City of Melbourne

Southbank Boulevard Microsimulation

Model option report

May 2015

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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.

As an extension of the master plan work, GHD was asked to model the City Road corridor in VISSIM microsimulation software so that the impacts of the proposed changes could be assessed. The findings of that work are detailed in separate model validation and option testing reports.

As part of a separate project, Council is developing concept designs for the redevelopment of Southbank Boulevard in Southbank. The overarching aim of the project is to reclaim some of the road space and return it to the public realm. The road passes through Victoria's primary arts precinct and Council wishes to create a gateway and destination for the precinct.

Prior to the base model being developed for the City Road project, Council requested that Southbank Boulevard be included in the microsimulation model to enable proposed changes on that road to be tested as well. The base model and all option scenarios therefore include both City Road and Southbank Boulevard, but this report only presents results for Southbank Boulevard.

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 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 Southbank Boulevard 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 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.

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 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 model trip matrices developed during the calibration and validation of the base 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 model calibration and validation

3.1 Introduction

This section sets out the key calibration and validation statistics from the preparation of the base 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.

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
- R^2 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

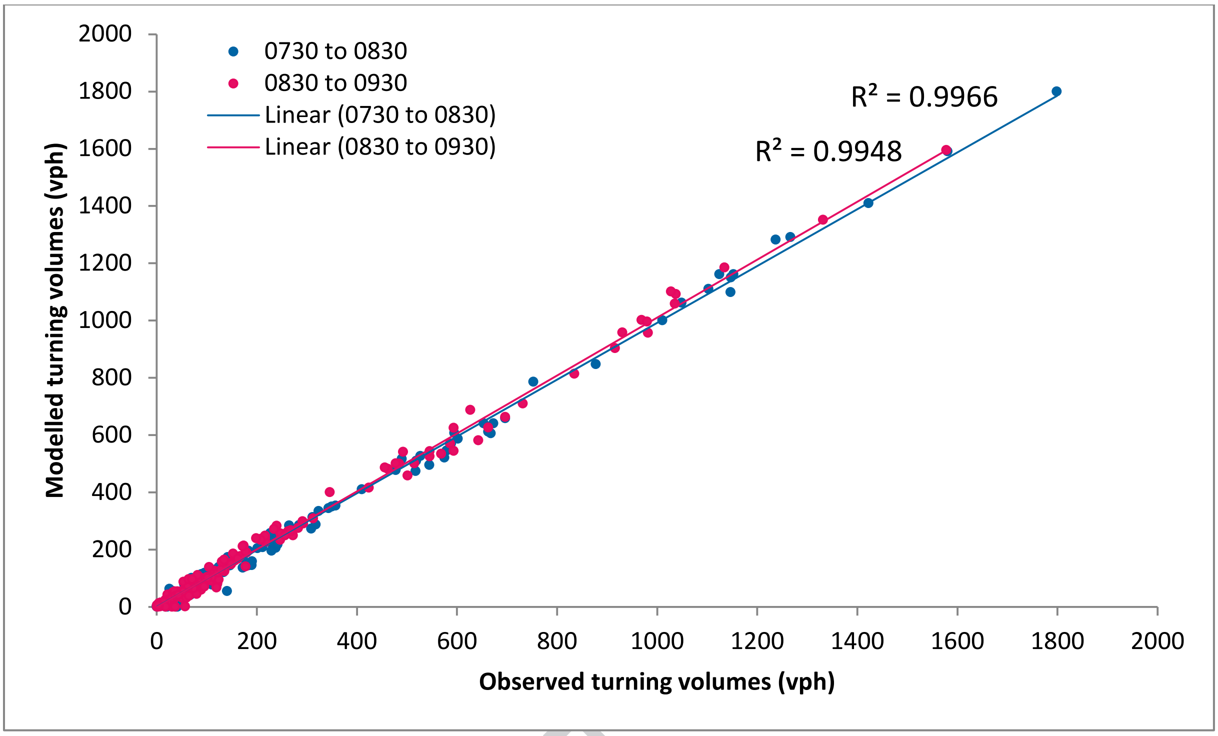
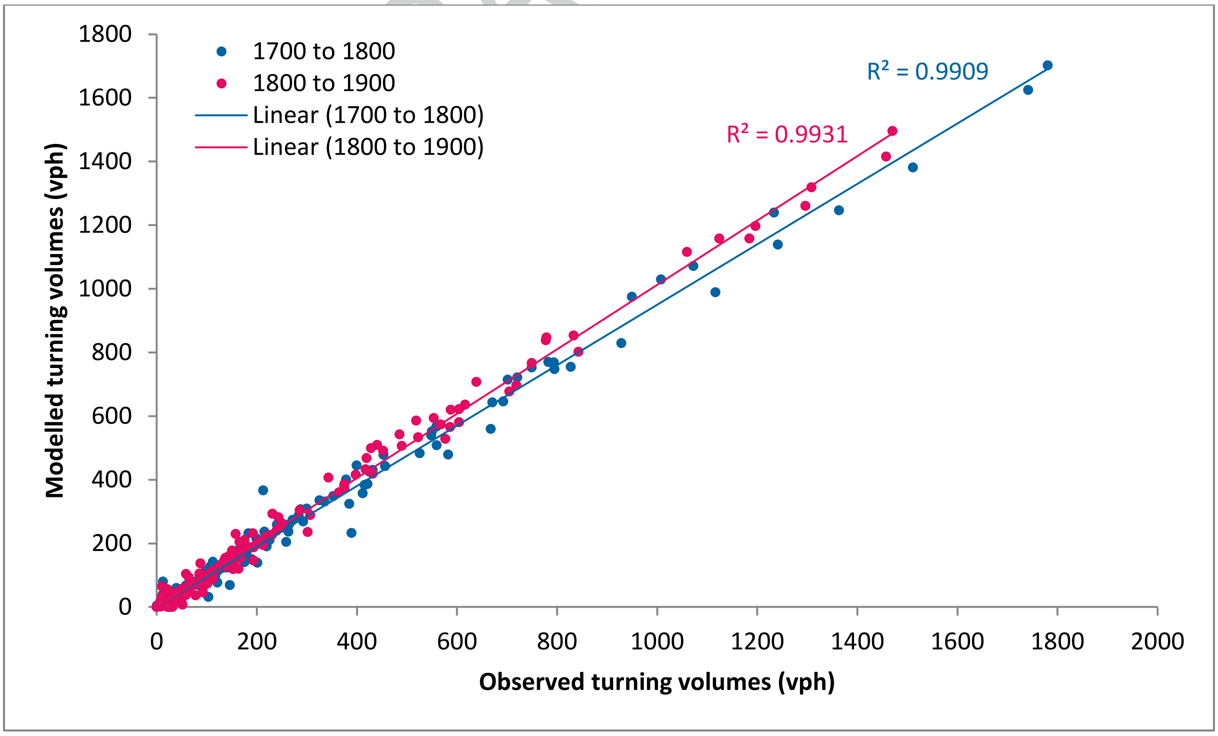


Figure 3.2 – PM peak VISSIM model observed vs modelled turning volume scatter plot



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 should be within 15% or one minute (whichever is the greater) of the observed median travel time value.

3.3.2 AM peak

Travel time validation results are presented in Table 3.1Table 3.2 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 3.2 – 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 3.3 to Figure 3.8.

Figure 3.3 – Route 1 journey time validation – Queensbridge Street/City Road (eastbound, AM peak)

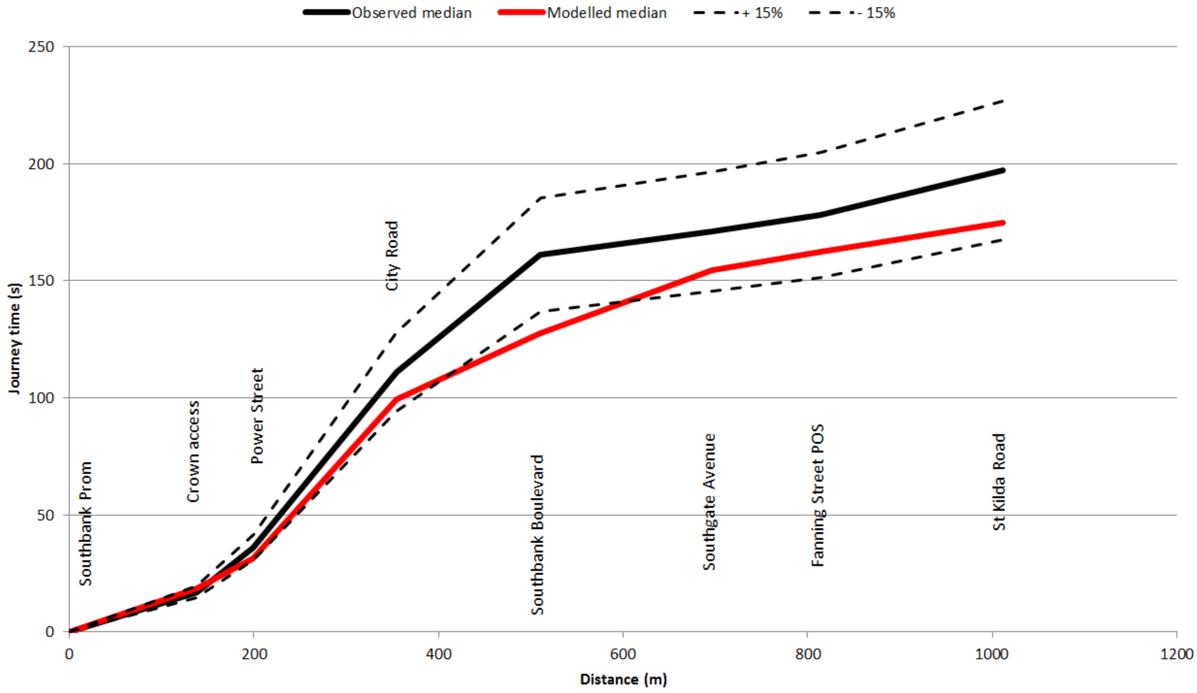


Figure 3.4 – Route 2 journey time validation – Queensbridge Street/City Road (westbound, AM peak)

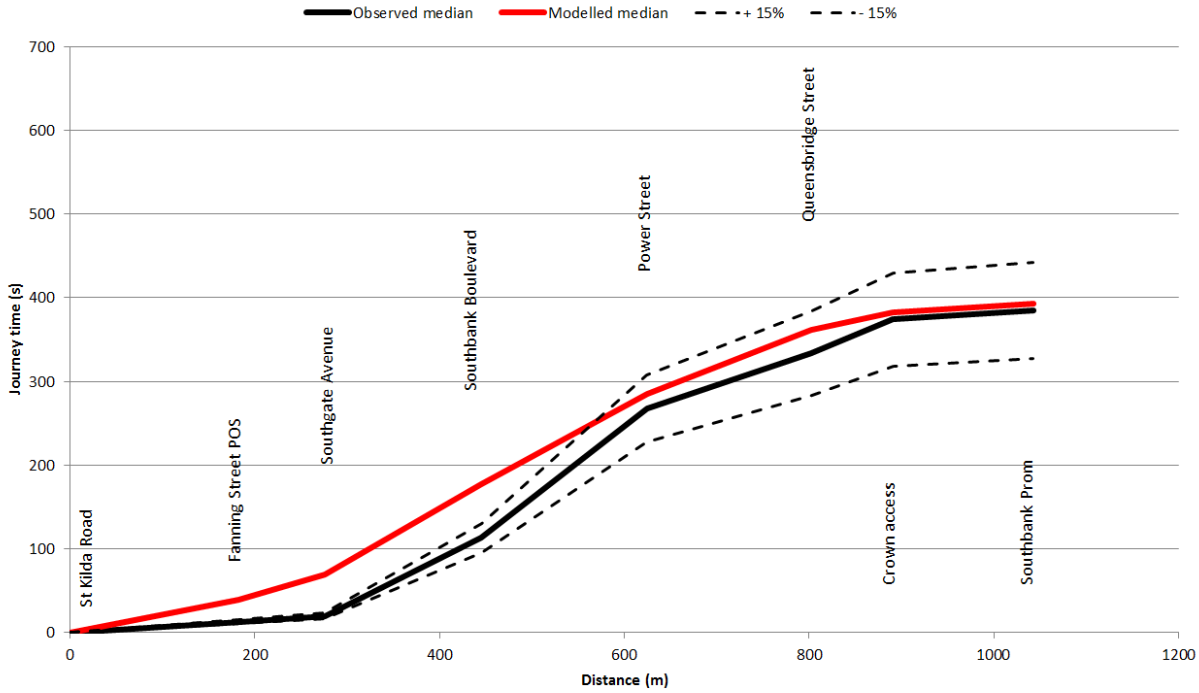


Figure 3.5 – Route 3 journey time validation – City Road (eastbound, AM peak)

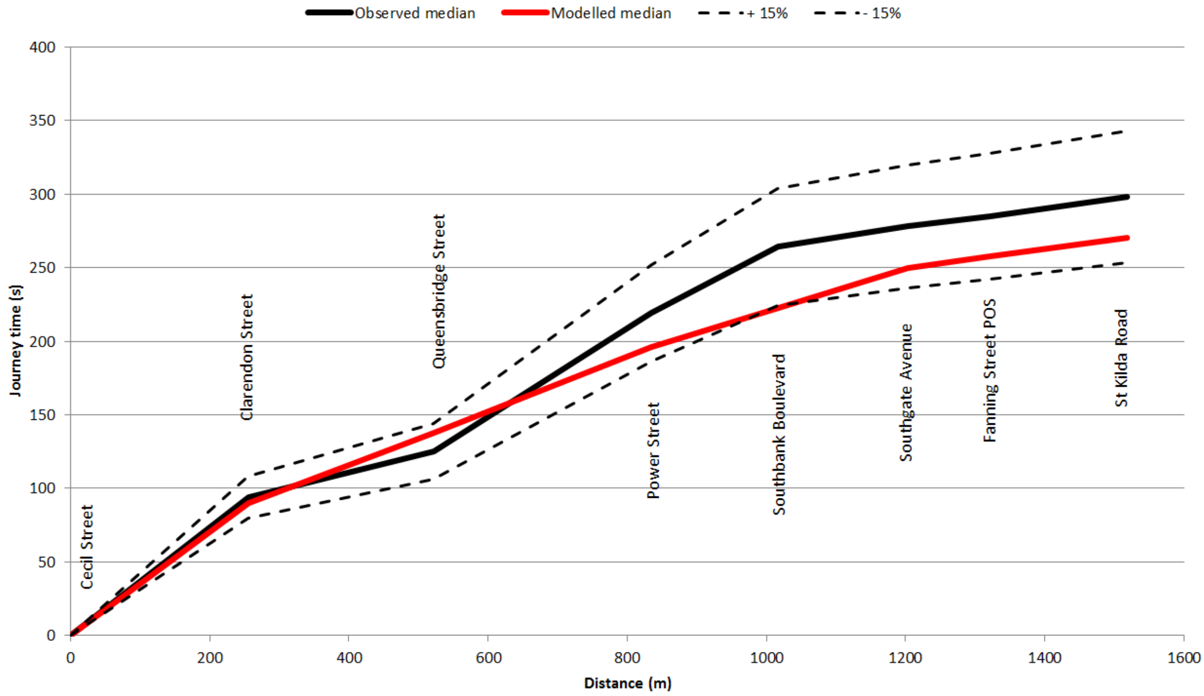


Figure 3.6 – Route 4 journey time validation – City Road (westbound, AM peak)

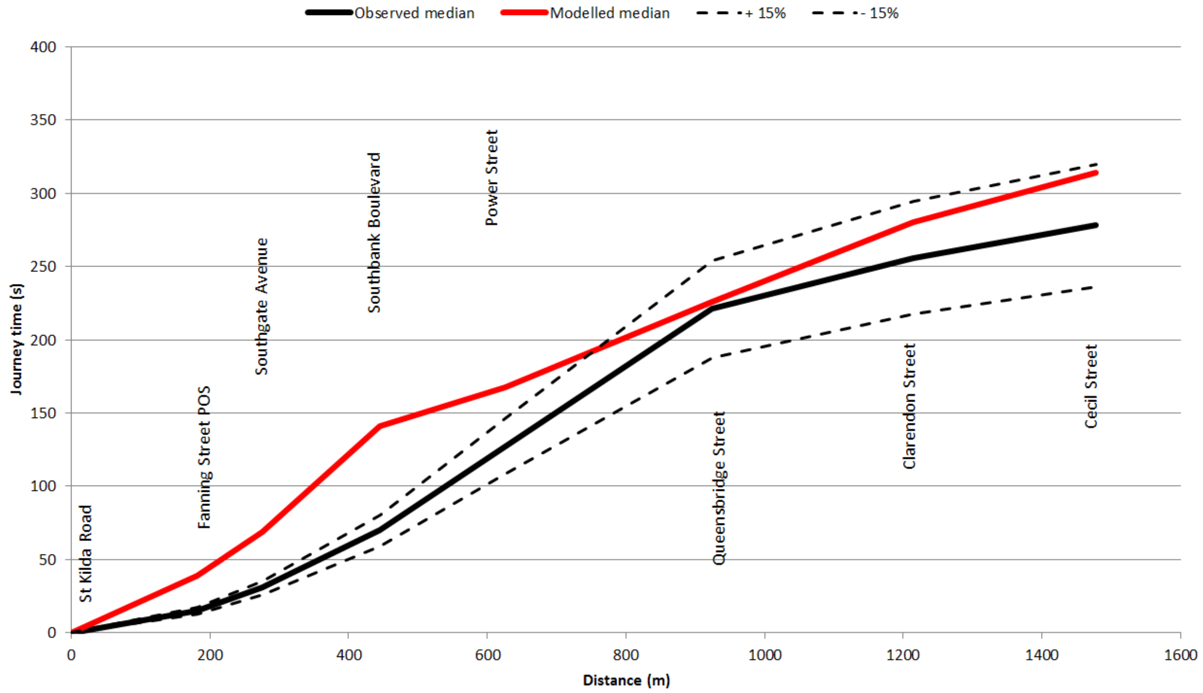


Figure 3.7 – Route 5 journey time validation – Southbank Boulevard (eastbound, AM peak)

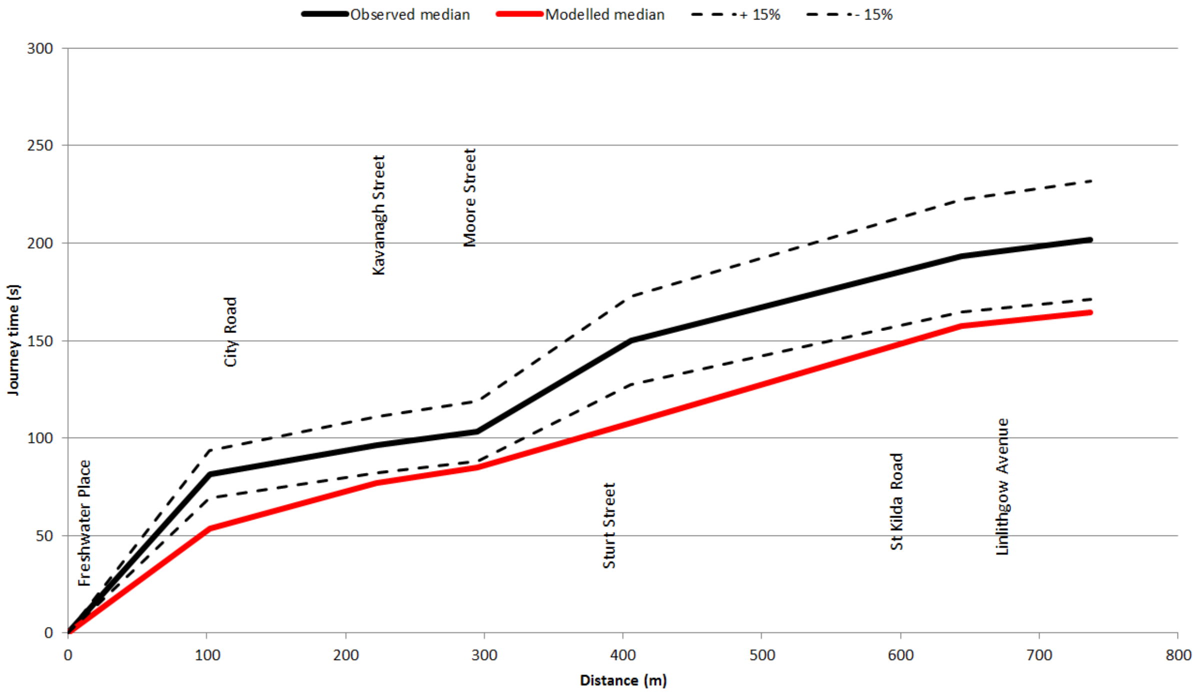
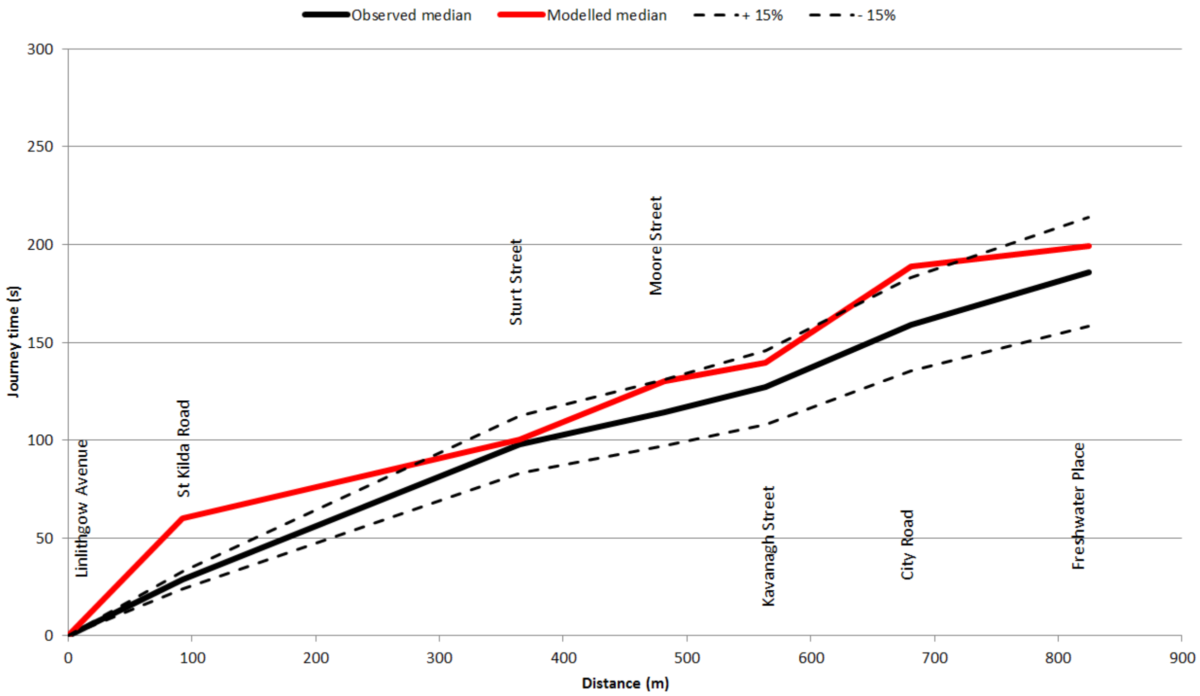


Figure 3.8 – Route 6 journey time validation – Southbank Boulevard (westbound, AM peak)



3.3.3 PM peak

Travel time validation results are presented in Table 3.3 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.

Table 3.3 – 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 3.9 to Figure 3.14.

Figure 3.9 – Route 1 journey time validation – Queensbridge Street/City Road (eastbound, PM peak)

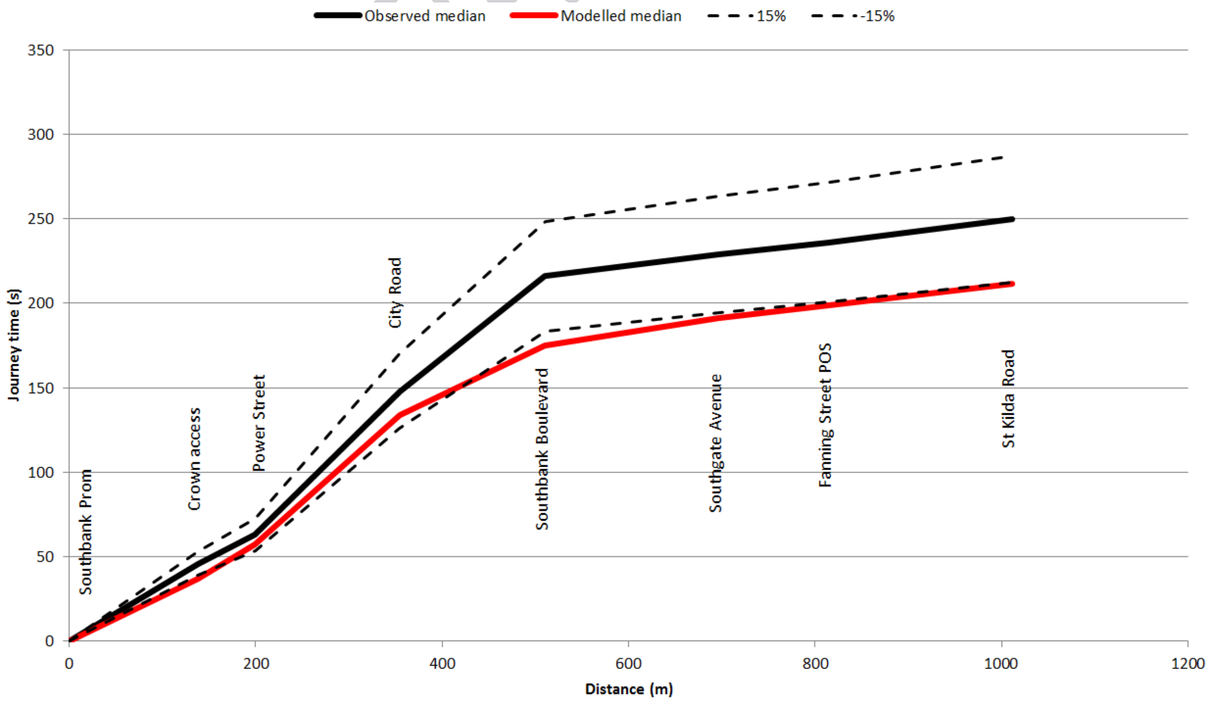


Figure 3.10 – Route 2 journey time validation – Queensbridge Street/City Road (westbound, PM peak)

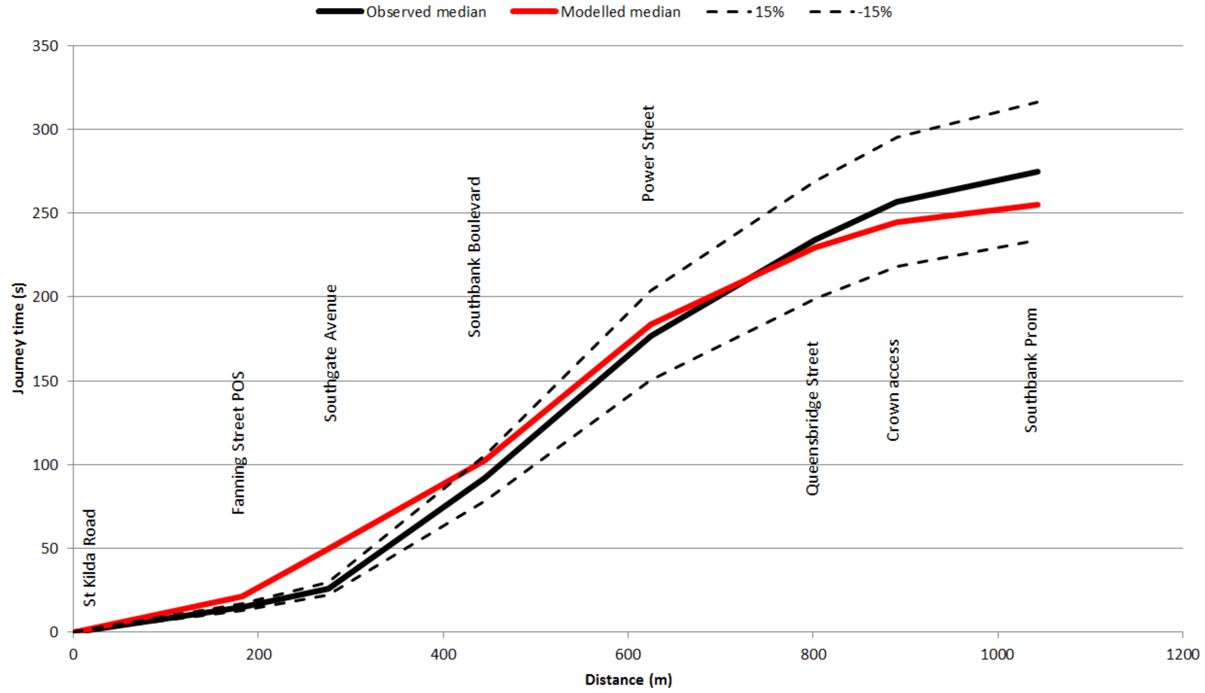


Figure 3.11 – Route 3 journey time validation – City Road (eastbound, PM peak)

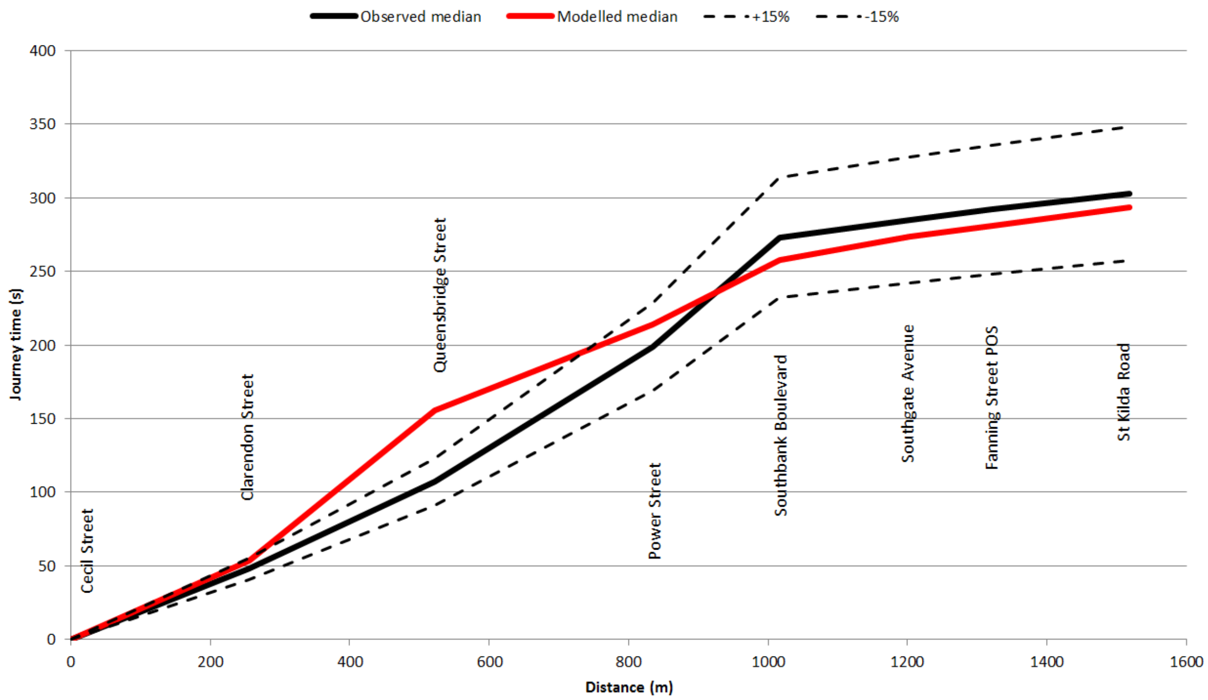


Figure 3.12 – Route 4 journey time validation – City Road (westbound, PM peak)

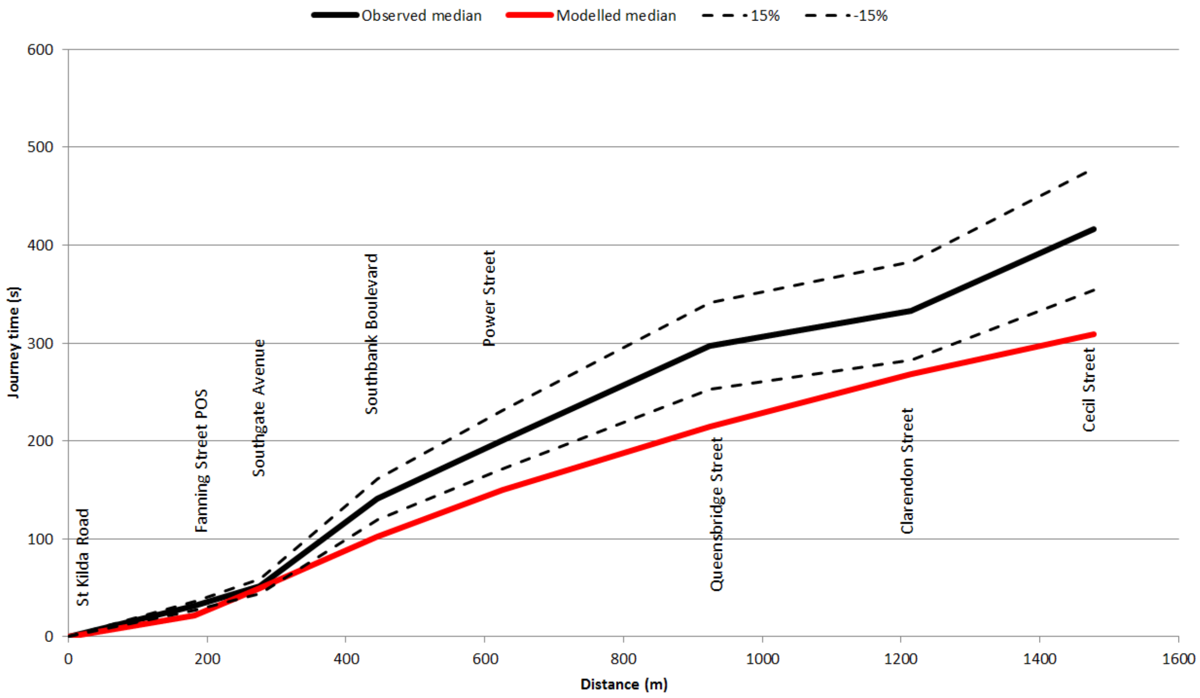


Figure 3.13 – Route 5 journey time validation – Southbank Boulevard (eastbound, PM peak)

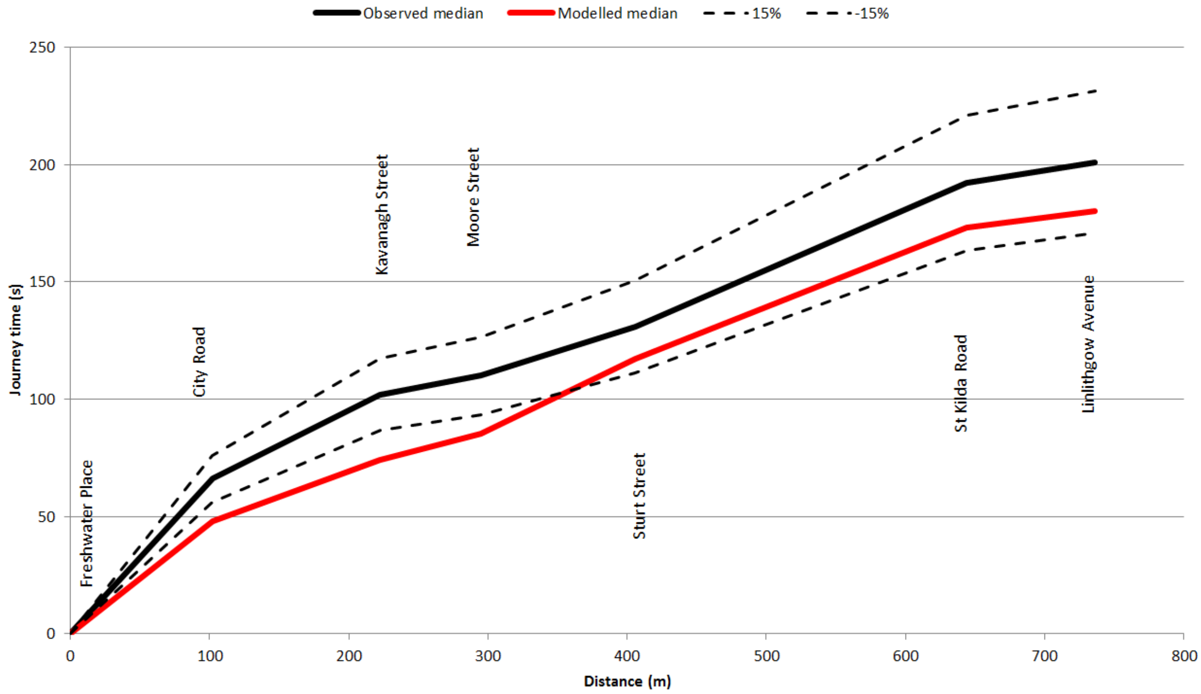
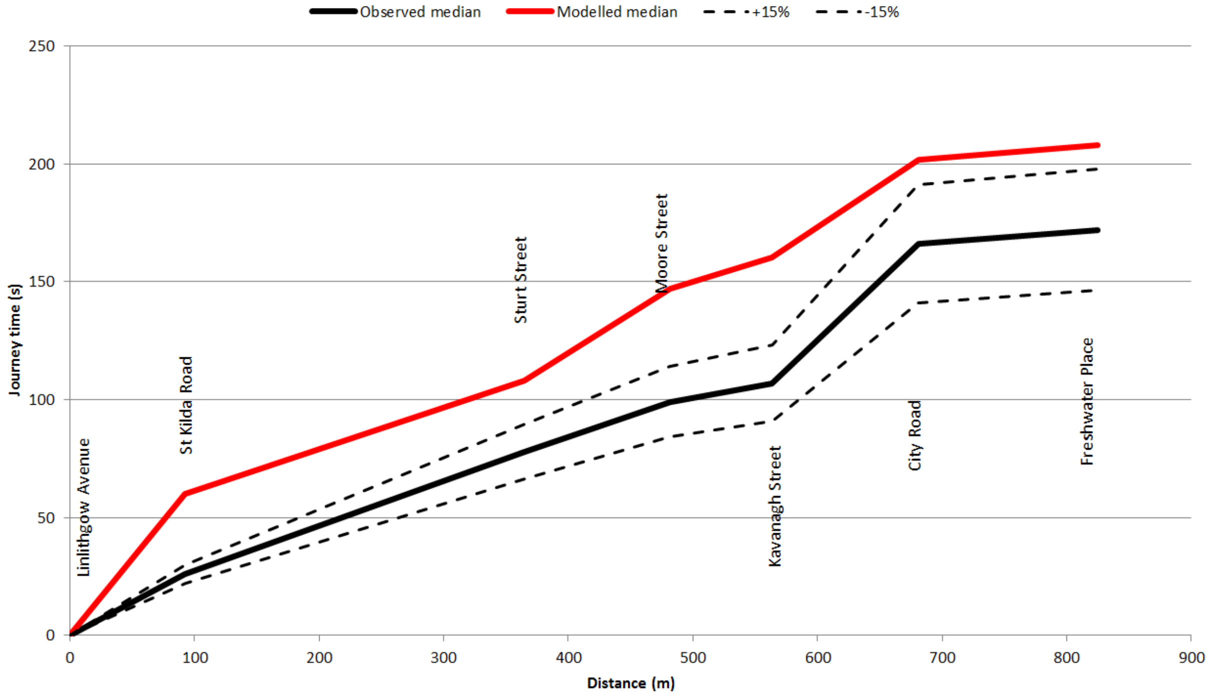


Figure 3.14 – Route 6 journey time validation – Southbank Boulevard (westbound, PM peak)



4. Concept designs

4.1 Introduction

Concept designs were initially developed by Council and refined by Cardno to a standard suitable for replicating in VISSIM. The designs have been coded into VISSIM using a combination of aerial photography and imported CAD drawings. Changes to signal coding, which have been required at all intersections along Southbank Boulevard, are based on sound engineering principles and monitoring driver behaviour in the model.

The concept designs are included in Appendix A. The main features of the design are as follows:

- Reduction of the Southbank Boulevard cross-section to one lane in each direction west of Sturt Street
- Removal of the right turn into Sturt Street from the east approach. Right turn movements to the north now take place at Kavanagh Street
- Provision of a central island platform tram stop on the east side of Sturt Street (and removal of the existing safety zone stop on Sturt Street)
- Removal of traffic signals at the Kavanagh Street South intersection and the provision of a zebra crossing on the south leg. Signals are retained at the Kavanagh Street North/Moore Street intersection
- Removal of the left turn slip lanes at all corners of the City Road/Southbank Boulevard intersection.

The last item above was also tested as part of the City Road project and the modelling indicated that a left turn stand-up lane was still required on the south approach to avoid excessive queuing in the westbound/northbound direction. The concept designs tested in this project therefore include a dedicated left turn stand-up lane on the south approach to City Road rather than a shared left/through lane as is the case on other corners.

4.2 Options tested

While there is only one concept design layout to test, Council has also requested that different speed limits be tested as well. This creates a number of options which are as follows:

1. Concept design layout with existing speed limit (60 km/h)
2. Concept design layout plus 40 km/h speed limit on Southbank Boulevard
3. Concept design layout plus 40 km/h speed limit on Southbank Boulevard and City Road

4.3 New pedestrian crossing

The concept design includes a new pedestrian crossing at the eastern end of the new central island platform tram stop. The crossing has been modelled as follows:

- The new pedestrian crossing has been linked to the Sturt Street intersection. The pedestrian walk phase operates concurrently with the north-south movement at Sturt Street (i.e. during phase E or A) when there is pedestrian demand. It does not run unless there is a pedestrian demand.
- The volume of pedestrians using the crossing has been taken to be the same as that currently crossing Southbank Boulevard on the east side of Sturt Street. This allows for up to 50 pedestrians crossing per hour in one direction.

5. Option test results

5.1 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 options as described in Section 4.

Journey times and intersection delays are presented for all options.

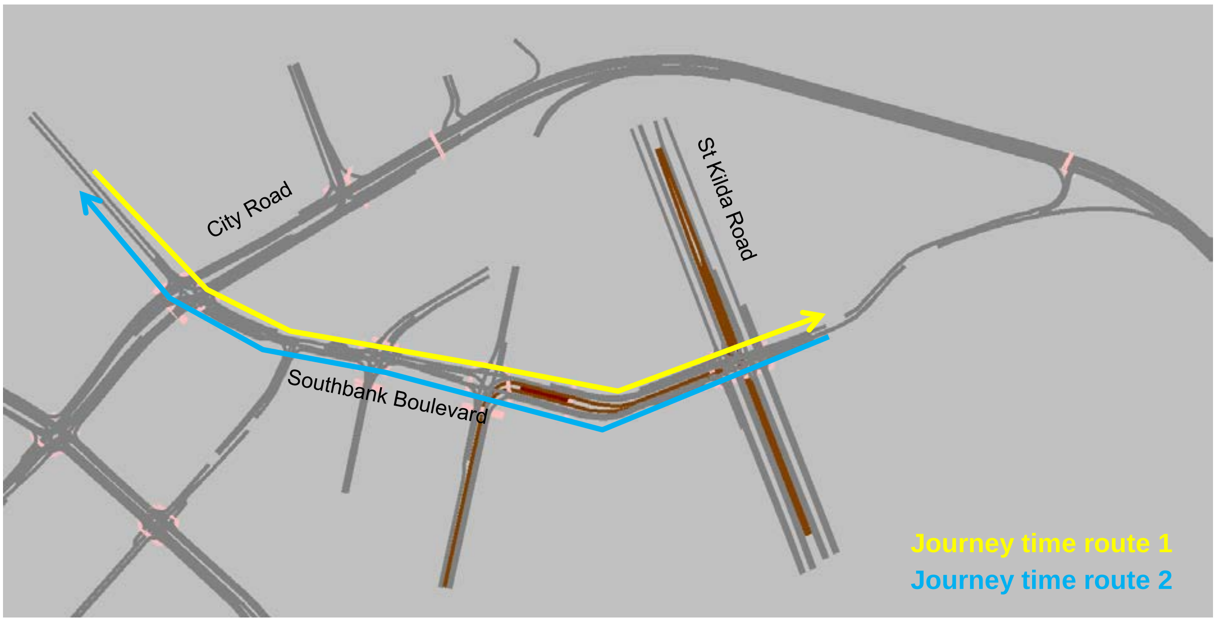
5.2 Journey time results

The journey time routes are as follows:

1. Southbank Boulevard eastbound between Freshwater Place and Linlithgow Avenue
2. Southbank Boulevard westbound between Linlithgow Avenue and Freshwater Place

These are shown in Figure 5.1.

Figure 5.1 – Journey time routes



5.2.1 AM peak

The journey time results are shown in Figure 5.2, Figure 5.3, Table 5.1 and Table 5.2.

The analysis indicates that—

- With no change in speed limit, there is a minor increase in journey time compared to the base case in the westbound direction, but not in the eastbound direction.
- With a 40 km/h speed limit on Southbank Boulevard, journey times increase slightly compared to the concept design in the eastbound directions, but not in the westbound direction.
- With a 40 km/h speed limit on Southbank Boulevard and City Road, journey times again increase slightly compared to the concept design in the eastbound direction, but not in the westbound direction.

Figure 5.2 – Eastbound/southbound journey time results (AM peak)

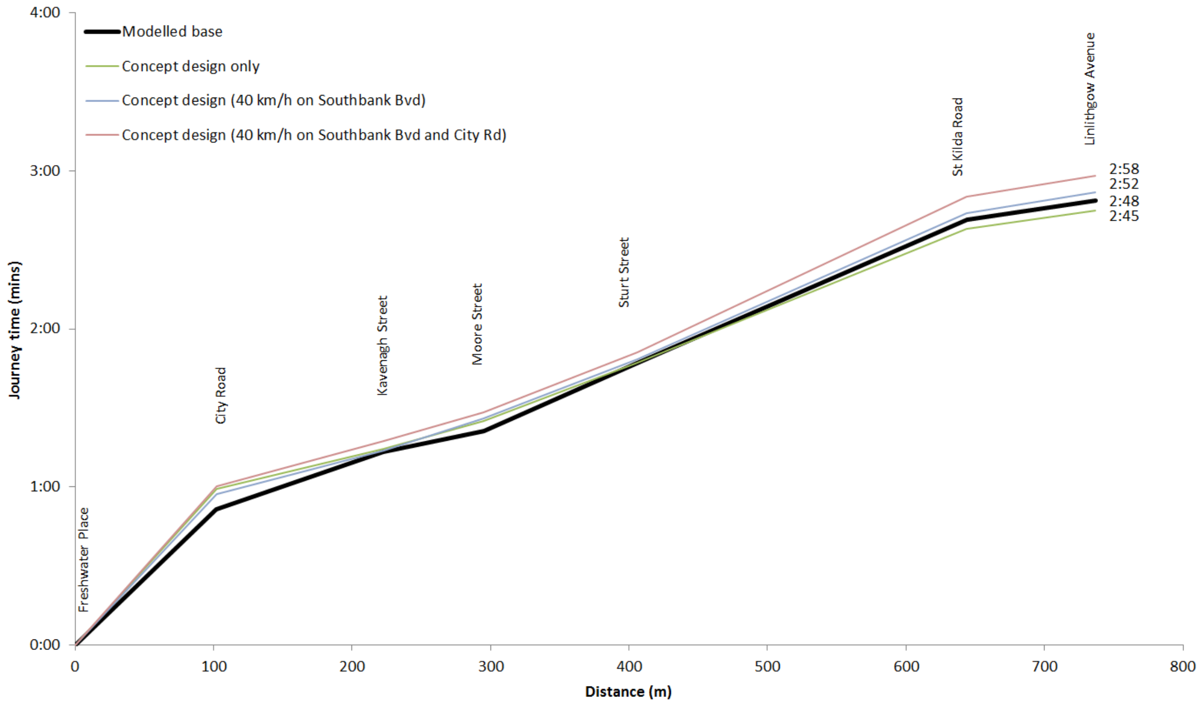


Figure 5.3 – Westbound/northbound journey time results (AM peak)

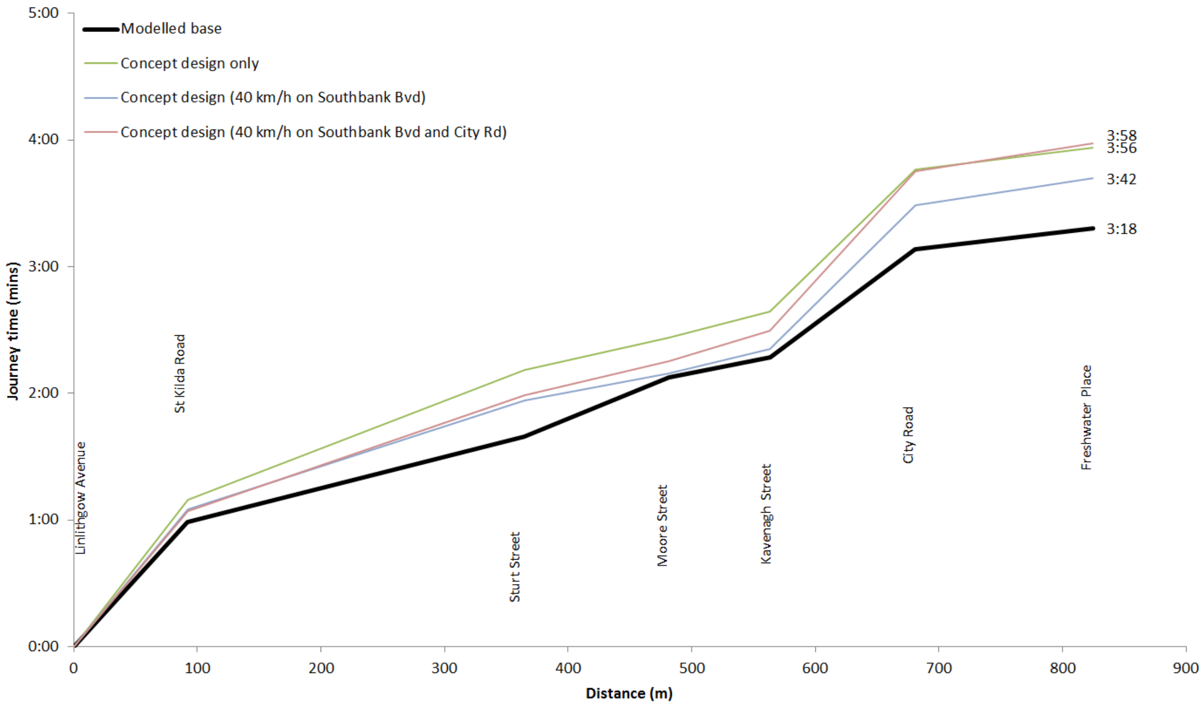


Table 5.1 – Eastbound journey time results by section in seconds (AM peak)

Section ending	Base case	Concept design (60 km/h)
City Road	0:51	0:59
Kavanagh Street	0:22	0:15
Moore Street	0:08	0:11
Sturt Street	0:26	0:22
St Kilda Road	0:54	0:51
Linlithgow Avenue	0:07	0:07

Table 5.2 – Westbound journey time results by section in seconds (AM peak)

Section ending	Base case	Concept design (60 km/h)
St Kilda Road	0:59	1:10
Sturt Street	0:41	1:02
Moore Street	0:28	0:15
Kavanagh Street	0:09	0:13
City Road	0:51	1:07
Freshwater Place	0:10	0:10

5.2.2 PM peak

The journey time results are shown in Figure 5.4, Figure 5.5, Table 5.3 and Table 5.4.

The analysis indicates that—

- With no change in speed limit there is no change to journey times in the eastbound direction and a decrease in the westbound direction. The decrease is due to the additional green time assigned to Southbank Boulevard to compensate for the loss of through capacity.
- In the reduced speed limit options, there is a slight increase in journey times compared to the concept design.

On occasions it has been noted that eastbound traffic does queue back to City Road during busy periods. The signal timing changes that have been implemented along Southbank Boulevard reduce the risk of traffic queuing onto strategic routes. However, it should be noted that there is little contingency in the event of continual traffic congestion along Southbank Boulevard (i.e. a minor incident would most likely lead to rapid escalation of congestion).

Figure 5.4 – Eastbound/southbound journey time results (PM peak)

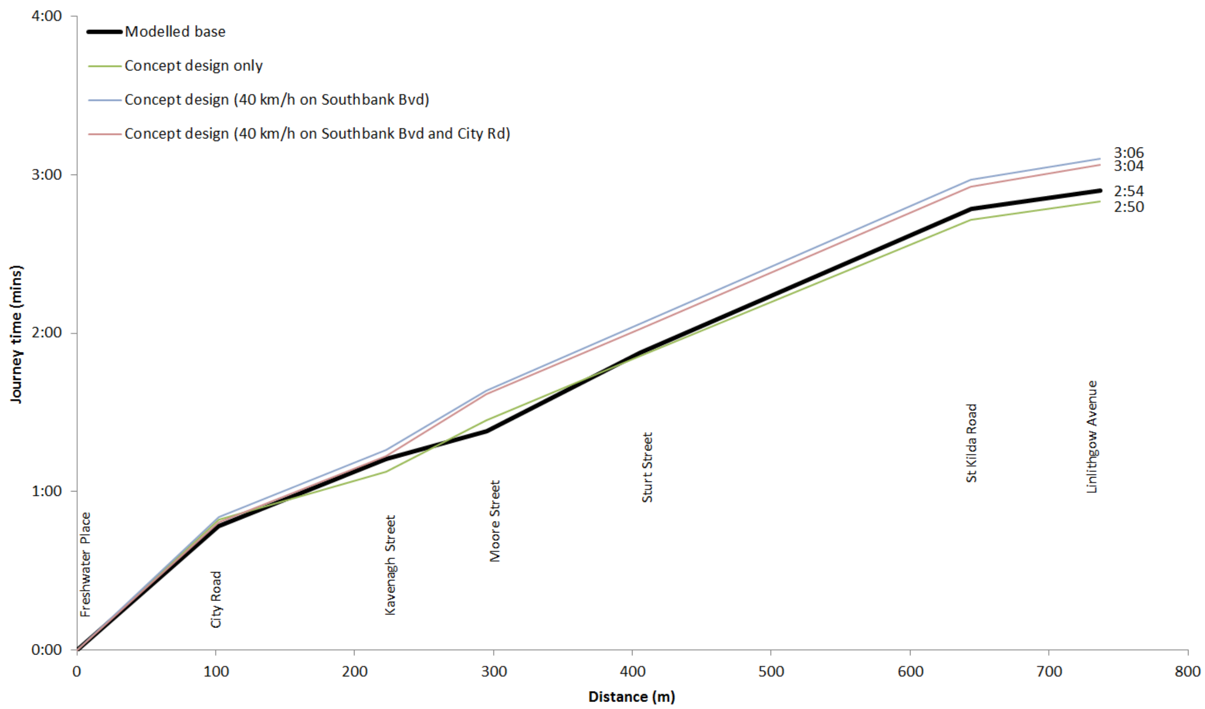


Figure 5.5 – Westbound/northbound journey time results (PM peak)

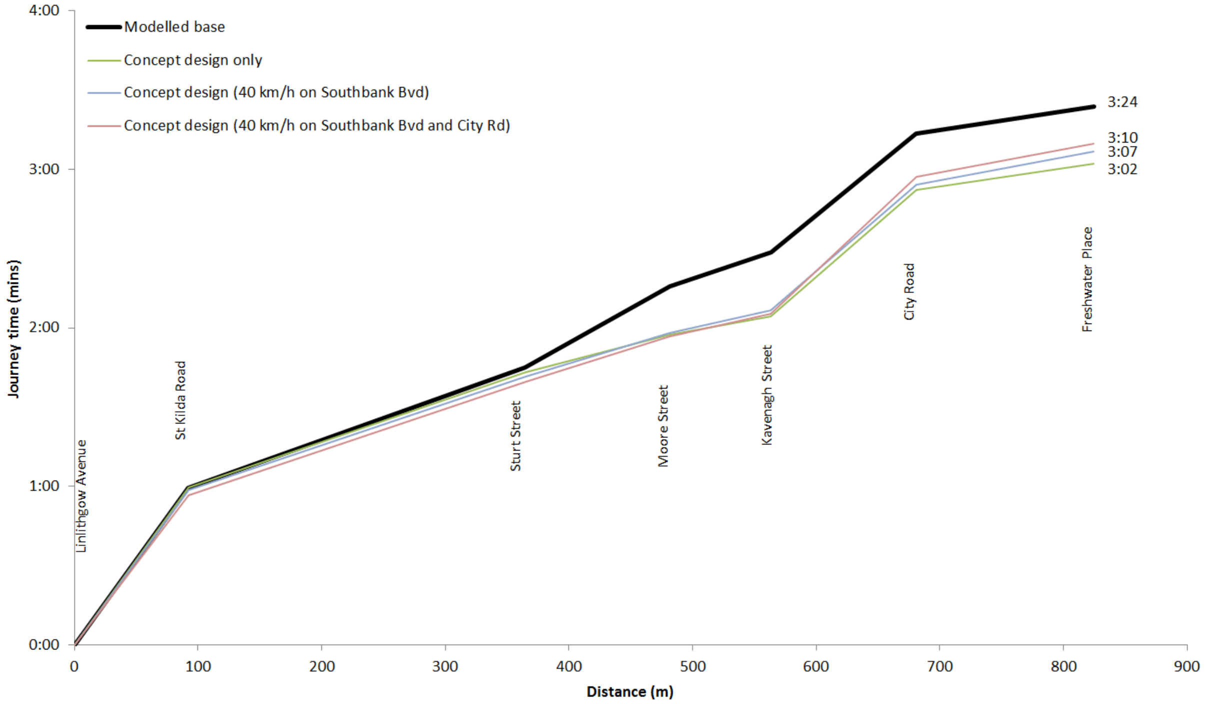


Table 5.3 – Eastbound journey time results by section in seconds (PM peak)

Section ending	Base case	Concept design (60 km/h)
City Road	0:47	0:49
Kavanagh Street	0:25	0:18
Moore Street	0:11	0:20
Sturt Street	0:30	0:24
St Kilda Road	0:54	0:52
Linlithgow Avenue	0:07	0:07

Table 5.4 – Westbound journey time results by section in seconds (PM peak)

Section ending	Base case	Concept design (60 km/h)
St Kilda Road	0:59	1:00
Sturt Street	0:46	0:44
Moore Street	0:31	0:14
Kavanagh Street	0:13	0:07
City Road	0:45	0:48
Freshwater Place	0:10	0:10

5.3 Level of service

5.3.1 Introduction

Delays for each intersection 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 an intersection performs and is directly related to the average delay a vehicle experiences at the intersection. The relationship between average delay and LOS is shown in Table 5.5.

Table 5.5 – 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.

5.3.2 AM peak results

Level of service results for the AM peak are shown in Figure 5.6 and Figure 5.7 for the base case and concept design respectively.

The results indicate that—

- LOS drops from B to D on the north and south approaches at Moore Street due to the additional green time that has been reallocated to the east-west movement. The east-west movements improve to LOS A and the overall LOS for the intersection remains at B.
- LOS at the Sturt Street intersection drops from C to D due to the additional delay experienced by eastbound traffic which is now in one lane.
- LOS on the east approach to St Kilda Road drops from D to E as a result of the loss of through capacity at Sturt Street. This prevents vehicles crossing St Kilda Road.

5.3.3 PM peak results

Level of service results for the AM peak are shown in Figure 5.8 and Figure 5.9 for the base case and concept design respectively.

The results indicate that—

- LOS remains at base conditions on average at all intersections.
- The north-south legs generally experience a drop in LOS due to the extra green time which has been allocated to the east-west movements to compensate for the loss of capacity.
- The largest reductions are on Kavenagh Street South, which drops from LOS B to LOS E due to the loss of signal control at this location.

- The south approach to Sturt Street also reduces from LOS D to LOS E. Queues on this approach regularly extend outside the model network, which means that performance is likely to be worse than reported.

Figure 5.6 – Level of service results for the base case (AM peak)

Delay definitions	
A	≤ 10 secs
B	10-20 secs
C	20-35 secs
D	35-55 secs
E	55-80 secs
F	≥ 80 secs

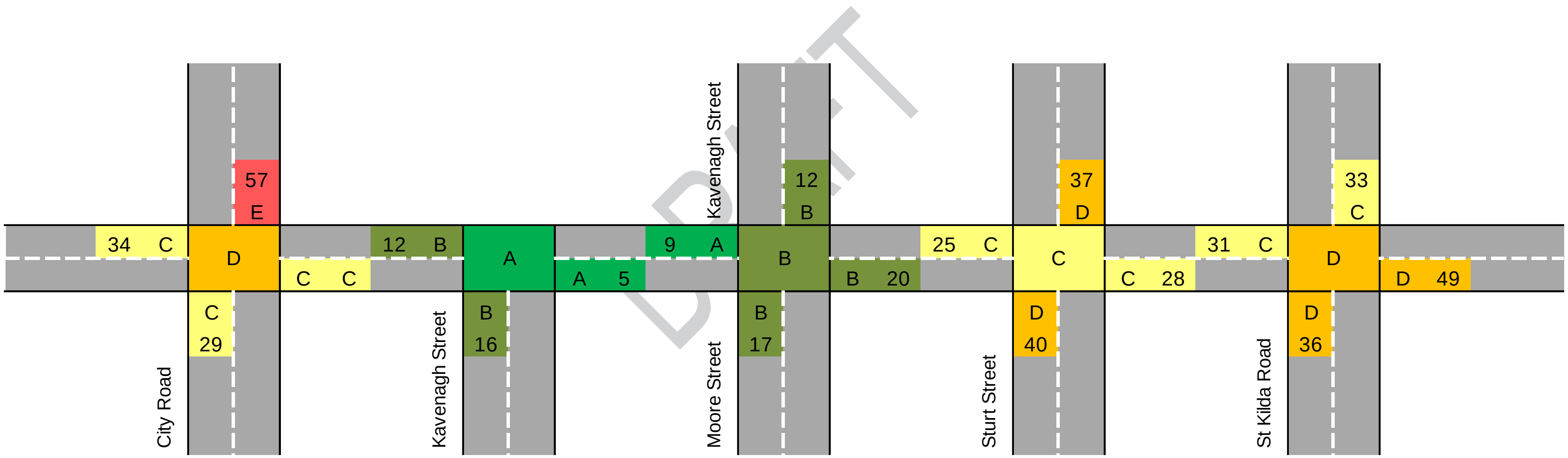


Figure 5.7 – Level of service results for the concept design (AM peak)

Delay definitions	
A	≤ 10 secs
B	10-20 secs
C	20-35 secs
D	35-55 secs
E	55-80 secs
F	≥ 80 secs

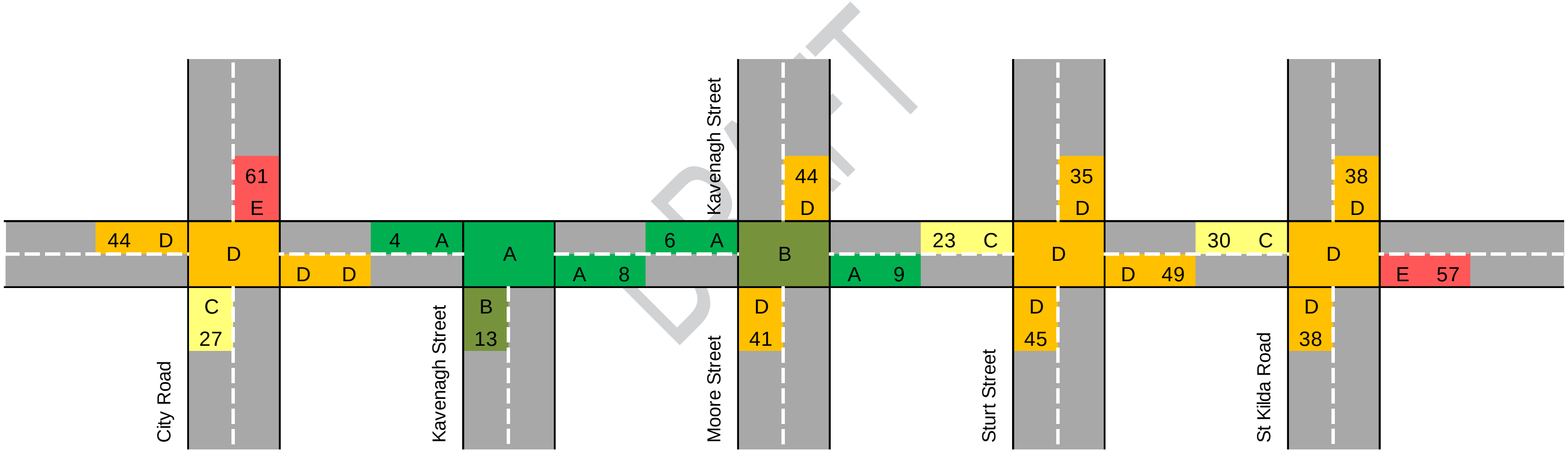


Figure 5.8 – Level of service results for the base case (PM peak)

Delay definitions	
A	≤ 10 secs
B	10-20 secs
C	20-35 secs
D	35-55 secs
E	55-80 secs
F	≥ 80 secs

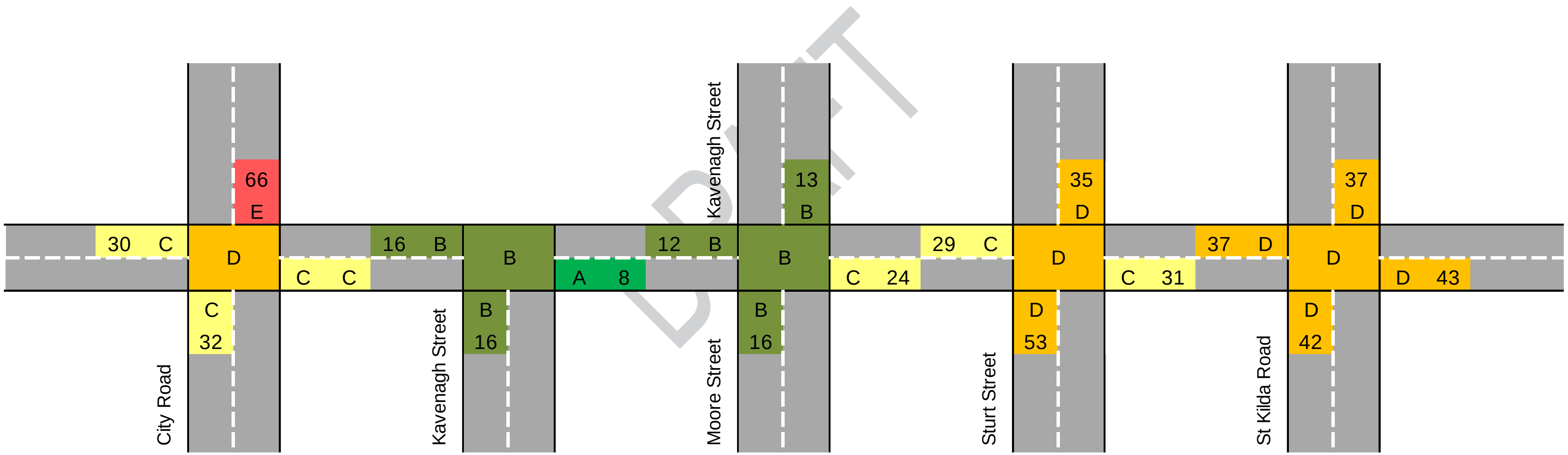
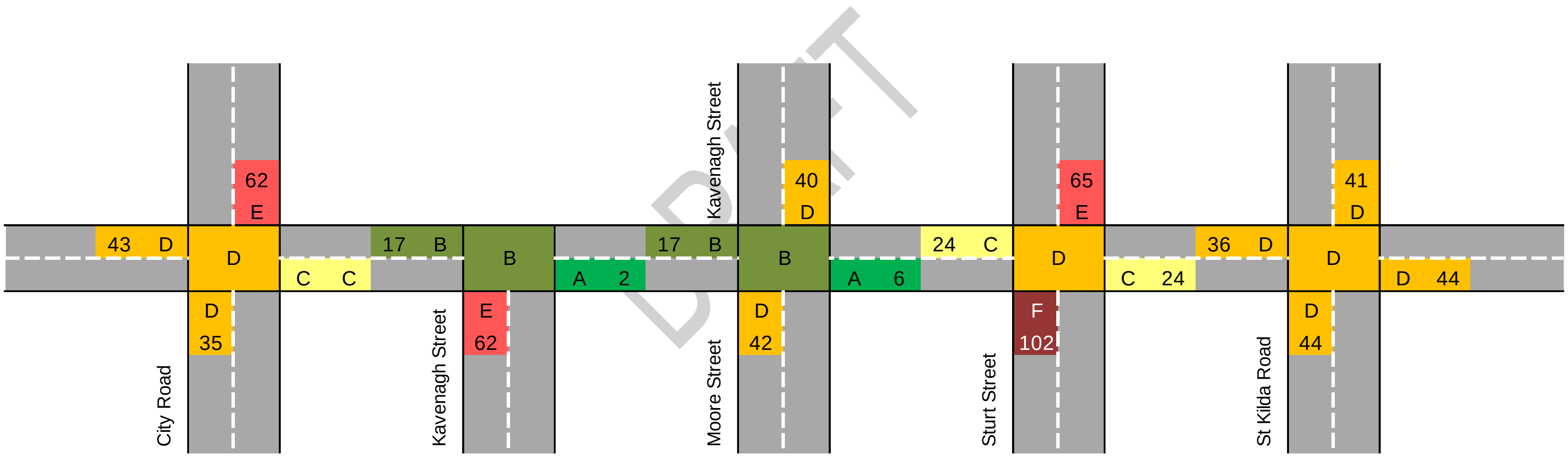


Figure 5.9 – Level of service results for the concept design (PM peak)

Delay definitions	
A	≤ 10 secs
B	10-20 secs
C	20-35 secs
D	35-55 secs
E	55-80 secs
F	≥ 80 secs



5.4 Vehicles unable to enter the network

The concept design increases congestion such that queues extend to the limits of the model network at Sturt Street (south approach) and Linlithgow Avenue (approach to Alexandra Avenue). It is considered that Linlithgow Avenue can be disregarded, as only four vehicles are unable to enter here. However, at Sturt Street, 33 vehicles cannot enter the network during the analysis period. As these vehicles cannot enter the network within the analysis period, there are fewer vehicles in the network than in the base case. This has the effect of suppressing demand, which means that the reported level of service result at Sturt Street is likely to be optimistic.

A summary of the number of vehicles unable to enter the network from selected entry points is shown in Table 5.6.

Table 5.6 – Median number of vehicles unable to enter the model in the concept design

Location	AM	PM
Linlithgow Avenue (approach to St Kilda Road)	-	4
Sturt Street South	-	33

6. Summary and conclusions

This report presents the results of VISSIM modelling of a concept design layout for Southbank Boulevard in Southbank. The design generally comprises of the removal of the westbound carriageway and the relocation of westbound traffic to the existing eastbound carriageway, which forms a two-lane two-way road for much of its length.

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

The options that have been tested are as follows:

1. Concept design layout with existing speed limit (60 km/h)
2. Concept design layout plus 40 km/h speed limit on Southbank Boulevard
3. Concept design layout plus 40 km/h speed limit on Southbank Boulevard and City Road

The broad conclusions of this report are as follows:

- In the eastbound direction there is little to no change in journey time when the speed limit remains at 60 km/h. Under the reduced speed scenarios, there are minor (negligible) increases in journey times.
- In the westbound direction there is an increase in journey time in the AM peak of approximately 40 seconds. In the PM peak there is a reduction in journey time due to the additional green time which has been given to Southbank Boulevard.
- Level of service drops from C to D at Sturt Street in the AM peak. Generally there are reductions in LOS on the north-south legs due to the additional priority that has been given to the east-west legs. In the PM peak there are no changes to overall LOS, although again there are reductions on the north-south legs for the same reason.

Appendices

Appendix A – Concept design

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