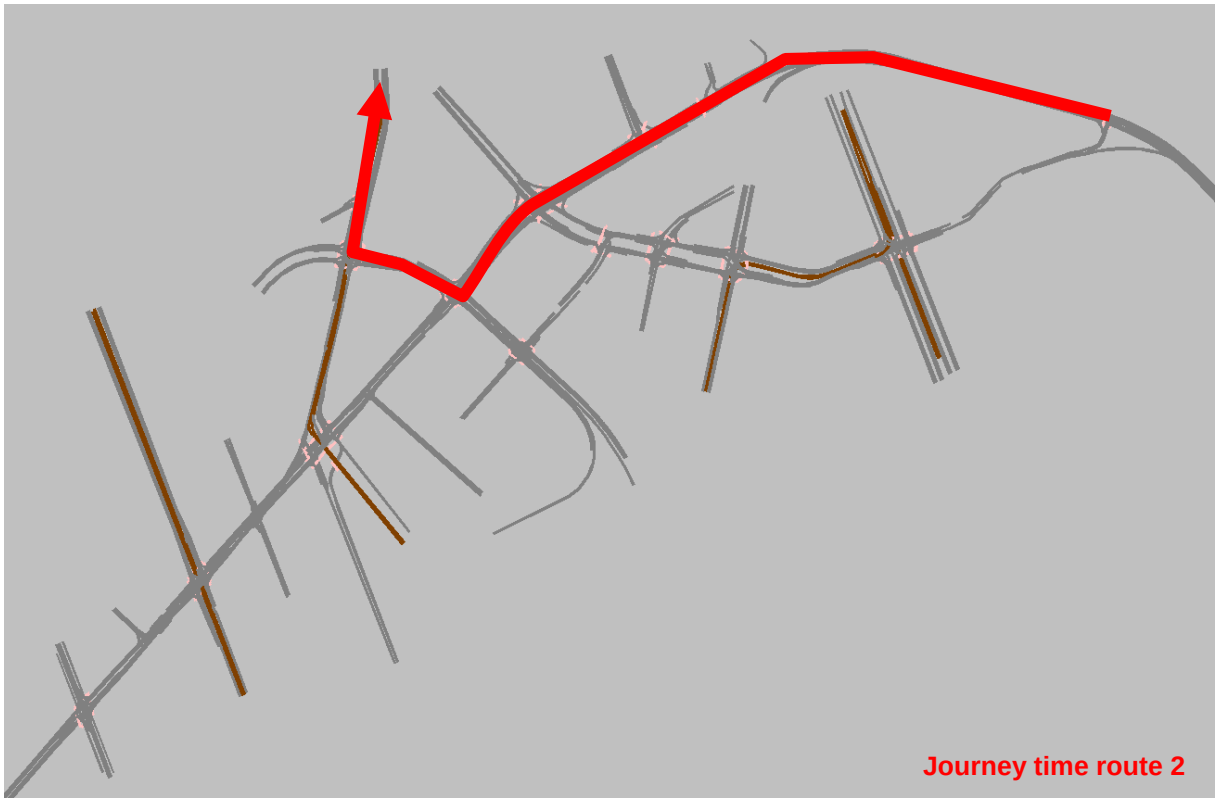


Table 6.17 – Journey time results by section for Route 1 (AM peak)

Section ending	Existing	Preferred option (60 km/h)	Preferred option (50 km/h)	Preferred option (40 km/h)
Crown access	0:20	0:20	0:19	0:19
Power Street	0:13	0:12	0:13	0:12
City Road	1:16	1:09	1:12	1:03
Southbank Boulevard	0:28	0:33	0:34	0:34
Southgate Avenue	0:27	0:23	0:23	0:27
Fanning Street POS	0:08	0:08	0:09	0:10
St Kilda Road	0:12	0:12	0:14	0:17
Alexandra Avenue POS	0:17	0:20	0:22	0:26
Linlithgow Avenue	0:22	0:20	0:26	0:51
TOTAL	**3:43**	**3:37**	**3:52**	**4:20**
Per cent change from base		-3%	4%	17%

Table 6.18 – Journey time results by section for Route 2 (AM peak)

Section ending	Existing	Preferred option (60 km/h)	Preferred option (50 km/h)	Preferred option (40 km/h)
Alexandra Avenue POS	0:12	0:26	0:20	0:29
St Kilda Road	0:20	0:48	0:43	0:50
Fanning Street POS	0:26	0:47	0:43	0:47
Southgate Avenue	0:25	0:31	0:29	0:32
Southbank Boulevard	1:47	2:01	2:03	2:06
Power Street	1:45	1:49	1:51	1:51
Queensbridge Street	0:57	0:56	1:00	1:03
Crown access	0:20	0:20	0:20	0:20
Southbank Prom	0:11	0:11	0:11	0:11
TOTAL	**6:22**	**7:47**	**7:40**	**8:08**
Per cent change from base		22%	20%	28%

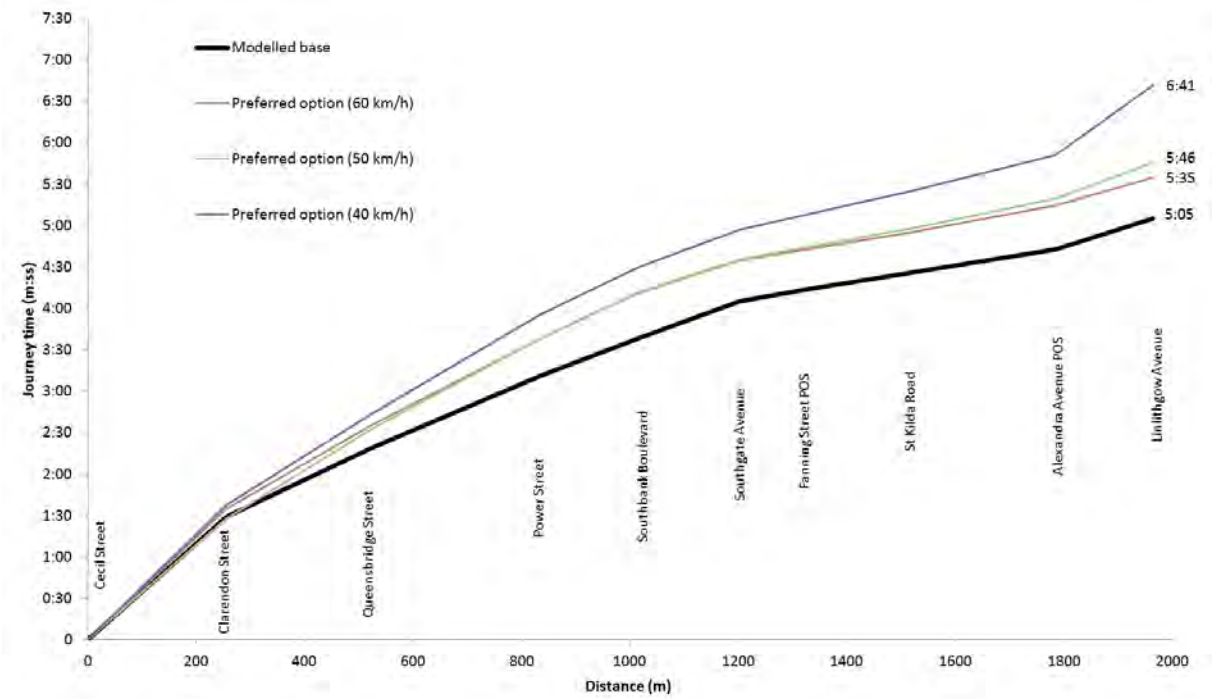
Routes 3 and 4

These routes travel along City Road/Alexandra Avenue between Cecil Street and Linlithgow Avenue in the eastbound and westbound directions respectively. The results of the option tests are shown in Figure 6.20, Figure 6.21, Table 6.19 and Table 6.20.

The analysis indicates that—

- For Route 3 there is an increase in overall difference in travel time particularly for the 40 km/h sensitivity test where travel times increase significantly between the proposed Alexandra Avenue pedestrian crossing and Linlithgow Avenue.
- For Route 4 all three sensitivity tests show an increase in travel time relative to the base model particularly on approach to Southbank Avenue. Overall the 40 km/h sensitivity test is the worst performing particularly west of Power Street.

Figure 6.20 – Results of journey time tests for Route 3 (AM peak)



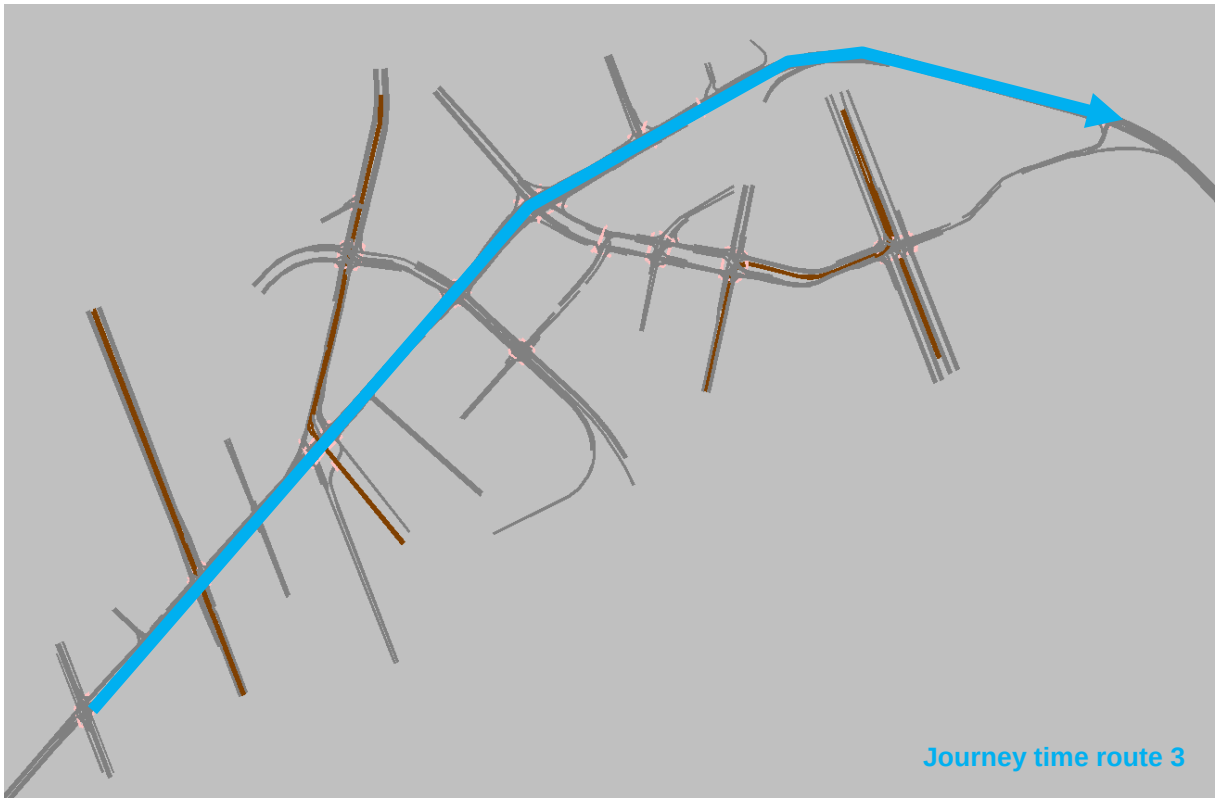
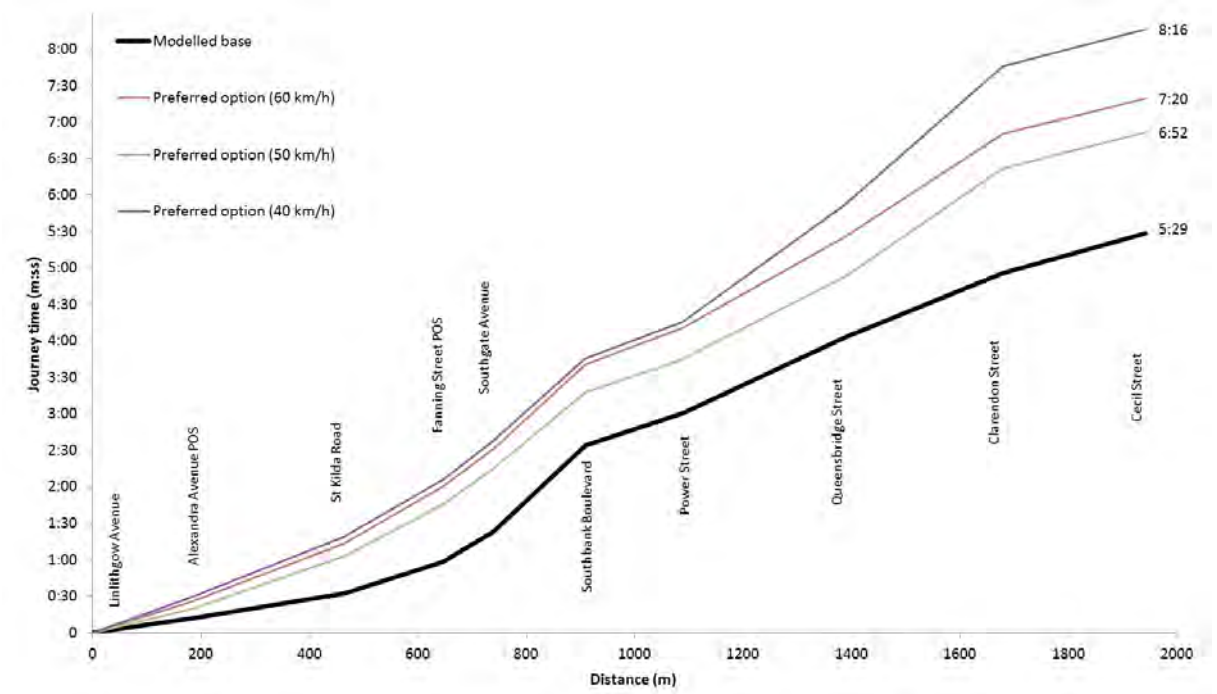


Figure 6.21 – Results of journey time tests for Route 4 (AM peak)



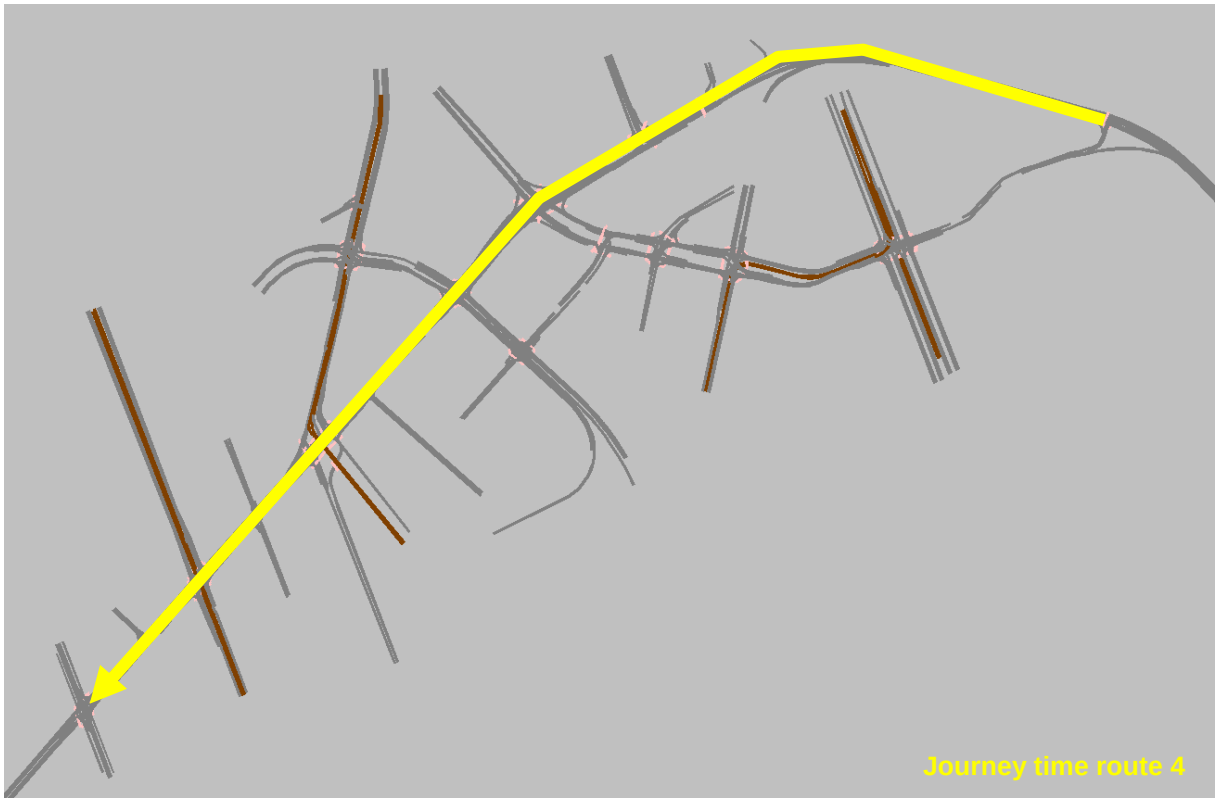


Table 6.19 – Journey time results by section for Route 3 (AM peak)

Section ending	Existing	Preferred option (60 km/h)	Preferred option (50 km/h)	Preferred option (40 km/h)
Clarendon Street	1:29	1:35	1:27	1:37
Queensbridge Street	0:49	1:00	1:05	1:06
Power Street	0:53	1:03	1:06	1:12
Southbank Boulevard	0:28	0:33	0:34	0:34
Southgate Avenue	0:27	0:23	0:23	0:27
Fanning Street POS	0:08	0:08	0:09	0:10
St Kilda Road	0:12	0:12	0:14	0:17
Alexandra Avenue POS	0:17	0:20	0:22	0:26
Linlithgow Avenue	0:22	0:20	0:26	0:51
TOTAL	**5:05**	**5:35**	**5:46**	**6:41**
Per cent change from base		10%	13%	31%

Table 6.20 – Journey time results by section for Route 4 (AM peak)

Section ending	Existing	Preferred option (60 km/h)	Preferred option (50 km/h)	Preferred option (40 km/h)
Alexandra Avenue POS	0:12	0:26	0:20	0:29
St Kilda Road	0:20	0:48	0:43	0:50
Fanning Street POS	0:26	0:47	0:43	0:47
Southgate Avenue	0:25	0:31	0:29	0:32
Southbank Boulevard	1:11	1:09	1:03	1:07
Power Street	0:26	0:30	0:27	0:30
Queensbridge Street	1:03	1:15	1:08	1:36
Clarendon Street	0:53	1:25	1:29	1:54
Cecil Street	0:33	0:29	0:30	0:30
TOTAL	**5:29**	**7:20**	**6:52**	**8:17**
Per cent change from base		34%	25%	51%

6.2.6 City Road preferred option sensitivity testing (PM peak)

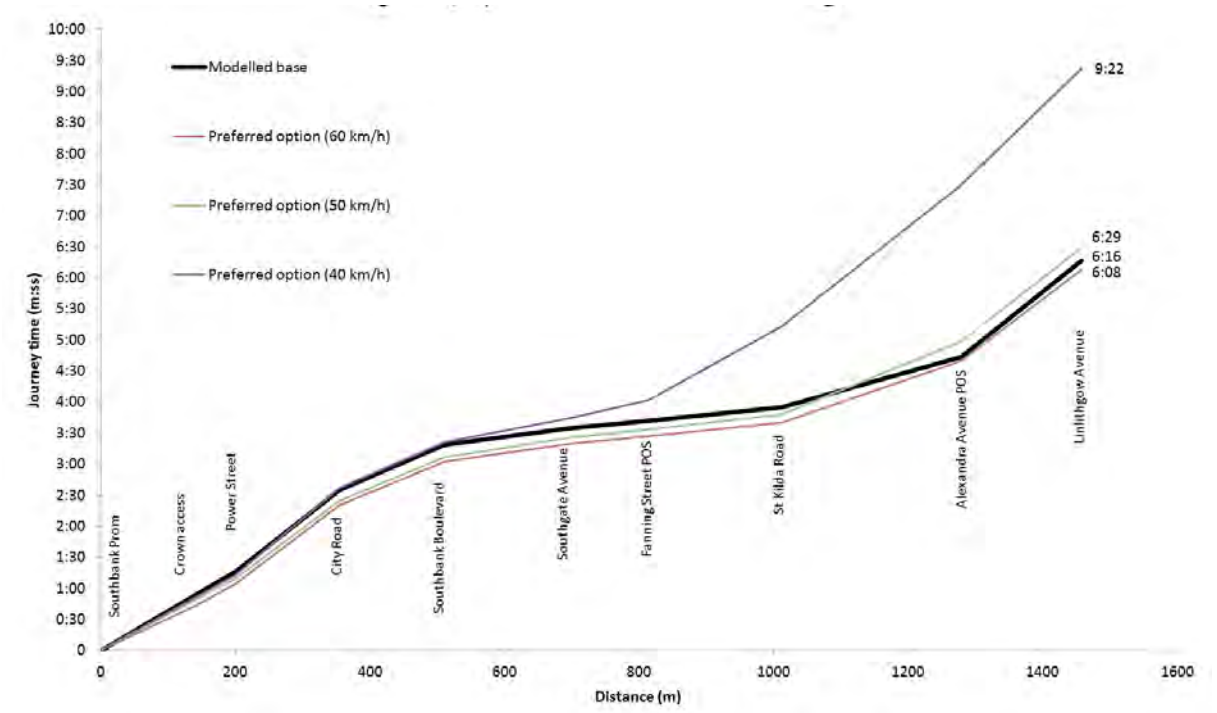
Routes 1 and 2

The results of the option tests are shown in Figure 6.22, Figure 6.23, Table 6.21 and Table 6.22.

The analysis indicates that—

- For Route 1 there is little difference in travel times between the base model and the 60 km/h and 50 km/h sensitivity tests. However the 40 km/h shows a significant increase in travel times east of Southgate Avenue. This appears to be due to a combination of queues of traffic not being able to disperse as quickly, and thus continuing to build up incrementally over time, and the signal progression being set for a journey time at 60 km/h.
- For Route 2 there are small increases in travel times for the 50 km/h and 60 km/h options. However, the 40 km/h sensitivity test leads to larger increases in travel time particularly on approach to Southbank Boulevard.

Figure 6.22 – Results of journey time tests for Route 1 (PM peak)



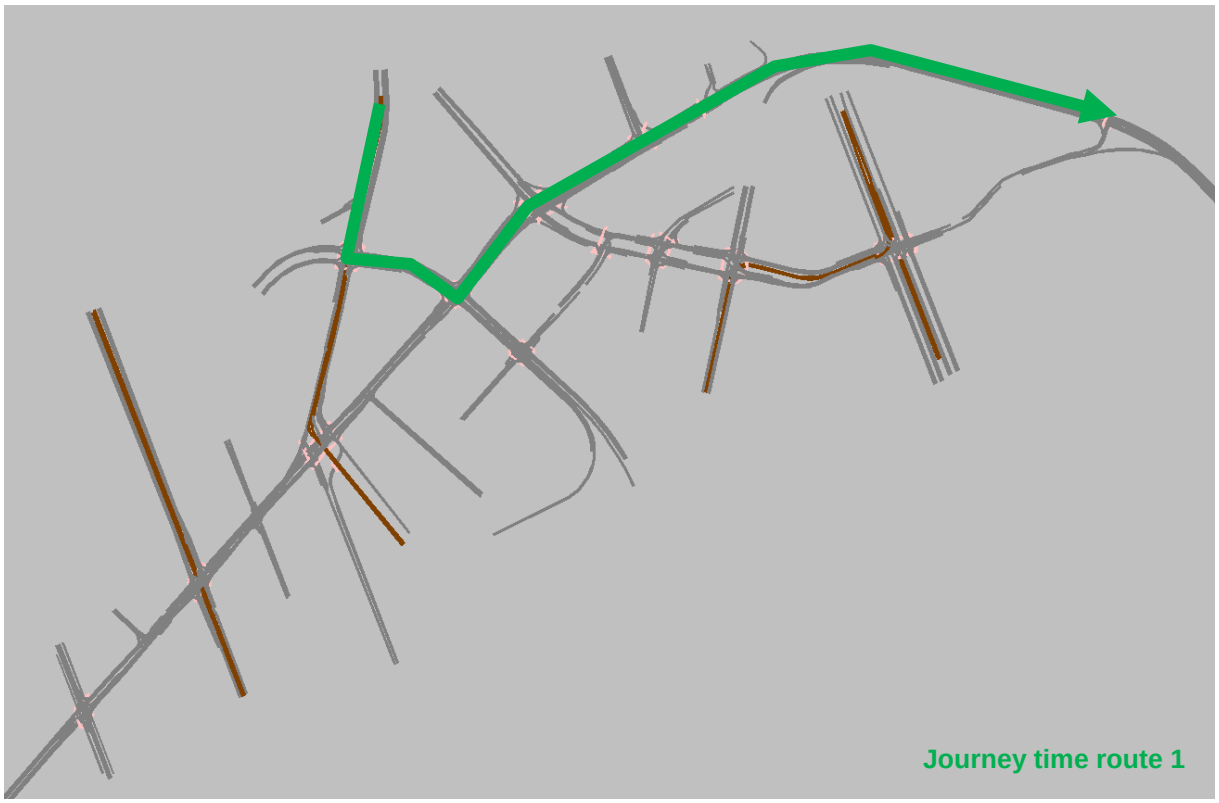
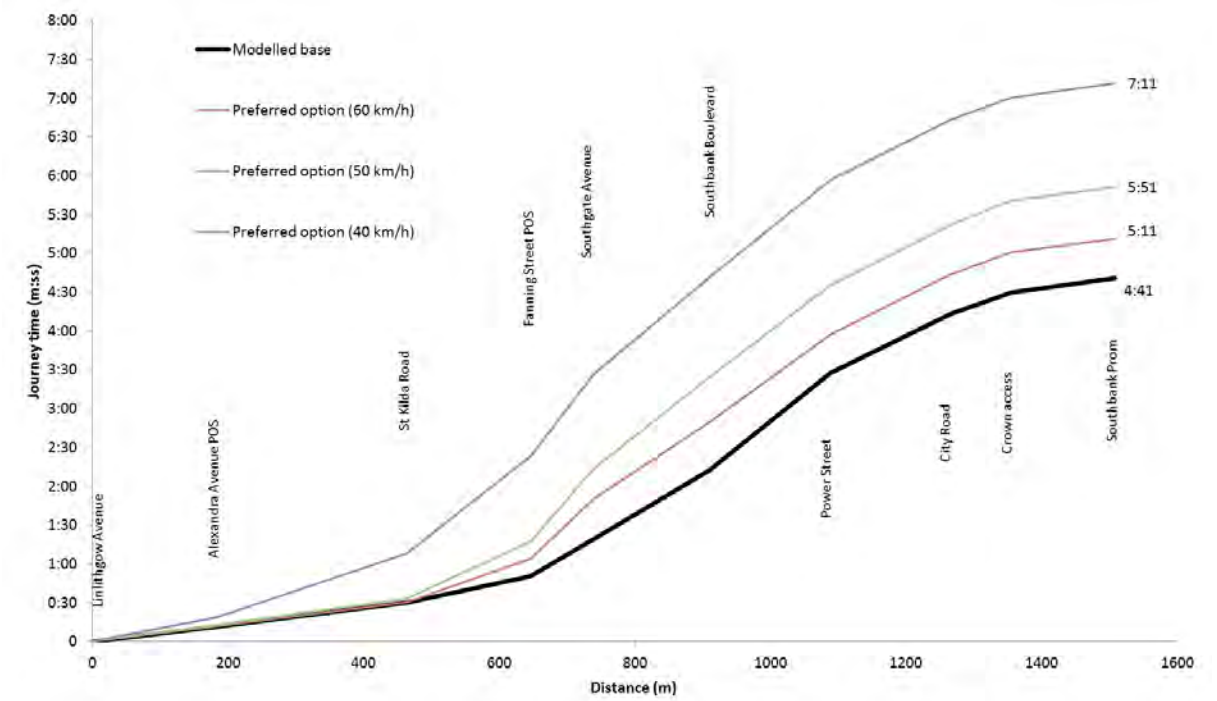


Figure 6.23 – Results of journey time tests for Route 2 (PM peak)



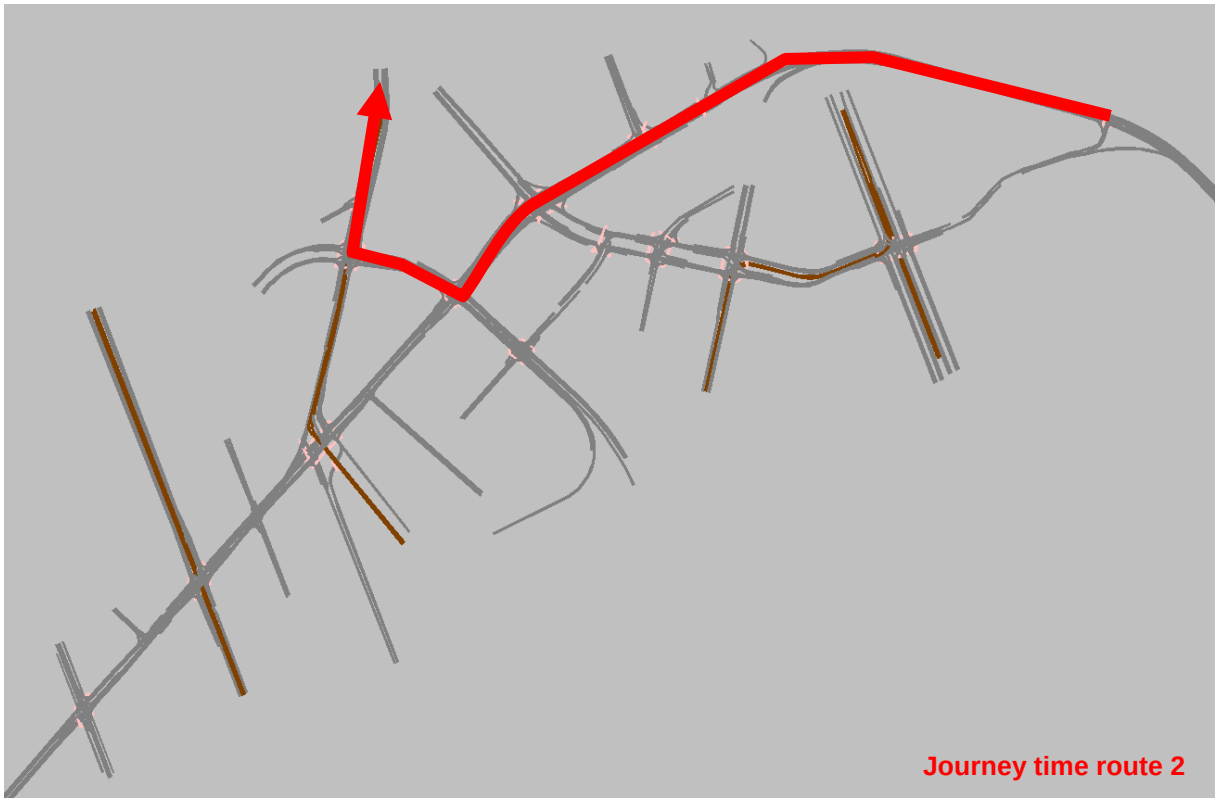


Table 6.21 – Journey time results by section for Route 1 (PM peak)

Section ending	Existing	Preferred option (60 km/h)	Preferred option (50 km/h)	Preferred option (40 km/h)
Crown access	0:53	0:43	0:48	0:51
Power Street	0:23	0:21	0:21	0:22
City Road	1:19	1:17	1:15	1:24
Southbank Boulevard	0:43	0:42	0:42	0:44
Southgate Avenue	0:16	0:17	0:18	0:23
Fanning Street POS	0:08	0:08	0:09	0:17
St Kilda Road	0:13	0:13	0:14	1:11
Alexandra Avenue POS	0:49	0:59	1:10	2:16
Linlithgow Avenue	1:33	1:28	1:30	1:54
TOTAL	**6:16**	**6:08**	**6:29**	**9:22**
Per cent change from base		-2%	3%	49%

Table 6.22 – Journey time results by section for Route 2 (PM peak)

Section ending	Existing	Preferred option (60 km/h)	Preferred option (50 km/h)	Preferred option (40 km/h)
Alexandra Avenue POS	0:12	0:12	0:13	0:19
St Kilda Road	0:18	0:18	0:20	0:49
Fanning Street POS	0:21	0:34	0:44	1:15
Southgate Avenue	0:29	0:46	0:56	1:04
Southbank Boulevard	0:53	0:59	1:10	1:14
Power Street	1:16	1:09	1:12	1:16
Queensbridge Street	0:46	0:46	0:47	0:46
Crown access	0:16	0:17	0:18	0:17
Southbank Prom	0:11	0:11	0:11	0:11
TOTAL	**4:41**	**5:11**	**5:51**	**7:11**
Per cent change from base		11%	25%	53%

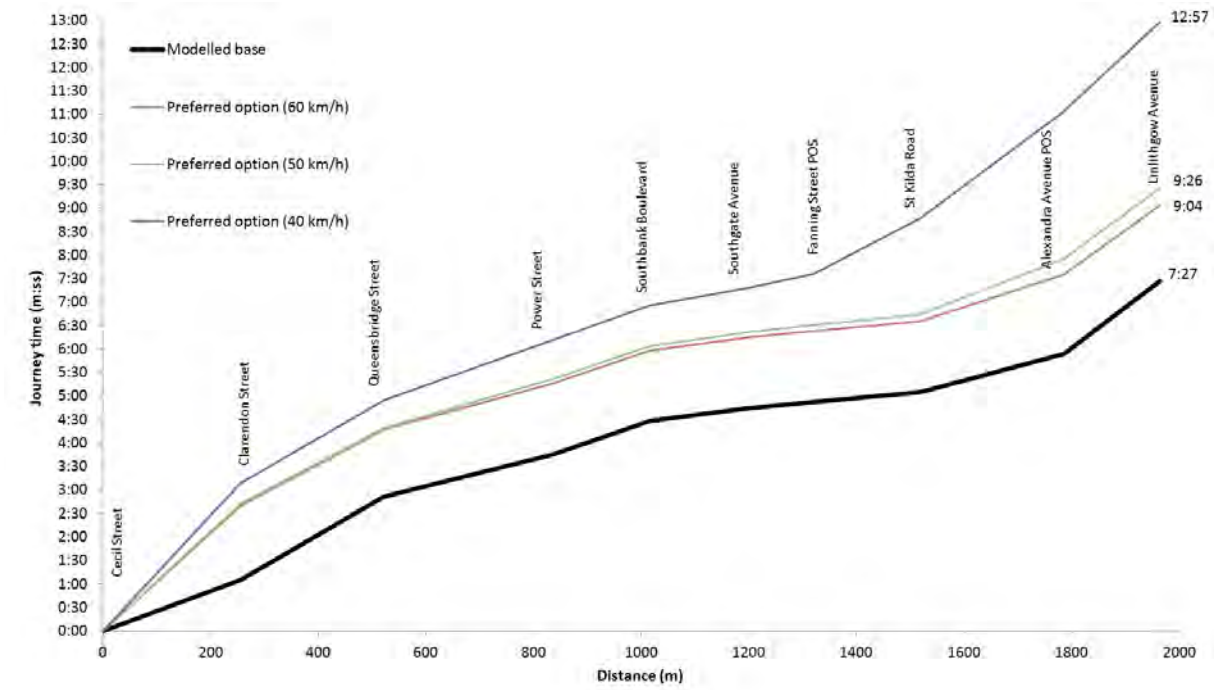
Routes 3 and 4

The results of the option tests are shown in Figure 6.24, Figure 6.25, Table 6.23 and Table 6.24.

The analysis indicates that—

- On Route 3 there are large increases in travel for all sensitivity tests on approach to Clarendon Street. However, the 40 km/h sensitivity test shows large increases in travel time east of Southgate Avenue for the reasons discussed in Routes 1 and 2. Overall there are large increases in travel time especially for the 40 km/h sensitivity test.
- On Route 4 all three sensitivity tests show an increase in travel time relative to the base model particularly on approach to Southbank Avenue. Overall the 40 km/h sensitivity test is the worst performing test.

Figure 6.24 – Results of journey time tests for Route 3 (PM peak)



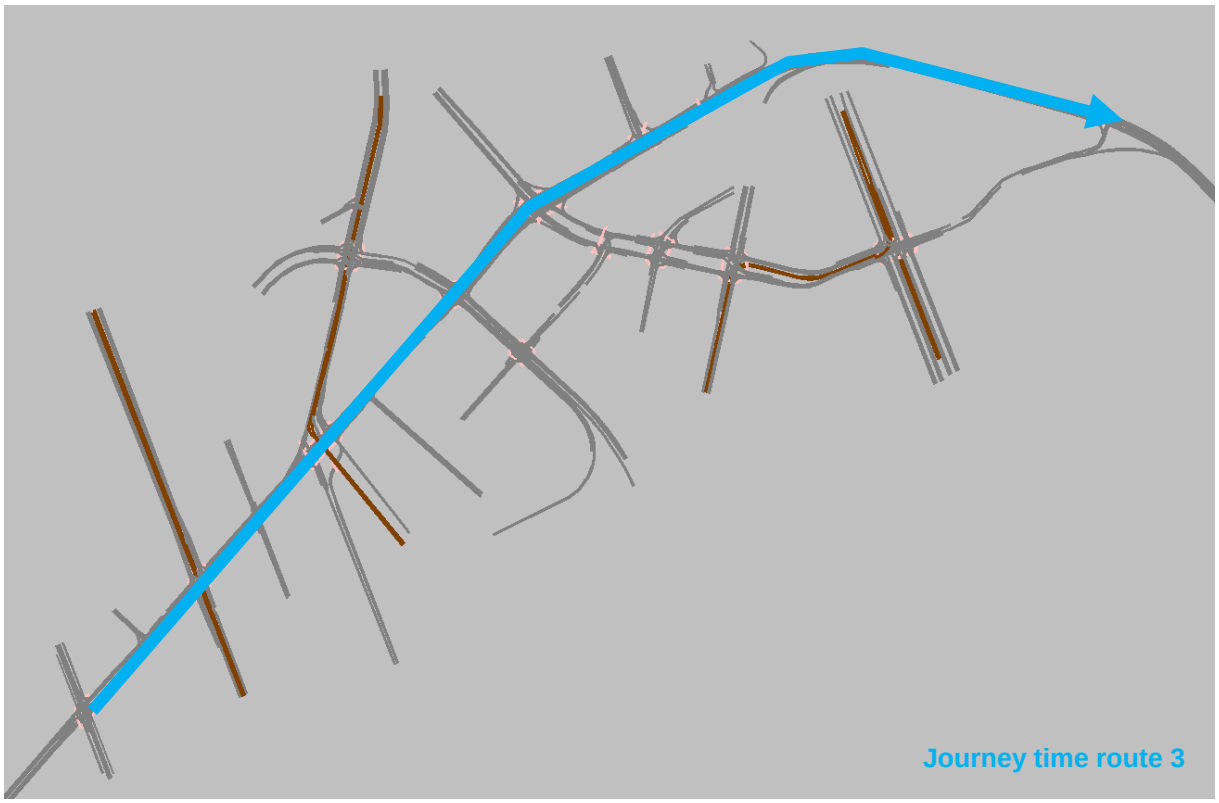
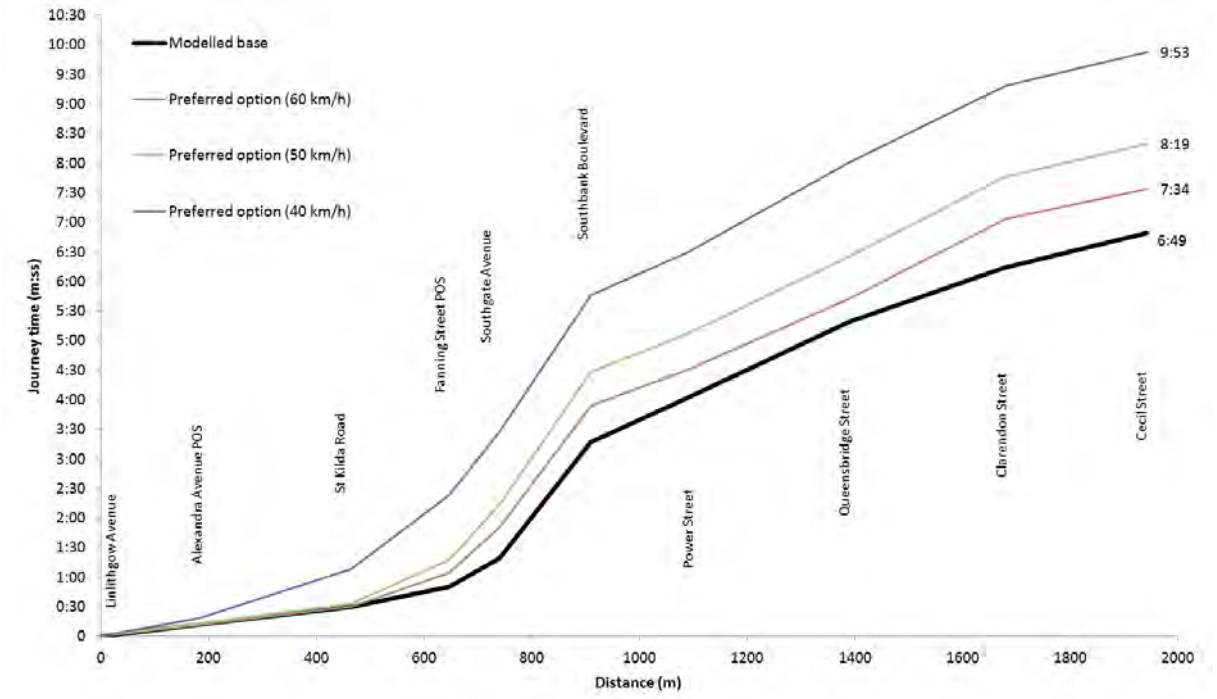


Figure 6.25 – Results of journey time tests for Route 4 (PM peak)



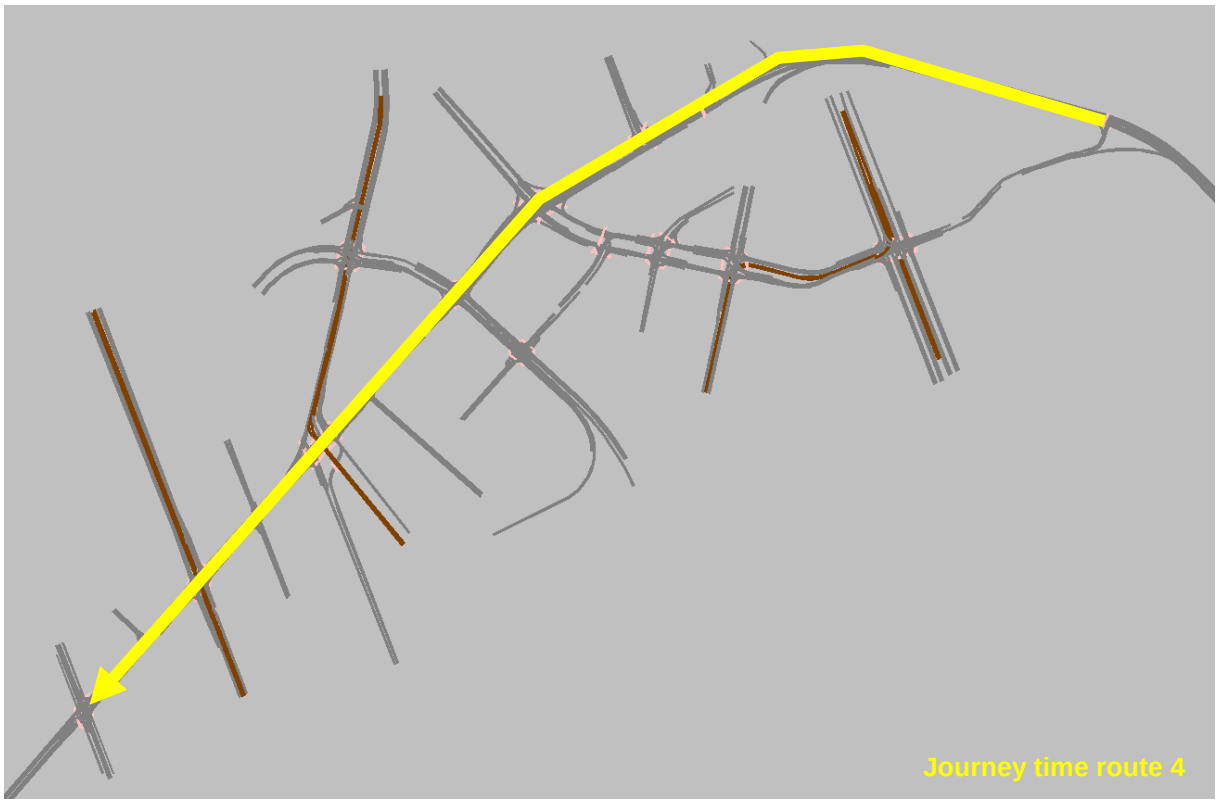


Table 6.23 – Journey time results by section for Route 3 (PM peak)

Section ending	Existing	Preferred option (60 km/h)	Preferred option (50 km/h)	Preferred option (40 km/h)
Clarendon Street	1:05	2:40	2:43	3:08
Queensbridge Street	1:47	1:38	1:37	1:47
Power Street	0:54	0:59	1:02	1:17
Southbank Boulevard	0:43	0:42	0:42	0:44
Southgate Avenue	0:16	0:17	0:18	0:23
Fanning Street POS	0:08	0:08	0:09	0:17
St Kilda Road	0:13	0:13	0:14	1:11
Alexandra Avenue POS	0:49	0:59	1:11	2:16
Linlithgow Avenue	1:33	1:28	1:30	1:54
TOTAL	**7:27**	**9:04**	**9:26**	**12:57**
Per cent change from base		22%	27%	74%

Table 6.24 – Journey time results by section for Route 4 (PM peak)

Section ending	Existing	Preferred option (60 km/h)	Preferred option (50 km/h)	Preferred option (40 km/h)
Alexandra Avenue POS	0:12	0:12	0:13	0:19
St Kilda Road	0:18	0:18	0:20	0:49
Fanning Street POS	0:21	0:34	0:44	1:15
Southgate Avenue	0:29	0:46	0:56	1:04
Southbank Boulevard	1:58	2:03	2:14	2:19
Power Street	0:45	0:37	0:39	0:43
Queensbridge Street	1:17	1:12	1:17	1:31
Clarendon Street	0:55	1:20	1:21	1:18
Cecil Street	0:35	0:31	0:34	0:35
TOTAL	**6:49**	**7:34**	**8:19**	**9:53**
Per cent change from base		11%	22%	45%

6.2.7 Summary of sensitivity test analysis

The sensitivity tests presented in the preceding sections generally show that journey times increase as the speed limit reduces. While this is to some extent logical (it takes longer to travel a fixed distance at a lower speed) there is generally a disproportionately larger increase in journey time at 40 km/h than at 50 km/h (i.e. the increase is not linear). This may be due to the following reasons:

- At lower speeds, queues do not disperse as quickly and some vehicles at the back of the queue may not clear the signals in one cycle. This leaves a residual queue which continues to increase as time progresses.
- Signal progression (the so-called “green wave”) is optimised for a journey time at 60 km/h. Therefore, at lower (or higher) speeds the progression would not be as efficient and some vehicles are likely to be caught when previously they would not be.
- On some sections there are particularly large increases in journey time, such as between Fanning Street and St Kilda Road, where journey times increase from 14 to 71 seconds over a relatively short distance in the PM peak in the 40 km/h test. In this instance this appears to be due to the queue from downstream signals extending back and delaying vehicles that previously were not delayed at all.

6.2.8 Summary of journey time results – Power Street to Linlithgow Avenue

As the section of City Road between Power Street and Linlithgow Avenue is the designated bypass of the CityLink tunnels during tunnel closures and for over-height vehicles, this section is of particular interest to VicRoads.

Journey times on this section have been determined by taking results from Routes 3 and 4 for this section of the model and summing them into a single travel time. The results are presented below:

- Figure 6.26 presents the results of journey time tests for Route 3 in the AM peak
- Figure 6.27 presents the results of journey time tests for Route 4 in the AM peak
- Figure 6.28 presents the results of journey time tests for Route 3 in the PM peak
- Figure 6.29 presents the results of journey time tests for Route 4 in the PM peak

Figure 6.26 – Results of journey time tests for Route 3 (AM peak)

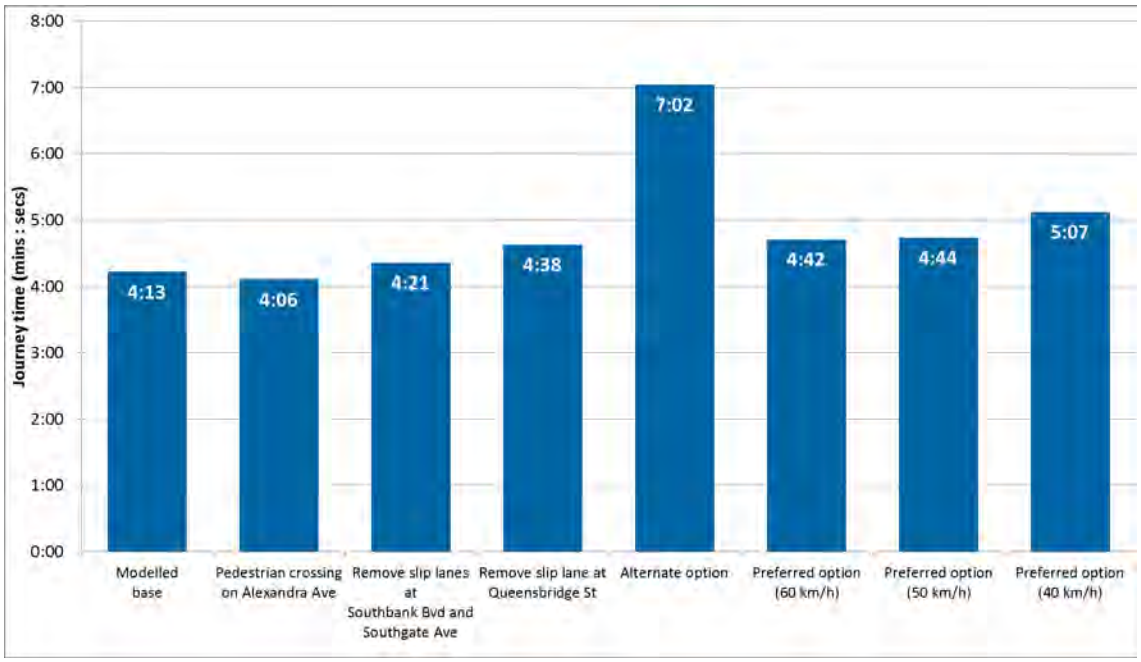


Figure 6.27 – Results of journey time tests for Route 4 (AM peak)

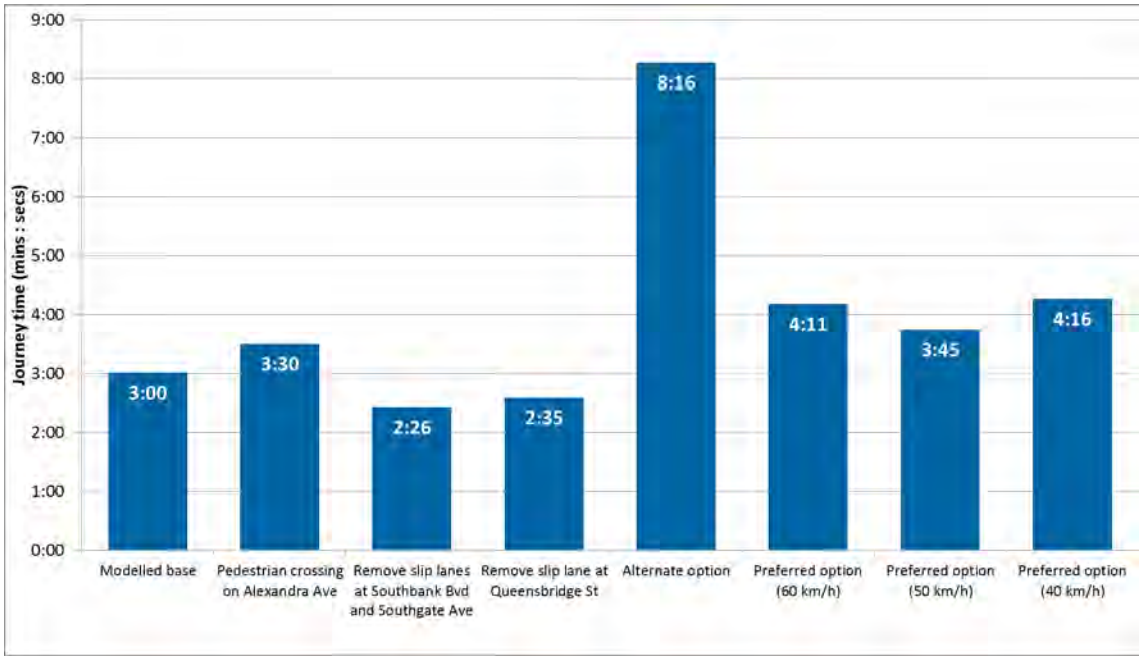


Figure 6.28 – Results of journey time tests for Route 3 (PM peak)

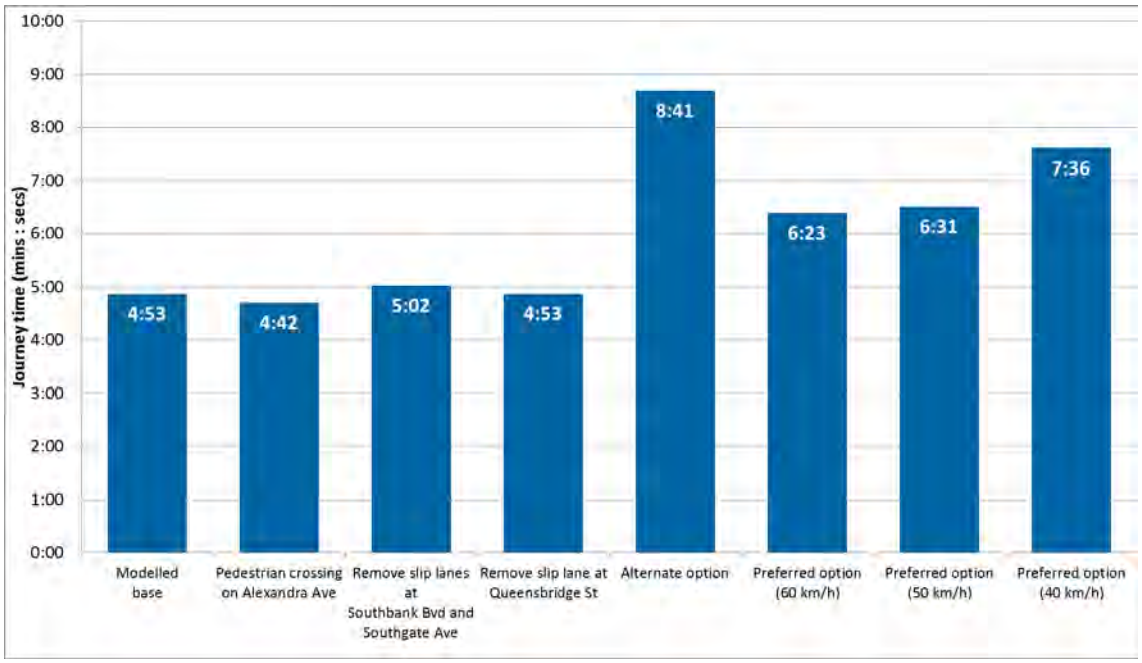
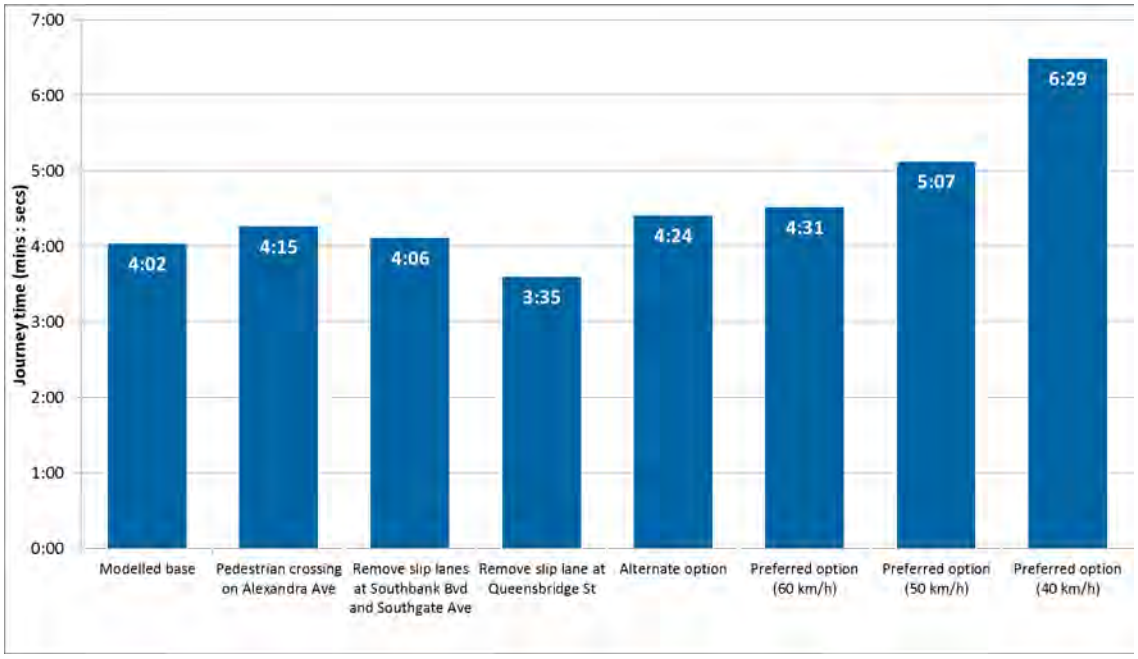


Figure 6.29 – Results of journey time tests for Route 4 (PM peak)



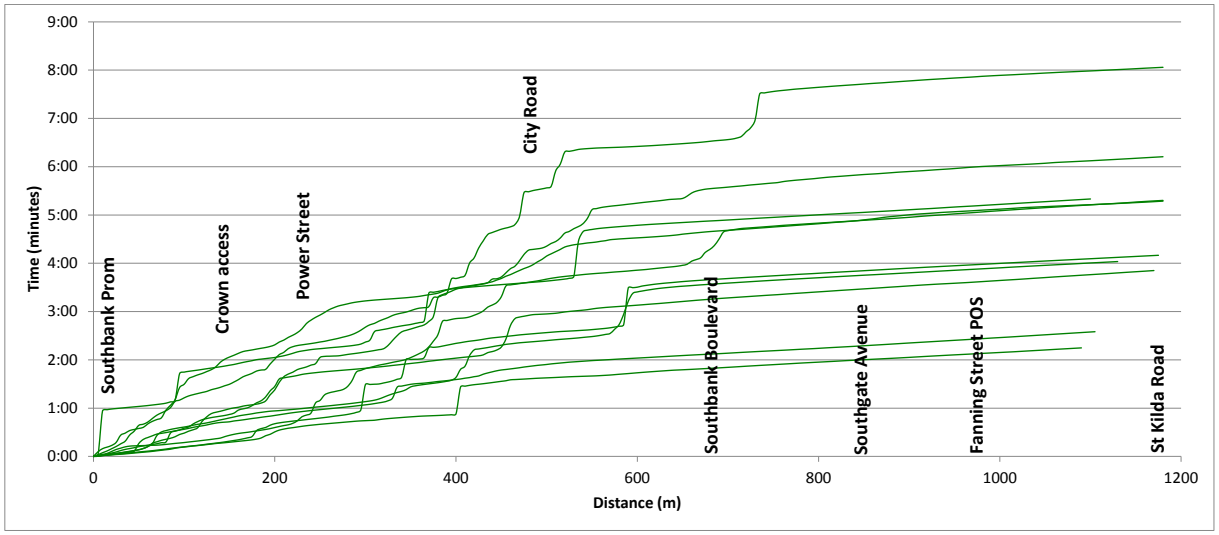
6.2.9 Impact of journey time increases

The modelled impacts to journey times vary between about 30 seconds and two minutes for the physical changes and up to a further four minutes for the 40 km/h speed limit tests. Journey time increases should be assessed both in relation to the overall median journey time (as a four-minute increase on a long journey would be less noticeable than on a short journey) and to the natural variation in journey time that occurs on a route.

The latter point can be illustrated by examining data collected during the journey time surveys undertaken as part of the base model validation exercise. Figure 6.30 shows the results of 10 journey time runs along Route 1 in the PM peak. These runs took place within a two-hour period. It can be seen that the difference between the fastest and slowest journey times is nearly six minutes.

In this context, the increases in journey times expected as a result of the proposed changes on City Road are relatively minor when compared to the natural variation already experienced on a day-to-day basis. In other words, while the proposed changes may increase the *median* journey time along a route by a certain amount, it is likely that the actual journey time experienced would vary substantially from this median (including being faster) because of natural causes such as the level of congestion on a given day.

Figure 6.30 – Example of variation in observed journey times (Route 1, PM)



6.3 Level of service

6.3.1 Introduction

Delays for each approach have been extracted and converted into level of service (LOS) equivalents using the thresholds given in the US Highway Capacity Manual. This analysis provides an alpha-numeric rating of how well the intersection performs and is directly related to the average delay a vehicle experiences at an intersection. The relationship between average delay and LOS is shown in Table 6.25.

Note that LOS results have been presented for the City Road East and Alexandra Avenue improvements scenario and for the preferred and alternate layouts.

Table 6.25 – Level of service criteria

Delay, d (seconds)	Level of service
d ≤ 10	A
11 ≤ d ≤ 20	B
21 ≤ d ≤ 35	C
36 ≤ d ≤ 55	D
56 ≤ d ≤ 80	E
d > 80	F

It should be noted that the realistic target for LOS in congested urban environments is typically D.

6.3.2 Base case (existing conditions)

LOS results for the base case (existing conditions) are shown in Figure 6.31 and Figure 6.32 for the AM and PM peaks respectively.

Figure 6.31 – Level of service results for base case (existing conditions) (AM peak)

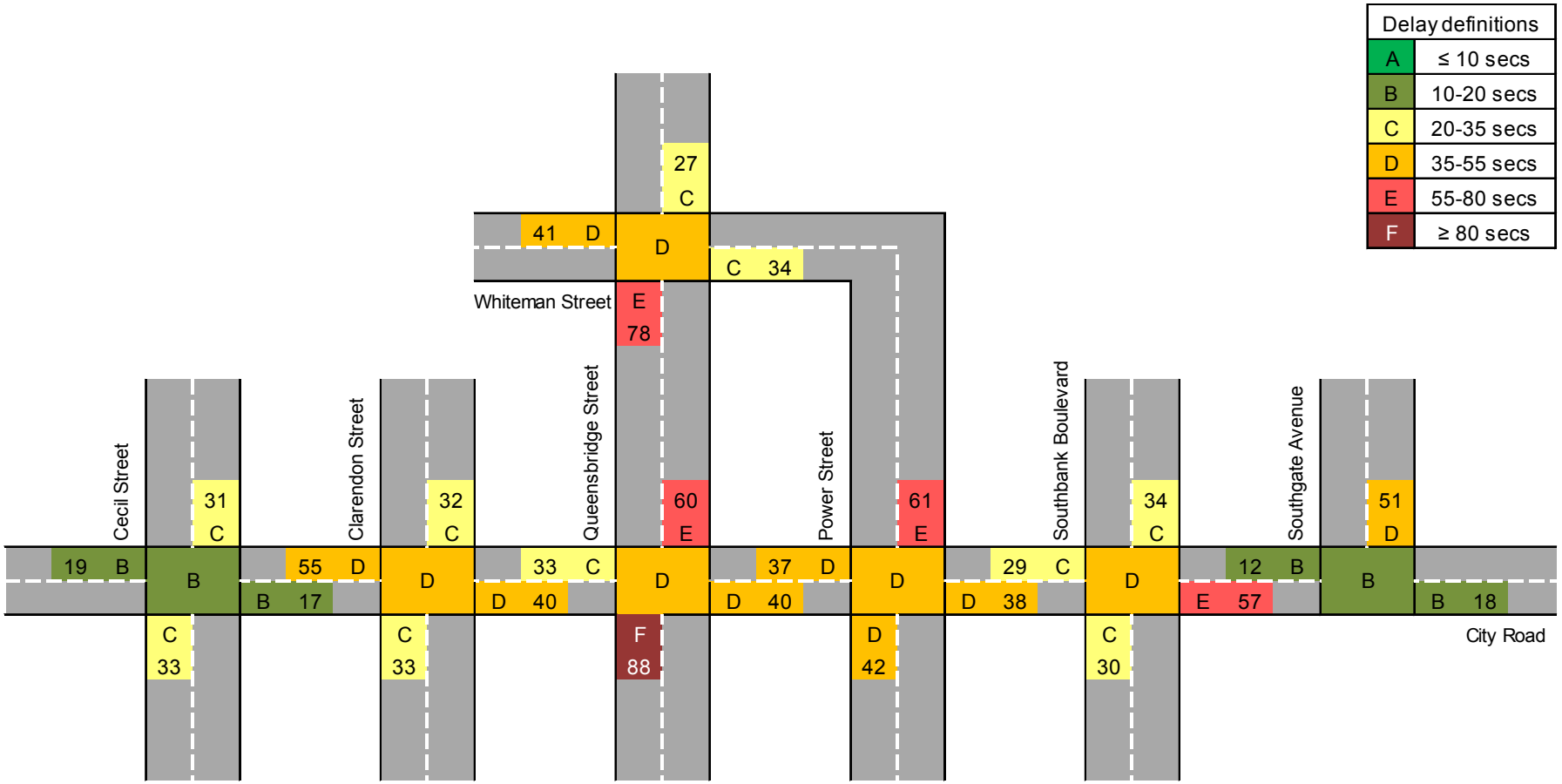
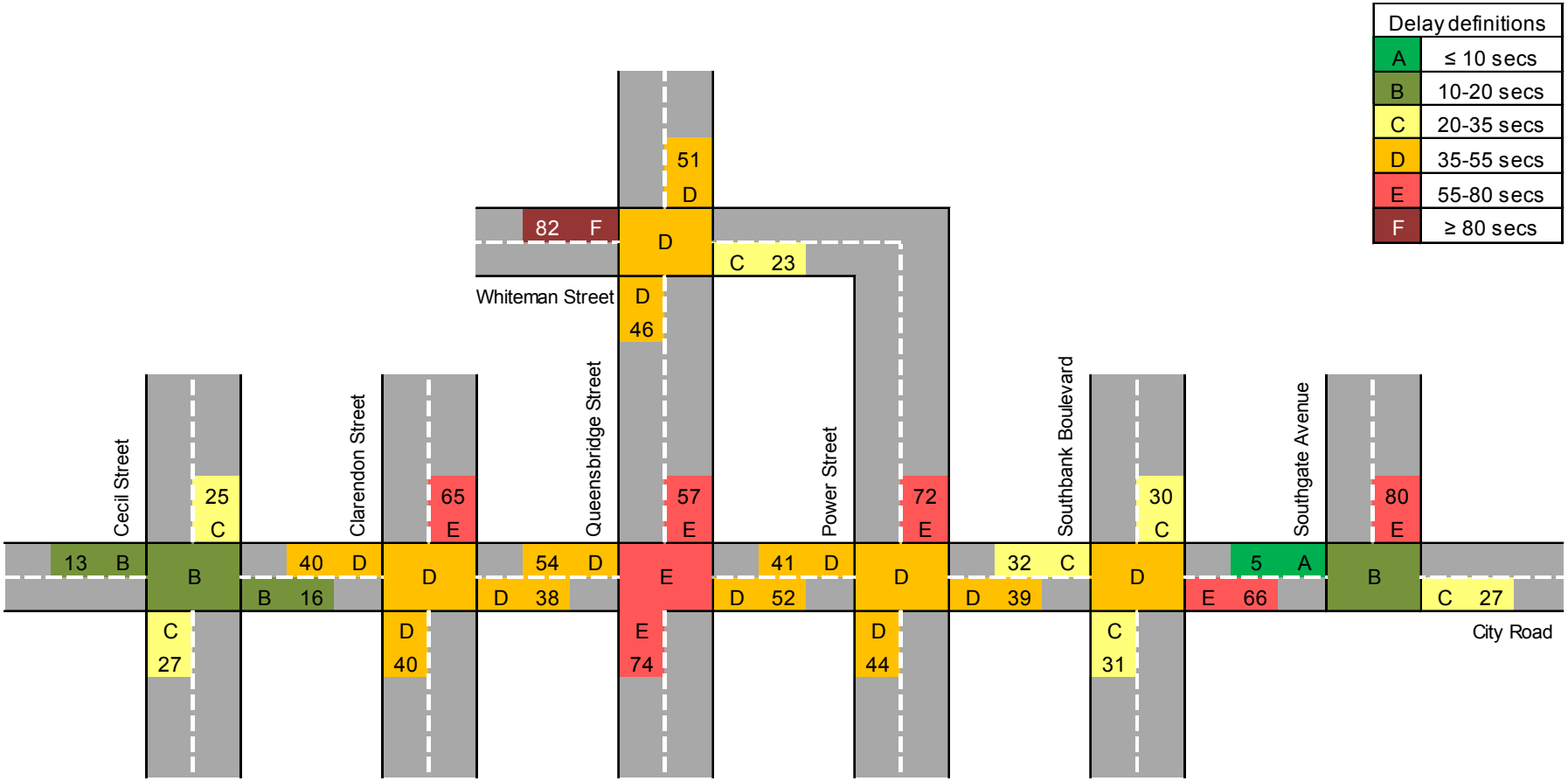


Figure 6.32 – Level of service results for base case (existing conditions) (PM peak)



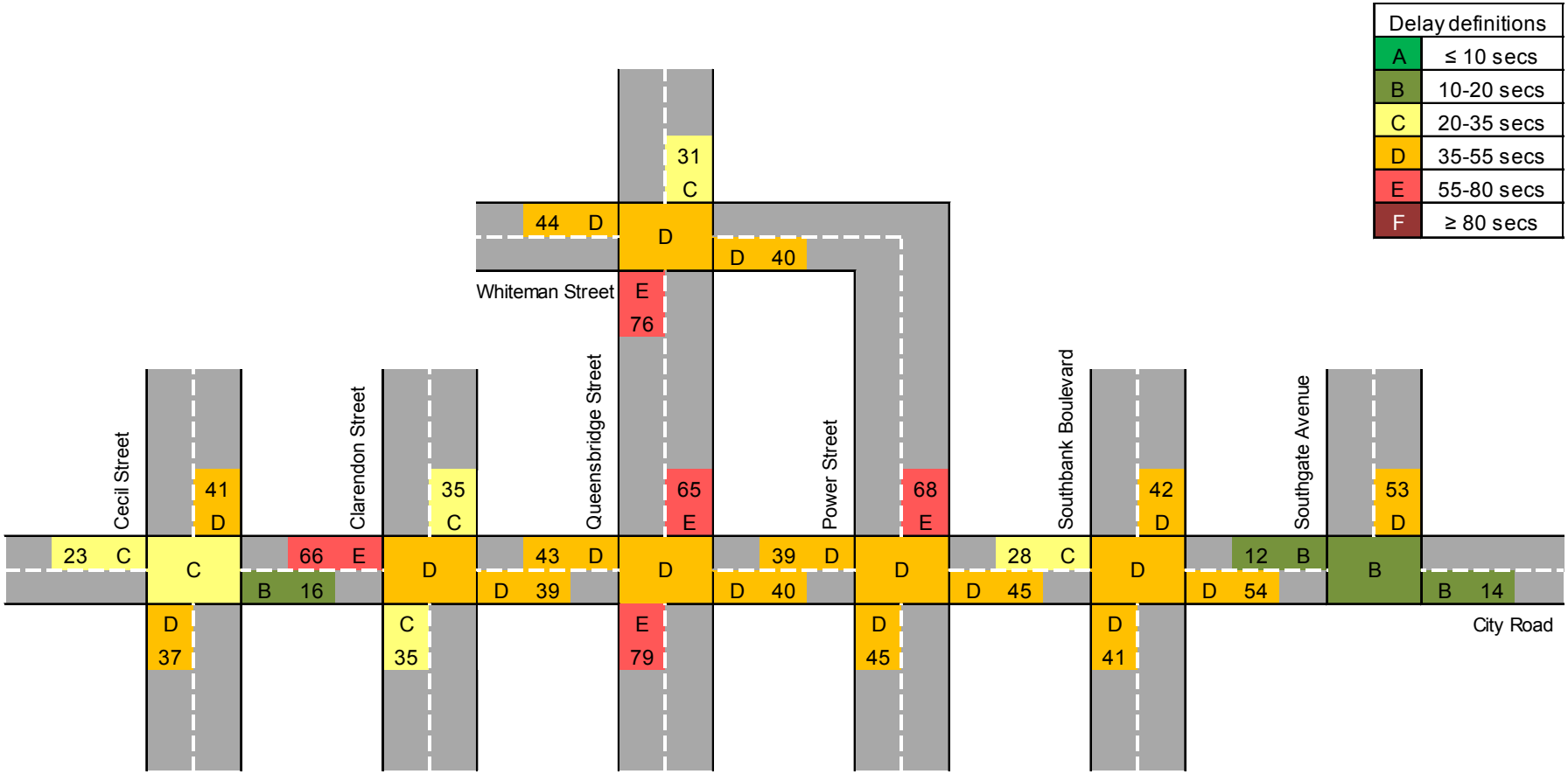
6.3.3 City Road East and Alexandra Avenue improvements scenario (AM)

LOS results for the City Road East and Alexandra Avenue improvements scenario are shown in Figure 6.33.

The results indicate that—

- Overall LOS only changes at the Cecil Street intersection where it drops from B to C. This is largest change observed.
- LOS on certain approaches at other intersections reduce, while some improve. For example, the south approach at the Southbank Boulevard intersection drops from LOS C to LOS D due to the loss of the slip lane on that approach.

Figure 6.33 – Level of service results for City Road East and Alexandra Avenue improvements scenario (AM peak)



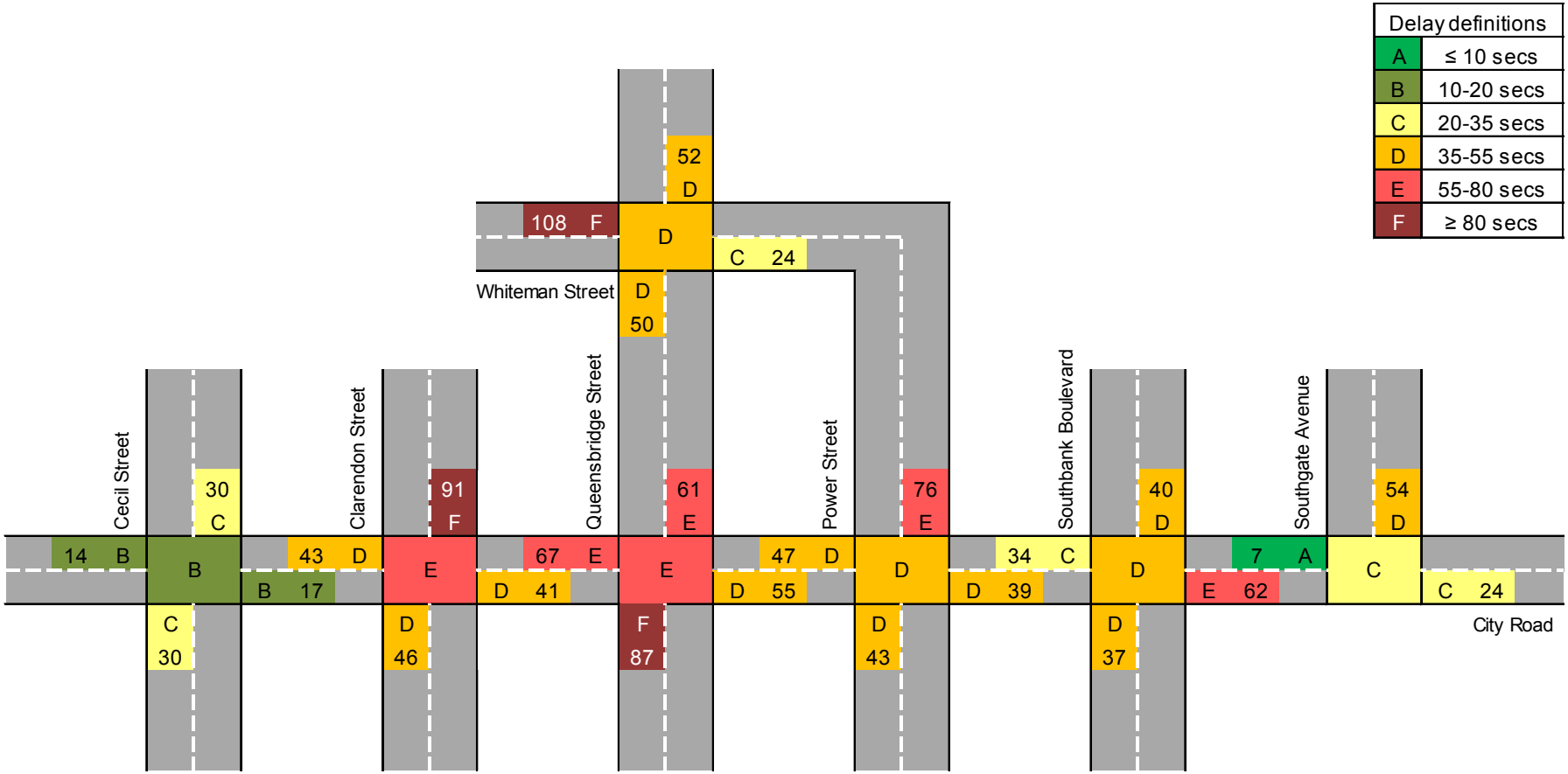
6.3.4 City Road East and Alexandra Avenue improvements scenario (PM)

LOS results for the City Road East and Alexandra Avenue improvements scenario are shown in Figure 6.34.

The results indicate that—

- Clarendon Street experiences a drop in LOS from D to E, with the north approach reducing from E to F. The only other significant change is at the Southgate Avenue intersection which experiences an overall drop in LOS from B to C.
- There are few changes elsewhere which indicates that the changes do not have a significant impact on the performance of intersections along City Road.

Figure 6.34 – Level of service results for City Road East and Alexandra Avenue improvements scenario (PM peak)



6.3.5 City Road West improvements – AM peak

The preferred and alternate layouts build on the City Road East and Alexandra Avenue improvements scenario but are themselves mutually exclusive. The City Road West improvements are therefore compared to the City Road East and Alexandra Avenue improvements scenario as well as to the base case (existing conditions).

Level of service results for the AM peak are shown in Figure 6.35 and Figure 6.36.

When compared to the City Road East and Alexandra Avenue improvements scenario the results indicate that—

Preferred layout

- The Clarendon Street intersection drops from LOS D to LOS E. The east approach also drops from LOS D to LOS F as a result of the loss of the right turn lane.
- The only other significant change to LOS is on the north approach at Southgate Avenue, where LOS drops from D to E and the overall LOS drops from B to C.

Alternate layout

- Significant reductions in LOS are experienced at most intersections, but particularly at Cecil, Clarendon, Queensbridge and Power streets. In the case of Cecil Street, LOS drops from C to F.
- At Power Street the south approach remains at LOS D which is important as additional delays on this approach have the potential to impact on freeway operations.

Figure 6.35 – Level of service results for the preferred layout (AM peak)

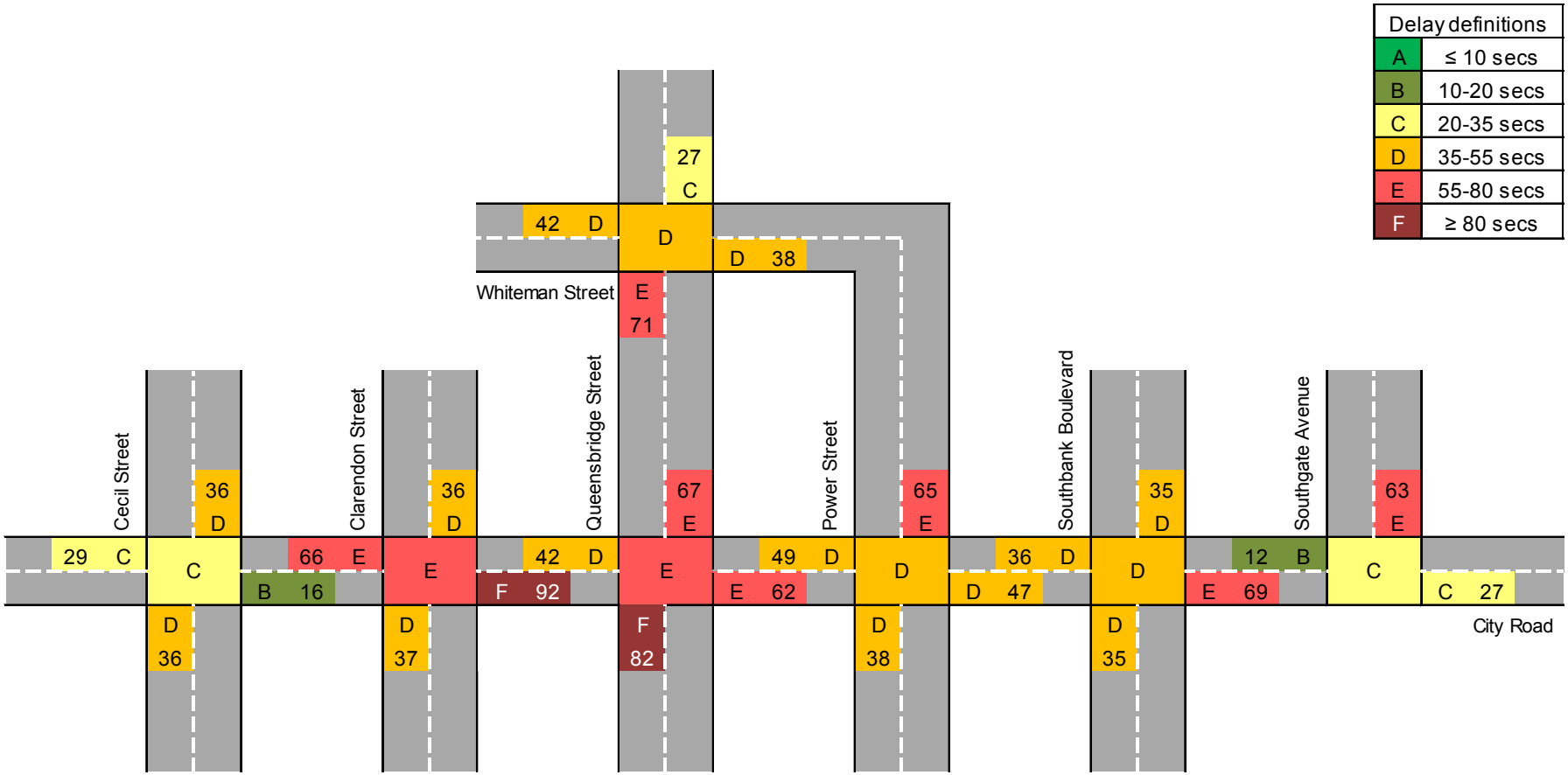
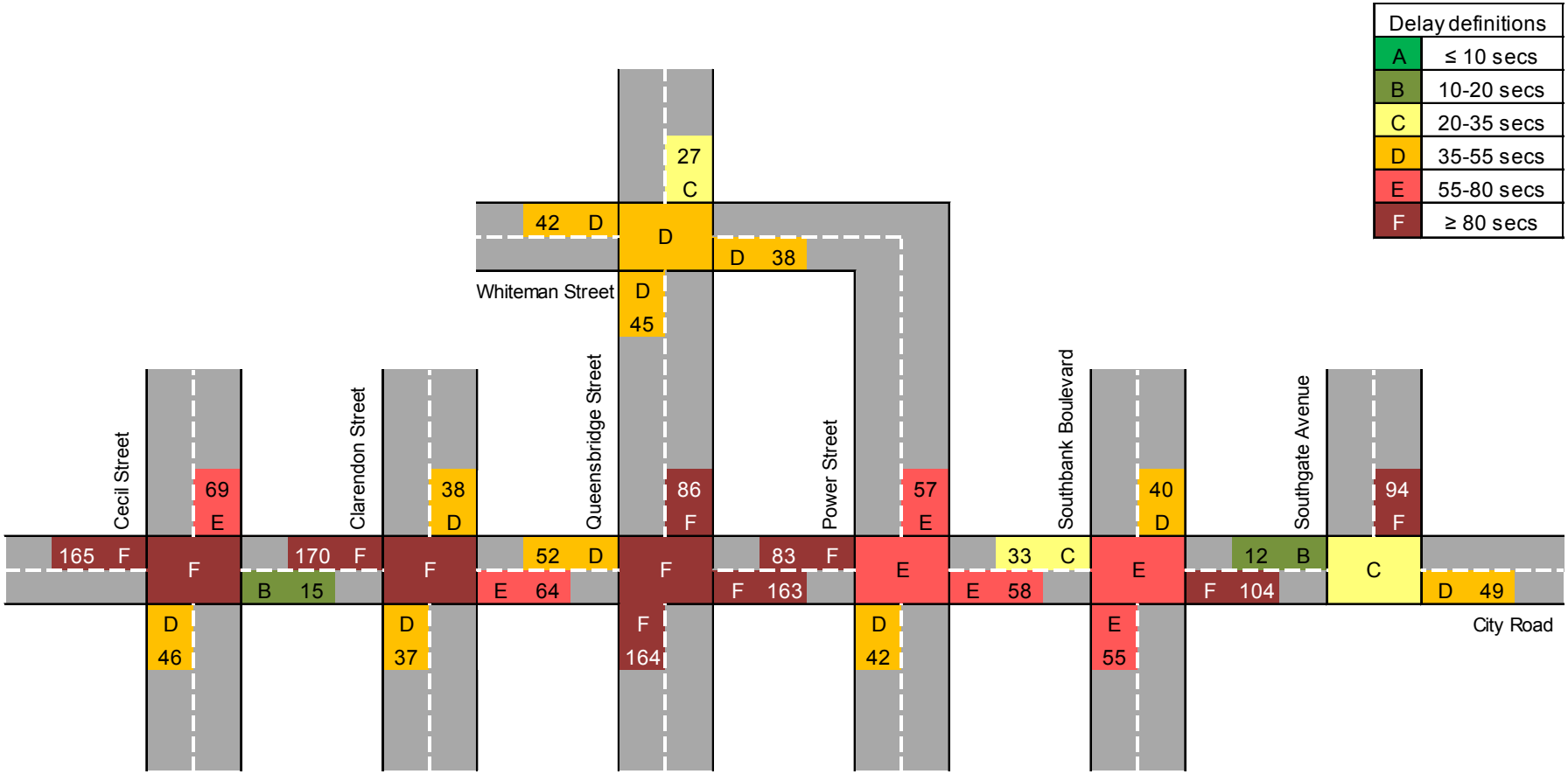


Figure 6.36 – Level of service results for the alternate layout(AM peak)



6.3.6 City Road west improvements – PM peak

Level of service results for the PM peak are shown in Figure 6.37 and Figure 6.38.

When compared to the City Road East and Alexandra Avenue improvements scenario the results indicate that—

Preferred layout

- Large reductions in LOS are experienced at Cecil, Clarendon and Queensbridge streets.
- The largest reductions are generally seen along City Road rather than on side roads which is due to the loss of capacity along the road.

Alternate layout

- Reductions in LOS are experienced at most intersections, but in particular at Cecil, Clarendon, Queensbridge and Power streets.
- The largest reductions are generally along City Road and are confined to the section west of Power Street where the cross-section has been reduced to one lane in each direction.
- There are also reductions in LOS southbound along Queensbridge Street due to right turners into City Road being forced to merge into one lane to avoid the westbound bus lane.

Figure 6.37 – Level of service results for the preferred layout (PM peak)

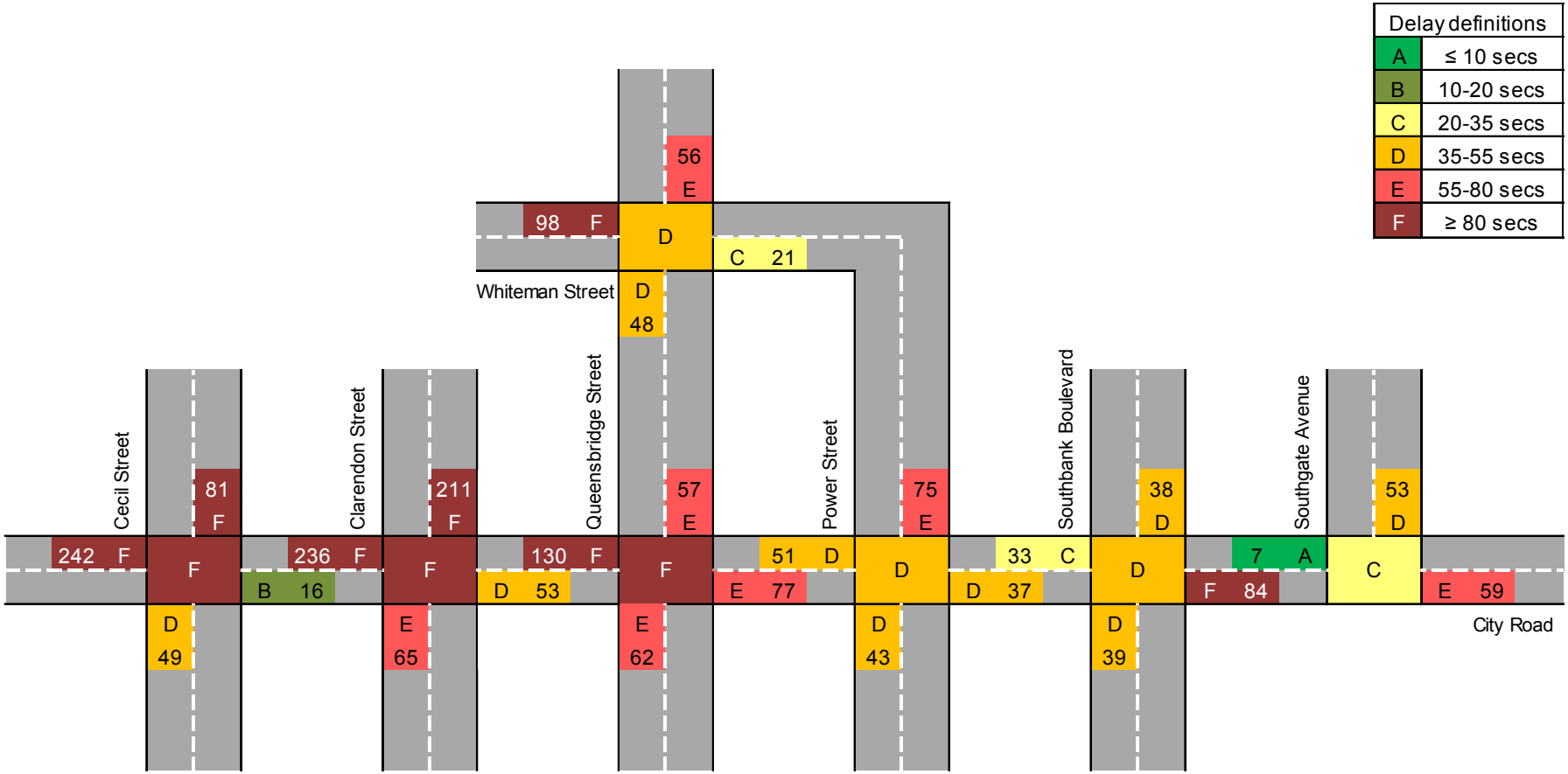
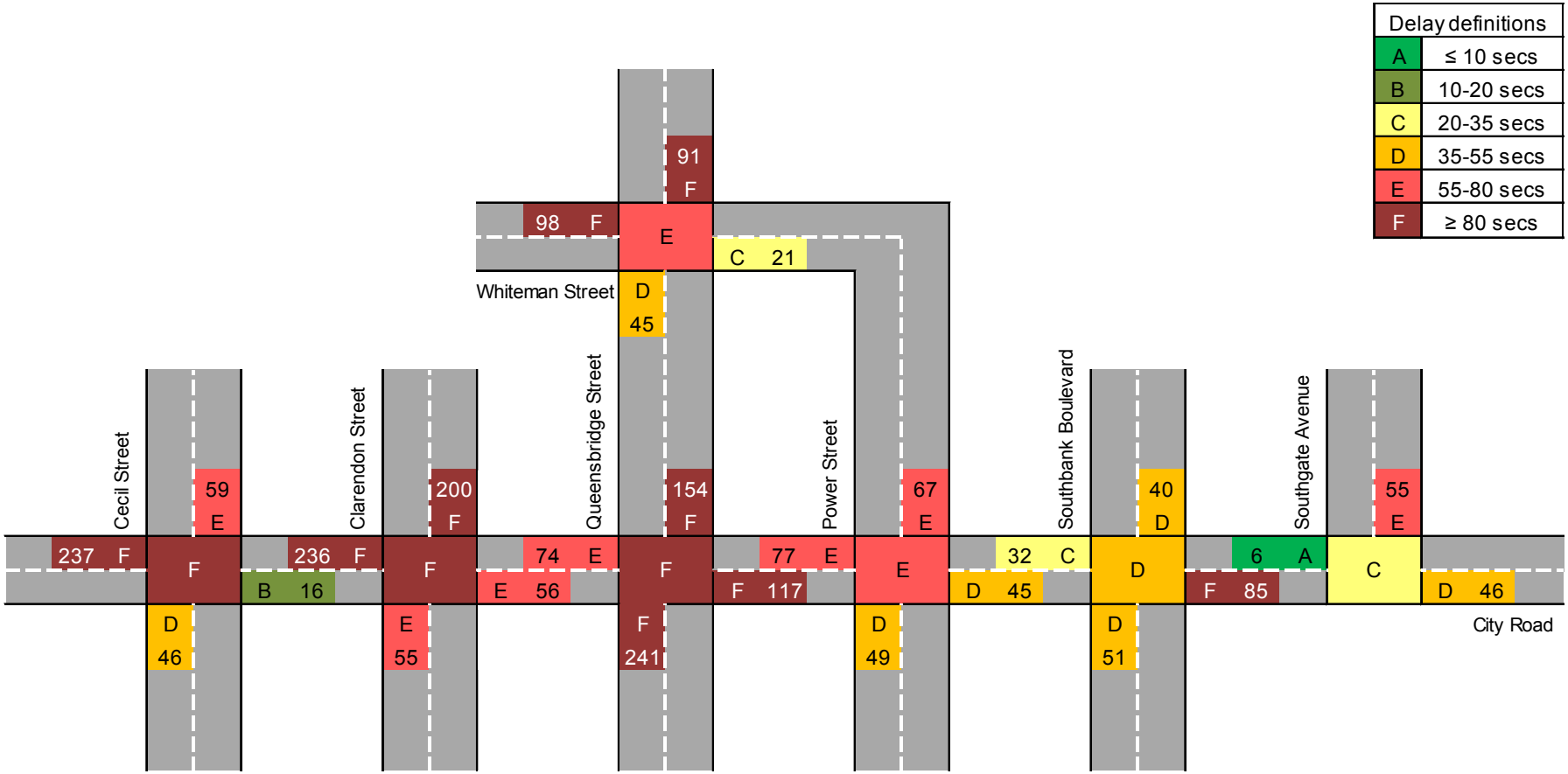


Figure 6.38 – Level of service results for the alternate layout(PM peak)



6.4 Vehicles unable to enter the network

In the alternate layout, congestion increases such that queues extend to the limits of the model network. The vehicles at the end of these queues are therefore unable to enter the model network within the core analysis period. As these vehicles cannot enter the network within the analysis period, there are fewer vehicles in the network than in less congested options. This has the effect of suppressing demand in the alternate layout, which means that the reported journey times are artificially low due to the fact that fewer vehicles are in the network.

The result of this is that in the alternate layout, the journey time charts in the sections above are likely to show faster journey times than would actually be the case. Generally, the more vehicles that are unable to enter the network, the greater the likelihood and magnitude of the difference between the displayed and actual journey times.

A summary of the number of vehicles unable to enter the network from selected entry points is shown in Table 6.26.

Large numbers of vehicles are unable to enter the network from the eastern and western ends of the model. This volume of vehicles would have an impact primarily on journey time routes 3 and 4, and to a lesser extent on routes 1 and 2. It is likely that the results for the alternate layout are optimistic and that the actual journey times would be longer than those shown in the charts.

Table 6.26 – Median number of vehicles unable to enter the model in the alternate layout

Location	AM	PM
City Road west of Cecil Street	579	251
Clarendon Street north	-	71
Clarke Street north	-	36
Queensbridge Street north	-	259
Moray Street	37	-
Balston Street	-	28
Alexandra Avenue east of Linlithgow Avenue	494	151

7. Summary and conclusions

This report presents the results of options testing of concept designs for City Road in Southbank. Options are made up of a number of discreet treatments. The first three of these treatments form the City Road East and Alexandra Avenue improvements scenario, and are common to all further options. The City Road East and Alexandra Avenue improvements scenario is therefore compared to existing conditions (i.e. the base case) when examining the impacts. Further options are called the City Road West improvements and consist of the preferred and alternate layouts. They are compared to the City Road East and Alexandra Avenue improvements scenario when examining their impacts.

The magnitude of impact has been measured both in terms of journey time changes and in level of service changes at intersections.

In summary, the options that have been tested are:

City Road East and Alexandra Avenue improvements scenario

- Pedestrian crossing on Alexandra Avenue
- Removal of slip lanes at Southbank Boulevard and Southgate Avenue intersections
- Removal of double slip lane on the west approach to Queensbridge Street

City Road West improvements

- Preferred layout (with 60 km/h, 50 km/h and 40 km/h variants)
- Alternate layout

Table 7.1 shows a summary of the journey time impacts for Routes 1 and 2 compared to the base case (existing conditions) and Table 7.2 shows the same for Routes 3 and 4.

Table 7.1 – Summary journey time impacts for Routes 1 and 2

Scenario	Change in journey time compared to existing			
	Route 1 (eastbound)		Route 2 (westbound)	
	AM peak	PM peak	AM peak	PM peak
Pedestrian crossing on Alexandra Avenue	-6%	+2%	+7%	+5%
Remove slip lanes at SBB and SGA*	-2%	-6%	-5%	+2%
Remove slip lane at Queensbridge Street	-2%	-4%	-3%	+1%
Preferred layout (60 km/h)	-3%	-2%	+22%	+11%
Alternate layout (60 km/h)	-10%	-21%	+55%	+5%
Preferred layout (50 km/h)	+4%	+3%	+20%	+25%
Preferred layout (40 km/h)	+17%	+49%	+28%	+53%

Table 7.2 – Summary journey time impacts for Routes 3 and 4

Scenario	Change in journey time compared to existing			
	Route 3 (eastbound)		Route 4 (westbound)	
	AM peak	PM peak	AM peak	PM peak
Pedestrian crossing on Alexandra Avenue	-2%	+1%	+8%	0%
Remove slip lanes at SBB and SGA*	+5%	-3%	-12%	0%
Remove slip lane at Queensbridge Street	+8%	-4%	-11%	-8%
Preferred layout (60 km/h)	+10%	+22%	+34%	+11%
Alternate layout (60 km/h)	+54%	+31%	+146%	+27%
Preferred layout (50 km/h)	+13%	+27%	+25%	+22%
Preferred layout (40 km/h)	+31%	+74%	+51%	+45%

* SBB and SGA = Southbank Boulevard and Southgate Avenue

The broad conclusions of this report are as follows:

- The pedestrian crossing on Alexandra Avenue has negligible impact on journey times.
- The loss of the slip lane on the south approach at the Southbank Boulevard intersection has a large impact on journey times along Southbank Boulevard and is considered not viable. Converting the slip lane into a stand-up lane mitigates the impact. The loss of the other slip lanes at Southbank Boulevard and the one at Southgate Avenue has little impact on journey times.
- The loss of the double slip lane on the west approach to Queensbridge Street has little impact on AM peak journey times, but a reasonably large impact on PM peak journey times in the eastbound direction only.
- The preferred layout treatments have little impact in the eastbound direction in the AM peak (up to 30 seconds), but a large impact in the westbound direction (up to two minutes). In the PM peak there is a similar, but reverse, increase of up to 1.5 minutes in the eastbound direction and of approximately 40 seconds in the westbound direction.
- The alternate layout generally has significant impacts on journey times in both peak periods and in both directions. This is primarily due to the loss of one lane in each direction between Clarendon Street and Queensbridge Street. Estimates of times cannot be given as the results are likely to be worse than those shown in the charts due to the large number of vehicles which cannot enter the model because of the congestion in this option.

Appendices

Appendix A – Concept designs for City Road West improvements

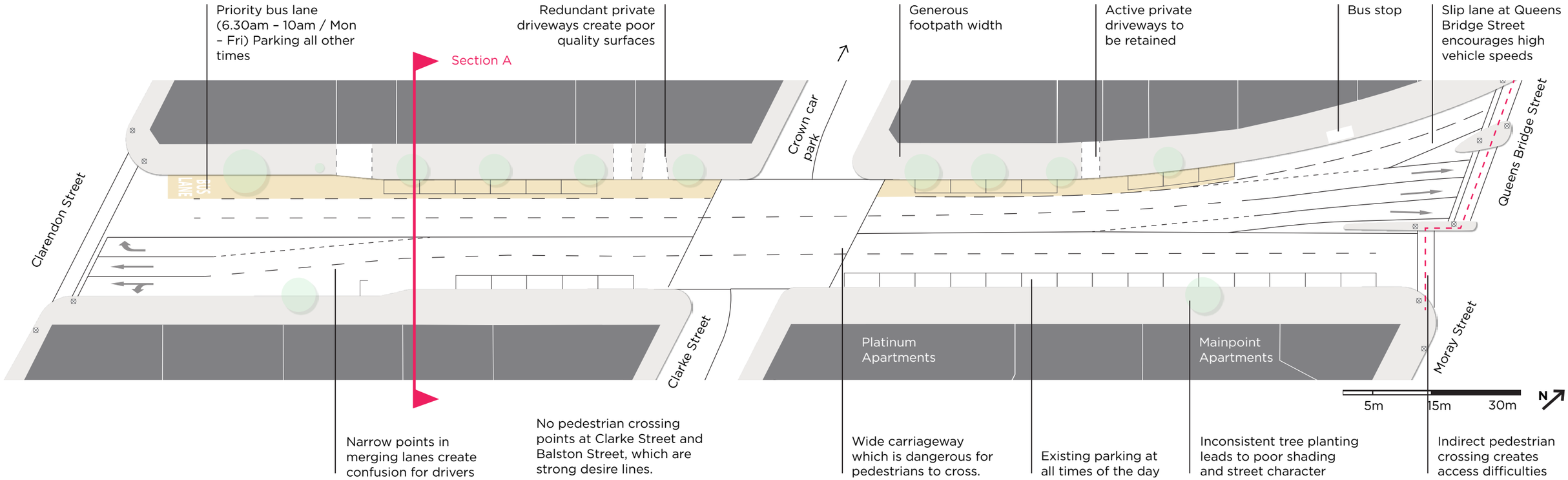
Preferred layout

Alternate layout

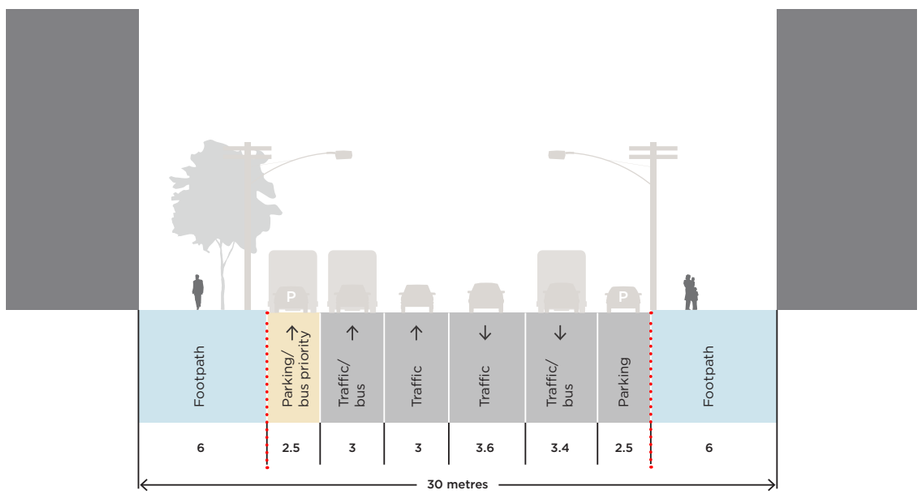
City Road West

Clarendon Street to Moray Street

EXISTING LAYOUT



Section A



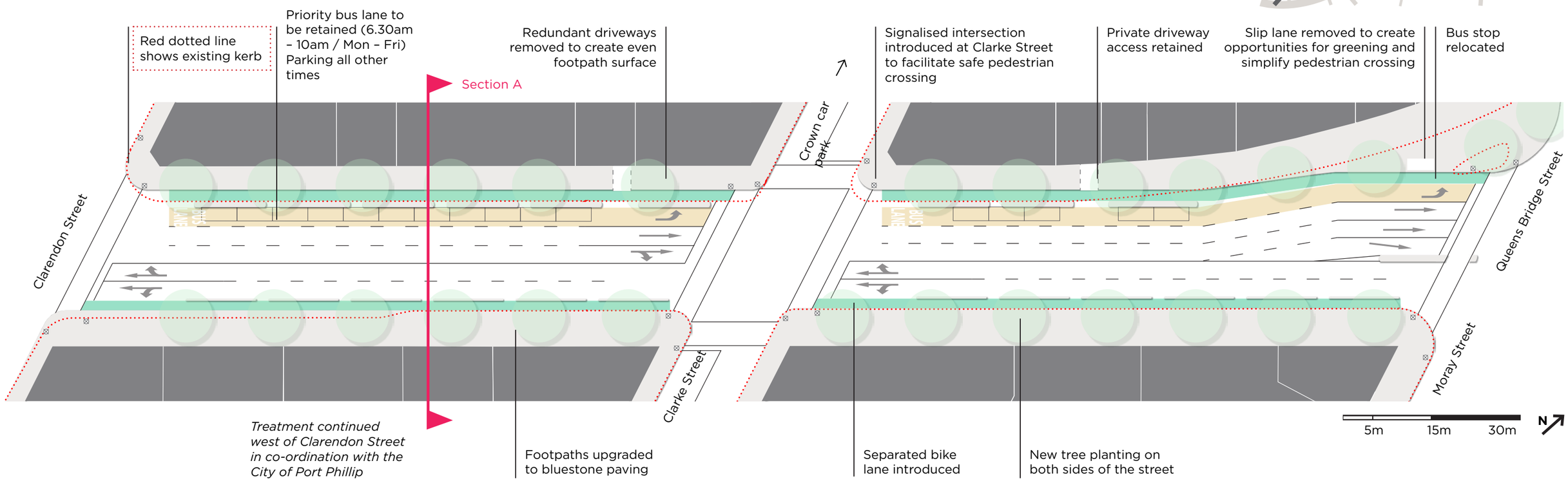
Legend

- Private property
- Footpath
- Bus priority lane
- Tree
- Traffic signal
- Pedestrian crossing

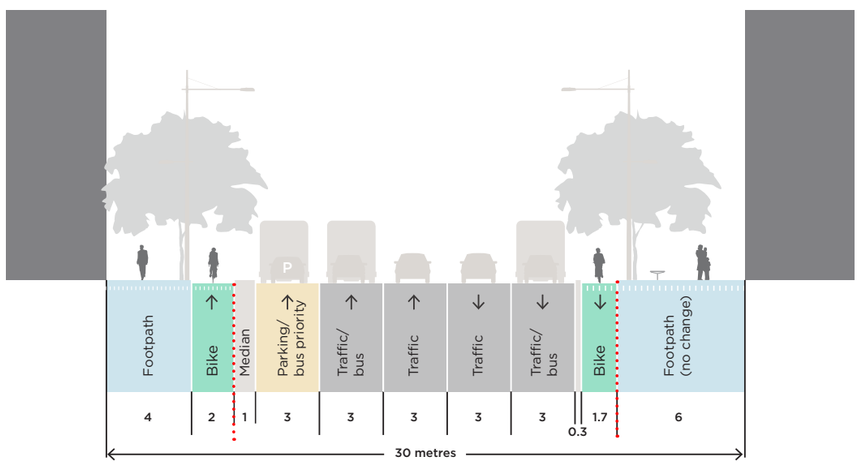
City Road West

Clarendon Street to Moray Street

PREFERRED LAYOUT



Section A

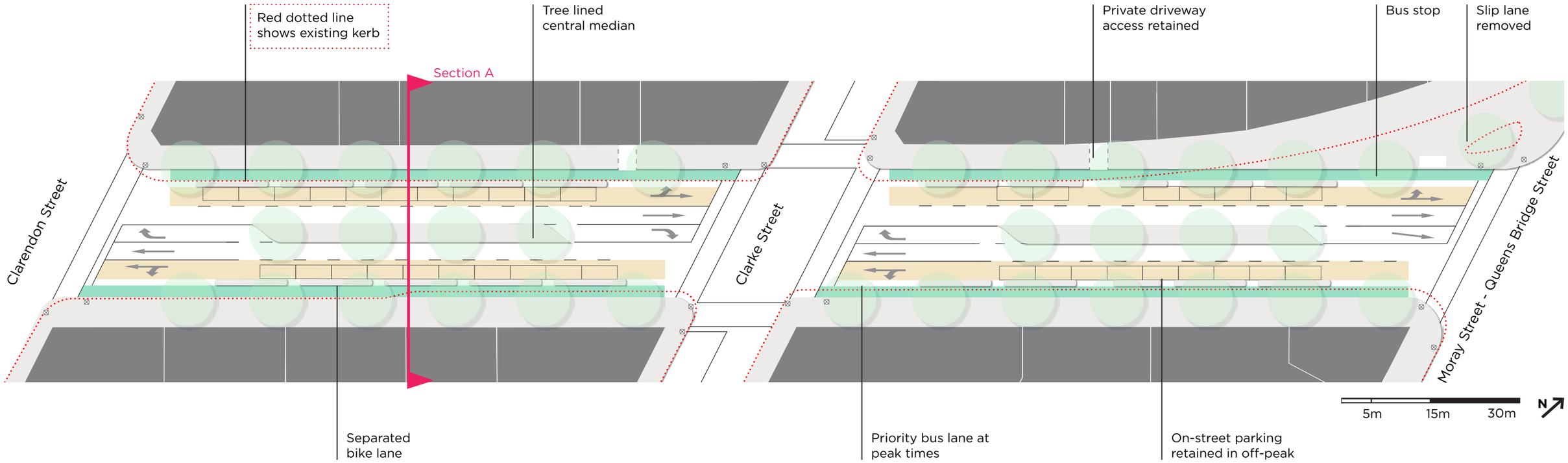


Legend

- Private property
- Footpath
- Bus priority lane
- Bicycle lane
- Tree
- Traffic signal
- Pedestrian crossing

City Road West
Clarendon Street to Moray Street

ALTERNATE LAYOUT



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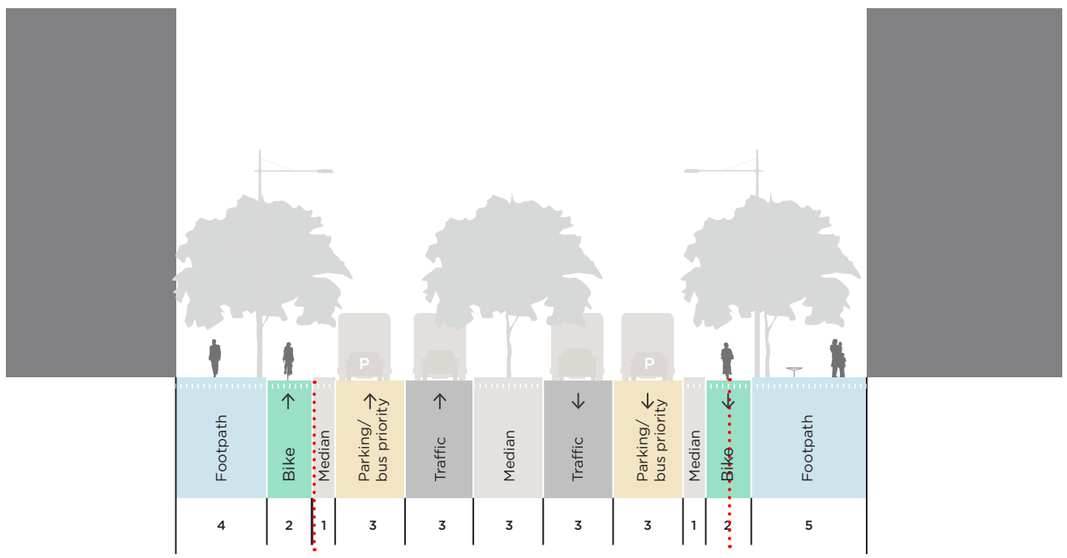


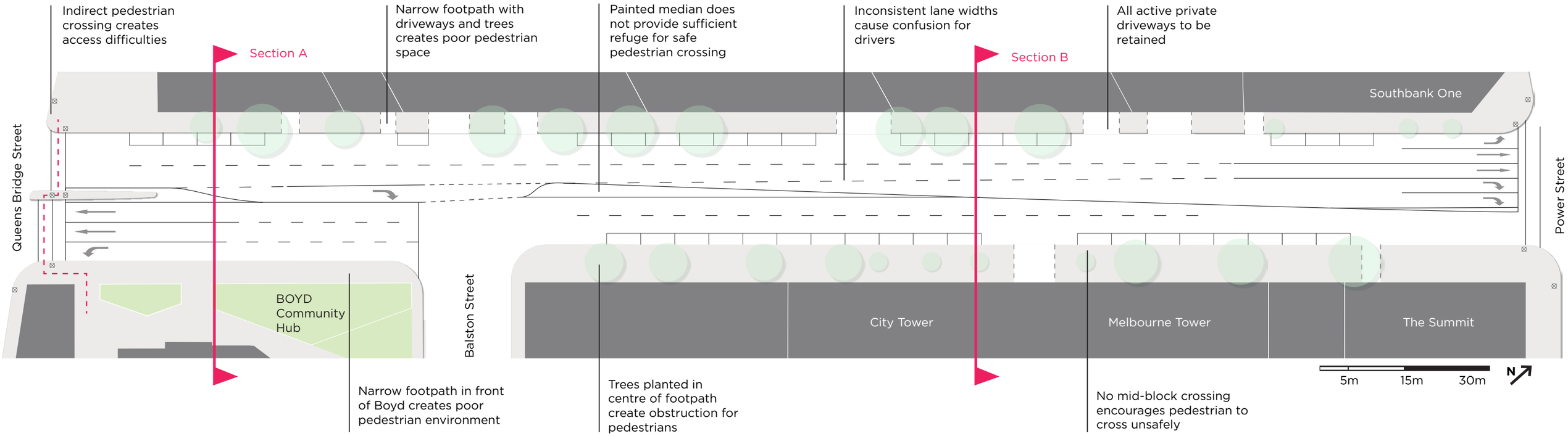
Legend

- Private property
- Footpath
- Bicycle Lane
- Bus priority lane
- Tree
- Traffic signal
- Pedestrian crossing

City Road West

Queens Bridge Street to Power Street

EXISTING LAYOUT



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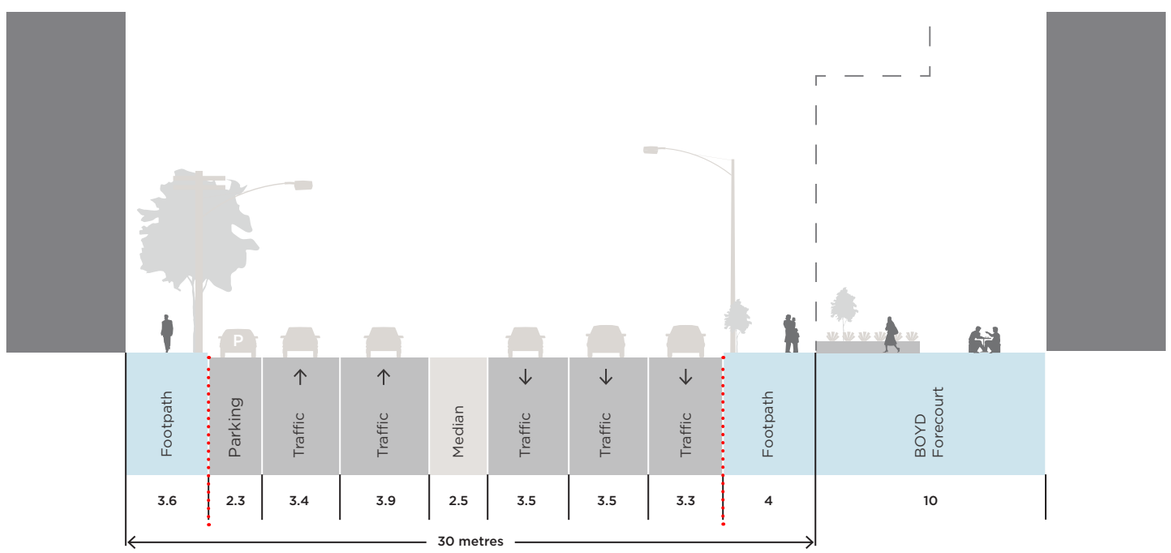

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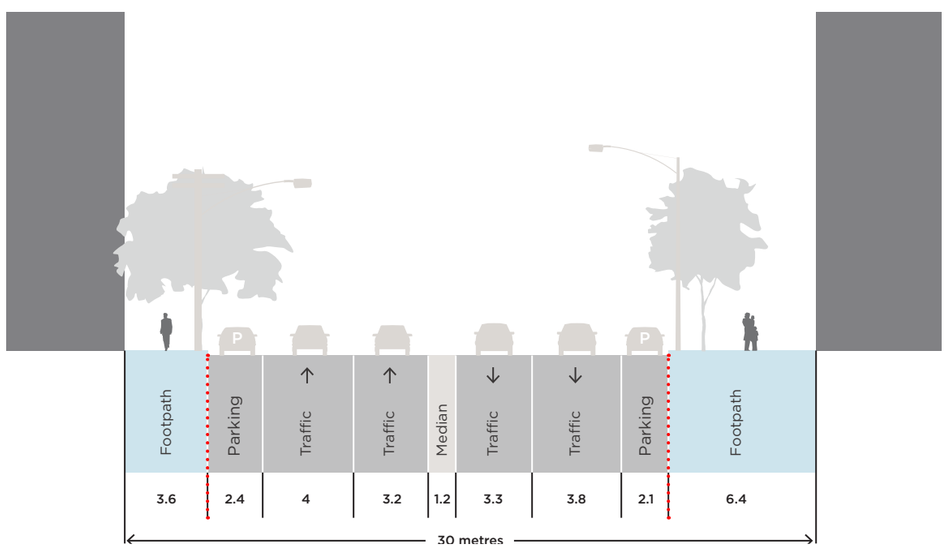


City Road West

Queens Bridge Street to Power Street

PREFERRED LAYOUT

Pedestrian crossing widened and relocated to improve access to Boyd

Signalised intersection introduced at Balston Street to facilitate pedestrian crossing

Cyclist activated right turn signal allows for safe cyclist movement

A tree-lined central median provides increased shade and creates opportunity for staged pedestrian crossing

Red dotted line shows existing kerb

Section A

Section B

Queens Bridge Street

Power Street

BOYD Community Hub

Balston Street

Extended footpath in front of Boyd creates opportunities for an improved City Road interface

Bicycle access to continue through to Kavanagh Street and Southbank Boulevard

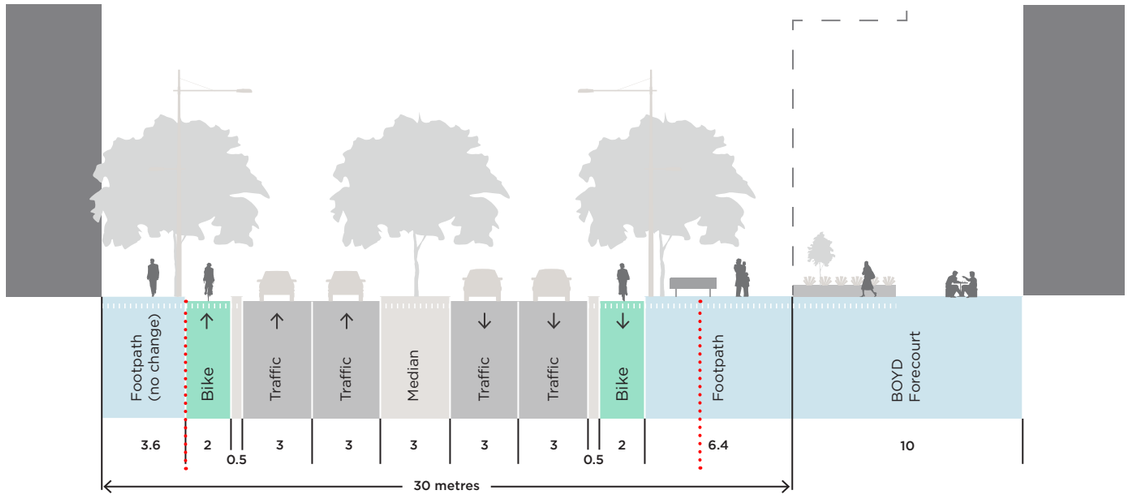
Private driveway access retained

Footpath extensions create opportunities for tree planting and street furniture

5m 15m 30m

N

Section A



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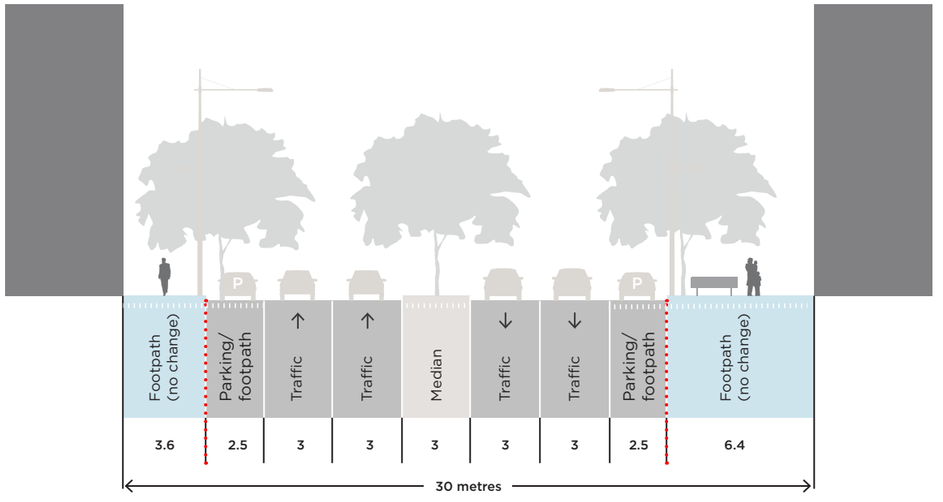


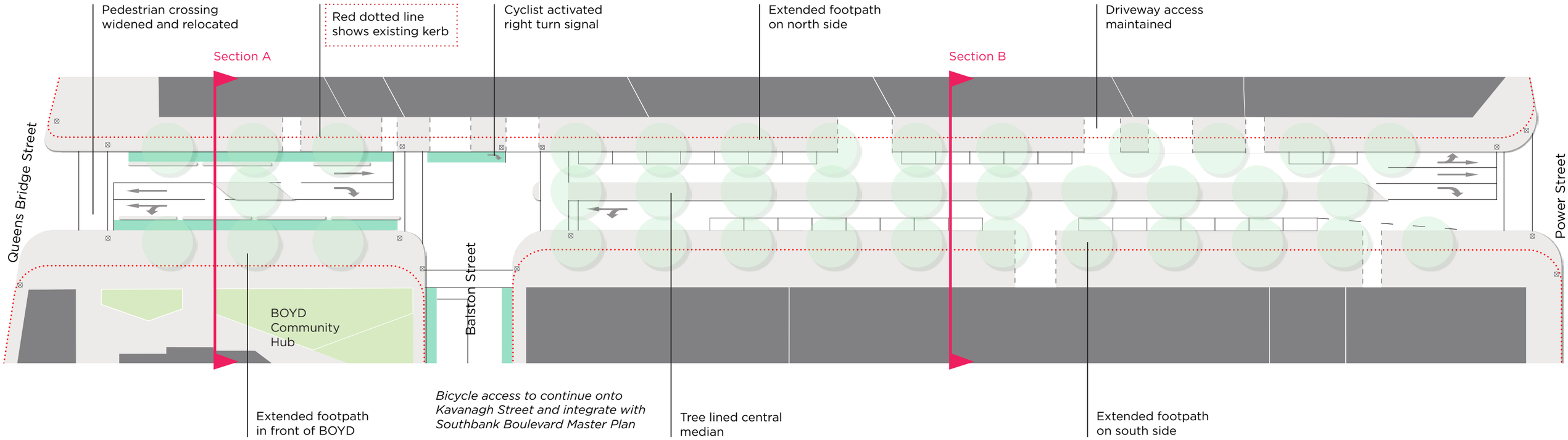
Legend

- Private property
- Footpath
- Bicycle lane
- Tree
- Traffic signal
- Pedestrian crossing

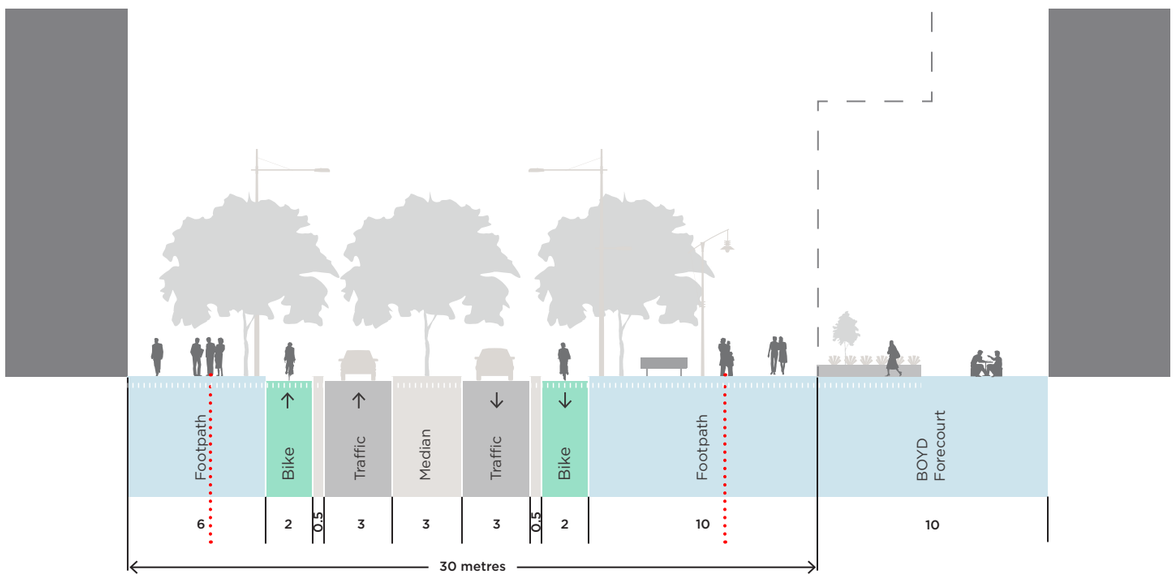
City Road West

Queens Bridge Street to Power Street

ALTERNATE LAYOUT



Section A



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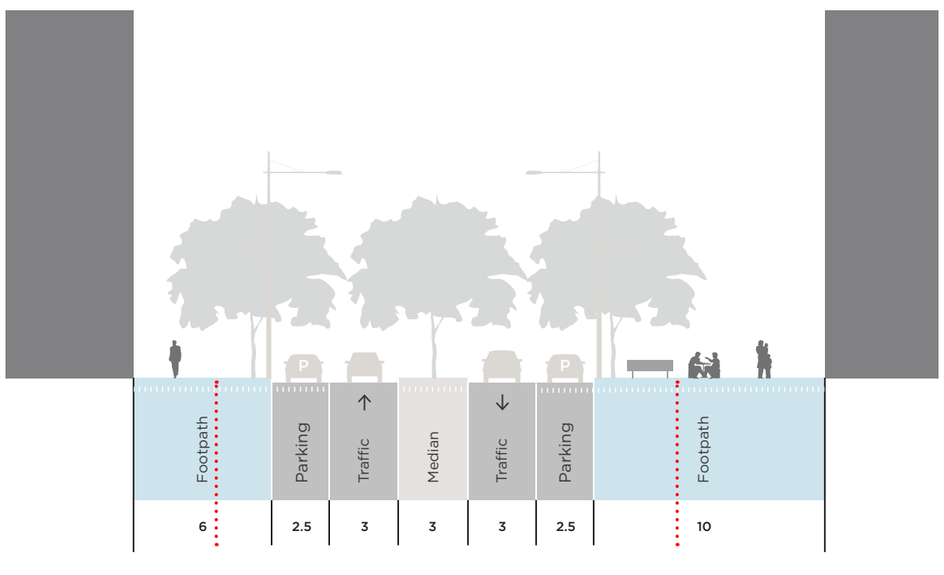

Legend

- Private property
- Footpath
- Bus priority lane
- Bicycle lane
- Tree
- Traffic signal
- Pedestrian crossing

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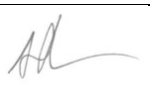
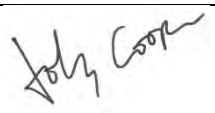
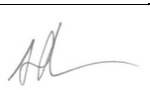
Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
A	C. Hall	T. Cooper		T. Frodsham		30/04/15
B	C. Hall	T. Cooper		T. Frodsham		15/05/15
C	C. Hall	T. Cooper		T. Frodsham		12/06/15
D	C. Hall	T. Cooper		T. Frodsham		29/07/15

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