



City Centre West to East Cycle and Street Improvement Scheme

VISSIM traffic modelling

12 December 2016

The City of Edinburgh Council



Roseburn to Leith Walk cycle route – traffic modelling

Project no: B2051400
Document title: Traffic modelling
Document No.: 2
Revision: 5
Date: 12.12.16
Client name: City of Edinburgh Council
Project manager: G Davidson
Author: D Sekar / I Esslemont
File name: I:\UNIF\Projects\B2051400\Technical\1-Roseburn to Leith Walk cycle route\Roseburn to Leith Walk - VISSIM modelling 180816.docx

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Document history and status

Revision	Date	Description	By	Review	Approved
1	10.09.15	Original	DS	LM	GD
2	03.11.15	Includes client comments	DS / GD	LM	GD
3	18.07.16	Updated with revised Roseburn modelling	GD	IE	GD
4	18.08.16	Updated with client comments	GD	IE	GD
5	12.12.16	Updated with revised Options A, B and B2	IE	GD	GD

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1. Introduction

1.1 Introduction

The City of Edinburgh Council (CEC) is designing a cycle route, with public realm and pedestrian improvements between Roseburn, the city centre and Leith Walk. The proposed scheme will tie into the existing city cycle networks and to national cycle routes 1 and 76.

The proposed design is being developed in three sections:

- Roseburn to Haymarket (Magdala)
- Haymarket (Magdala) to the West End
- East End

Jacobs has been asked to model the traffic impacts of these, helping to inform the selection and refinement of each area. All modelling has been undertaken using VISSIM software, consistent with other modelling analysis across the city centre.

The Haymarket to West End and East End proposals are located within the extent of the existing city centre VISSIM model area.



Figure 1.1: City Centre VISSIM model

The Roseburn to Haymarket section is to the west of the city centre model and so a new local model has been developed, calibrated and validated in order to assess potential traffic impacts at this location. A summary of the process and calibration validation results is given in Appendix A.



Figure 1.2: Roseburn VISSIM model

1.2 The VISSIM model

VISSIM is a 'microsimulation' model with 'fixed trip matrix'. It is best suited to forecasting the impacts of road layout and junction changes on known amounts of traffic. **VISSIM's use for the current modelling purpose is likely to generate worst case scenarios** for the following reasons:

1. The model does not forecast or take into account the effects of any projects on travel patterns. The current project is expressly intended to attract more people to cycle and , to a certain extent, walk. This would be expected to reduce traffic volume on the corridor, but this effect is not taken into account by the modelling.
2. The fixed trip matrix, combined with the relatively constrained road network modelled, means that there is no potential for any traffic to re-route in response to proposed changes. In reality, a degree of re-routing would be expected, especially in response to the removal of 'rat-running' opportunities as is proposed for Roseburn Gardens. Such re-routing would be likely to reduce the level of traffic on the streets concerned below that shown in the model and consequently reduce any additional delays and queuing.

1.3 Model years and time periods

The city centre VISSIM model has been updated to a 2015 base in the area of interest. The Roseburn to Haymarket model was developed for the current project and has been updated using new traffic count data collected in spring 2016.

All model time periods are;

- AM 08:00 to 09:00, and
- PM 17:00-18:00

A 15 minute 'warm up' period precedes each modelled hour.

2. Roseburn to Haymarket (Magdala)

2.1 Roseburn Area

A number of scheme designs for the Roseburn area were provided by CEC for testing in VISSIM. Minor changes have been made to the designs since the modelling was undertaken, however this will not significantly affect the results. The general arrangements of the options are summarised below.

The scenario numbering relating to the development proposals for the area have seen several iterations.

As part of the initial scenario assessment, the following potential layouts were developed:

Table 2.1: Original scenarios and revised scheme option numbering

Original scenarios	Aug 2016 scenarios	Enhanced Nov 2016 scenarios	Cycleway route	Roseburn St / Russell Rd priority
Scenario 1			via A8 Roseburn Terrace	Roseburn St priority over Russell Rd
Scenario 2	Option A	Option A	via A8 Roseburn Terrace	Russell Rd priority over Roseburn St
Scenario 3			Via Roseburn Street / Roseburn Place	Roseburn St priority over Russell Rd
Scenario 4	Option B	Option B	Via Roseburn Street adjacent to southbound carriageway/ Roseburn Place	Russell Rd priority over Roseburn St
		Option B2	Via Roseburn Street adjacent to northbound carriageway / Roseburn Place	Russell Rd priority over Roseburn St

Previous Scenario 2 is closest to 'Option A' currently (August 2016 & November 2016) referred to by the Council, while scenario 4 is closest to the 'Option B'. 'Option B2' is a new scenario similar to Option B but with the proposed cycleway route running along the opposite side of Roseburn Street.

All enhanced options now also include the following:

- An all green pedestrian crossing stage on all arms of the Roseburn Terrace junction with Roseburn St.
- One wide westbound lane replacing the current two separate straight ahead and left turn lanes at the Roseburn Terrace/ Roseburn Street Junction.
- Westbound bus lane on Roseburn Terrace/West Coates approach to the junction with Roseburn Street.
- Removal of road closures at Roseburn Gardens and Roseburn Place and a southbound one way system introduced from Roseburn Terrace onto Roseburn Gardens.

Scenario 1

This scenario maintains the cycleway on Roseburn Place, Roseburn Gardens and the A8 Roseburn Terrace as shown in Figure 2.1 below. Roseburn Gardens is closed to motorised traffic, removing a busy rat-run and thereby significantly improving condition for residents, pedestrians and cyclists.

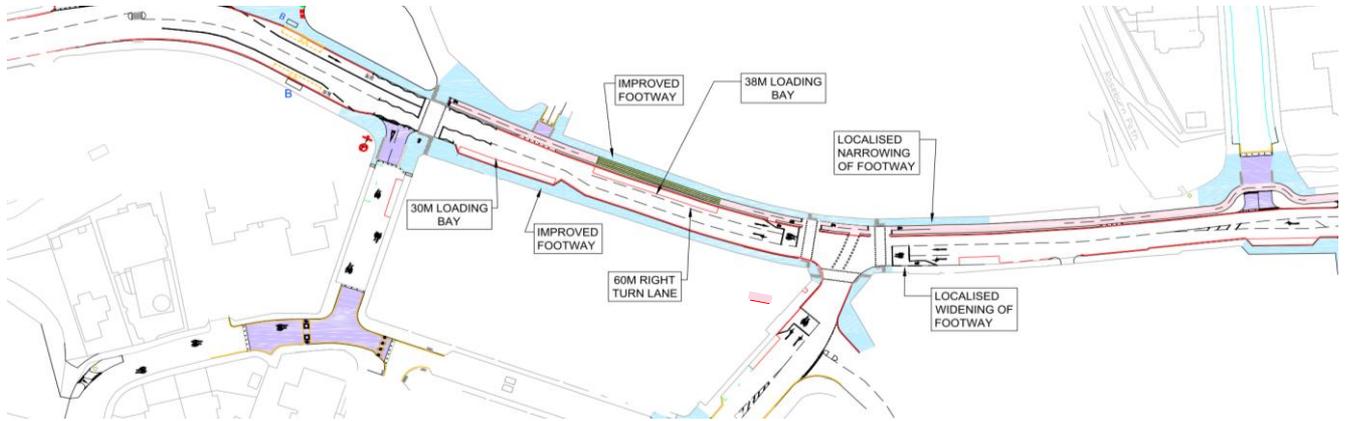


Figure 2.1: Scenario 1

Option A – August 2016 (previously Scenario 2)

This option is similar to Scenario 1 except for the junction layout at Roseburn Street / Russell Road. Traffic from Russell Road now takes priority over Roseburn Street. This design has been developed to alleviate the difficult right turn from Russell Road to Roseburn Street and the A8. It also helps improve access from Roseburn Street to Russell Road. The modified junction arrangement is shown in Figure 2.2;

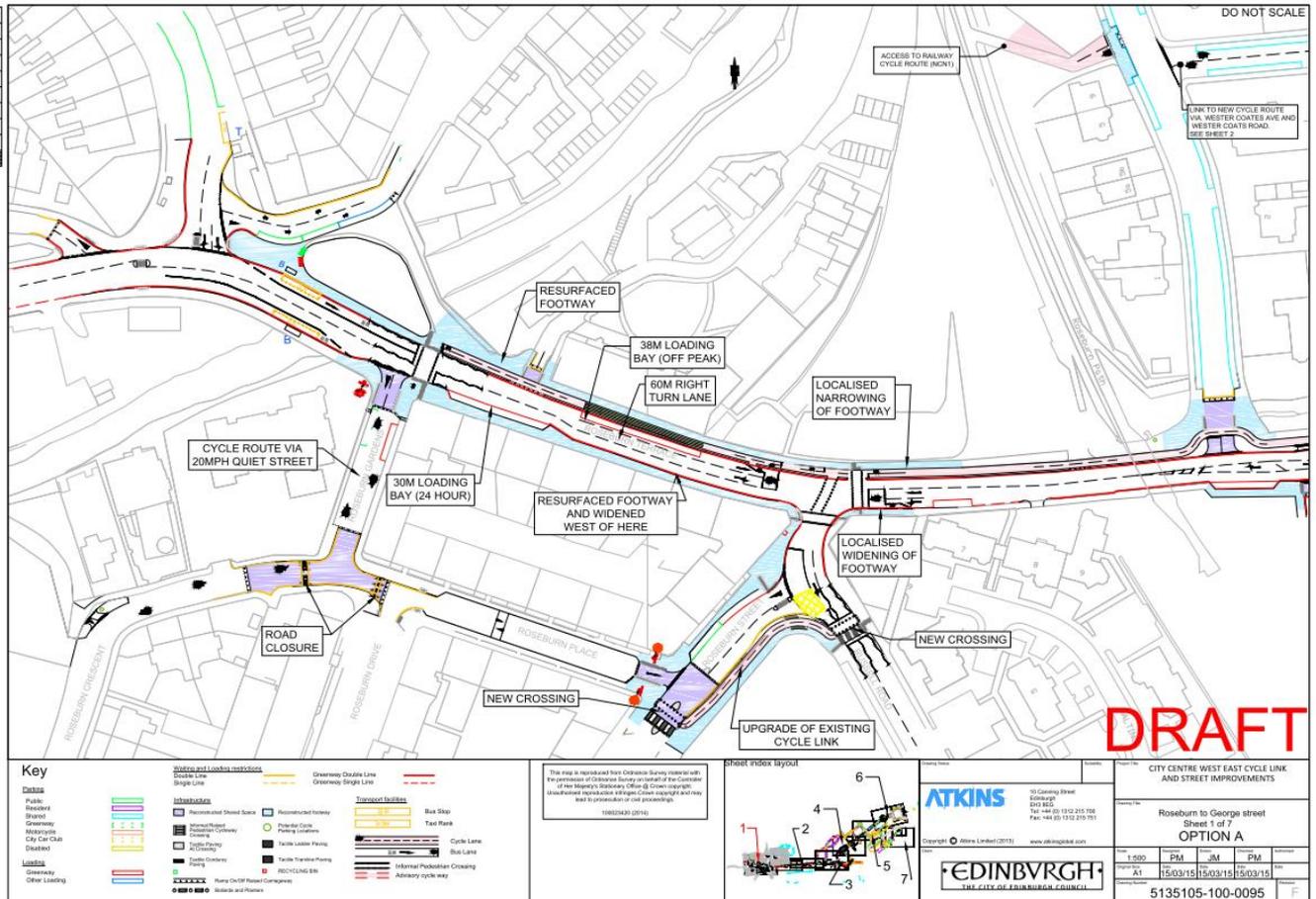


Figure 2.2: Option A – August 2016 (previously Scenario 2)

Enhanced Option A – November 2016

The enhanced Option A includes a number of the changes made during the Stakeholder Workshop process in Autumn 2016. The cycle route remains on Roseburn Place, Roseburn Gardens and the A8 Roseburn Terrace. Two effective lanes have been maintained along the eastbound approach to the junction. Figure 2.2 below outlines the main changes in enhanced Option A.

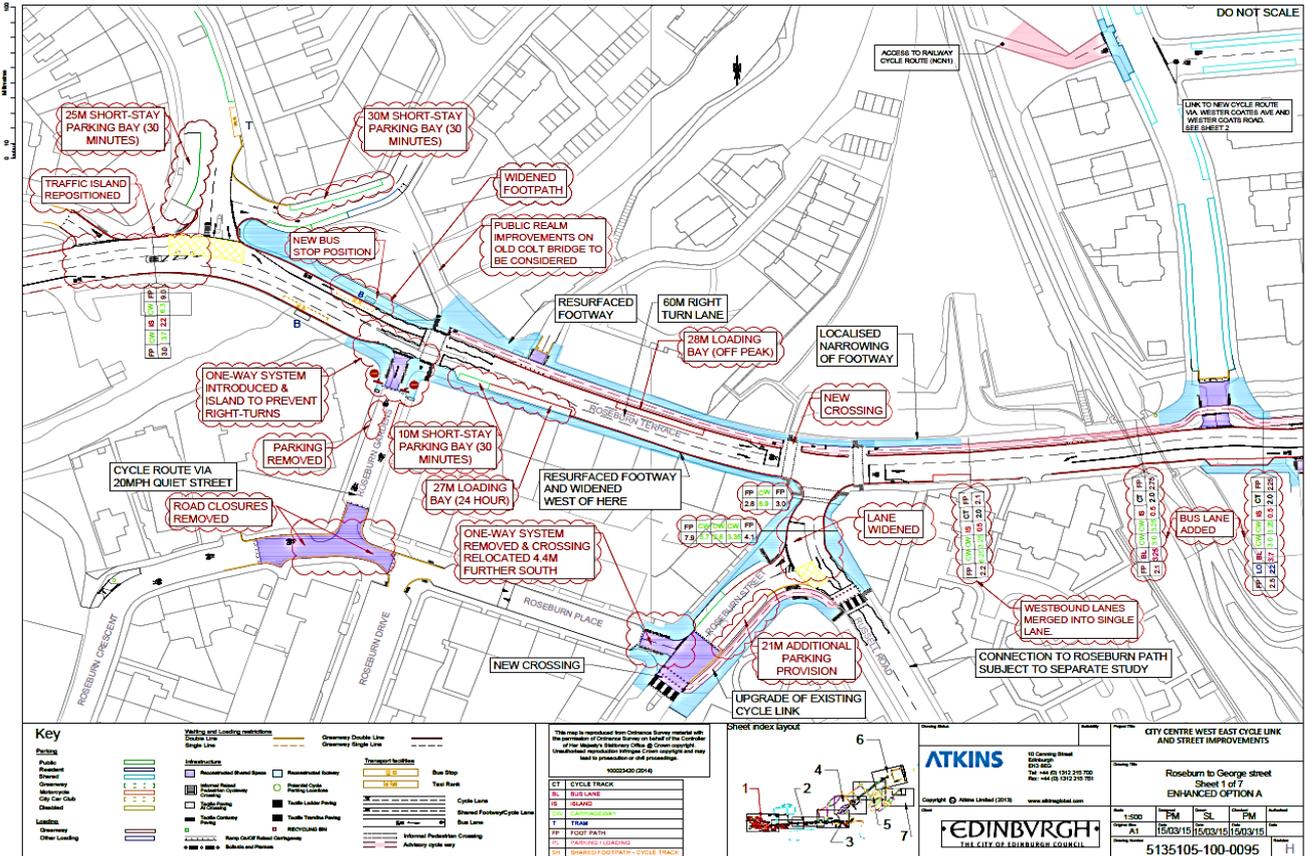


Figure 2.3: Enhanced Option A – November 2016

Scenario 3

In Scenario 3, the cycle path from Roseburn Terrace passes via Roseburn Street, Roseburn Place and Roseburn Gardens before joining the cycle route network to the west, as shown in Figure 2.4. A zebra crossing is introduced at Russell Road. The priority at Roseburn Street/ Russell Road remains unchanged.

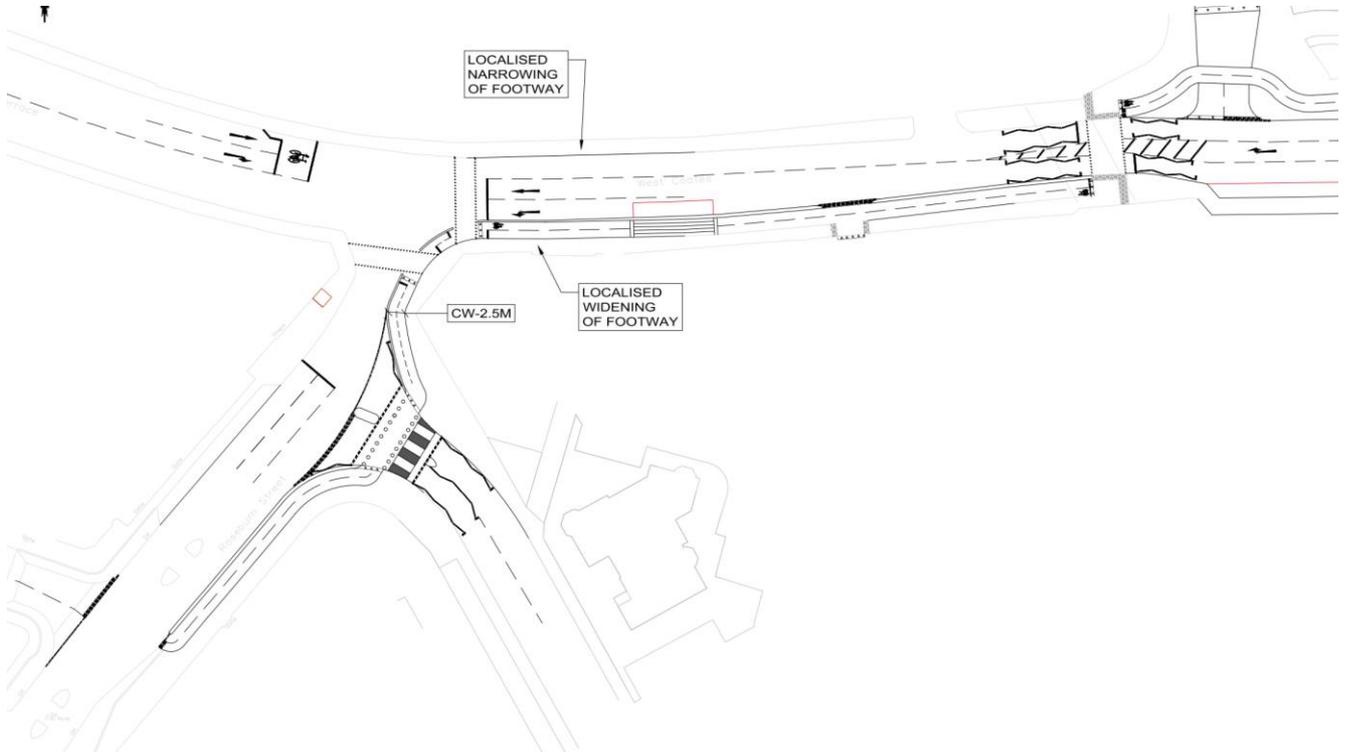


Figure 2.4: Scenario 3

Option B – August 2016 (previously Scenario 4)

Option B is shown in Figure 2.5 below. It is similar to Scenario 3 in terms of cycle path layout; the route from Roseburn Park passes via Roseburn Place and Roseburn Street to towards Roseburn Terrace (east) with a zebra crossing provided at Russell Road.

The priority at Roseburn Street / Russell Road is, however, changed in such a way that traffic from Roseburn Street now gives way to Russell Road.

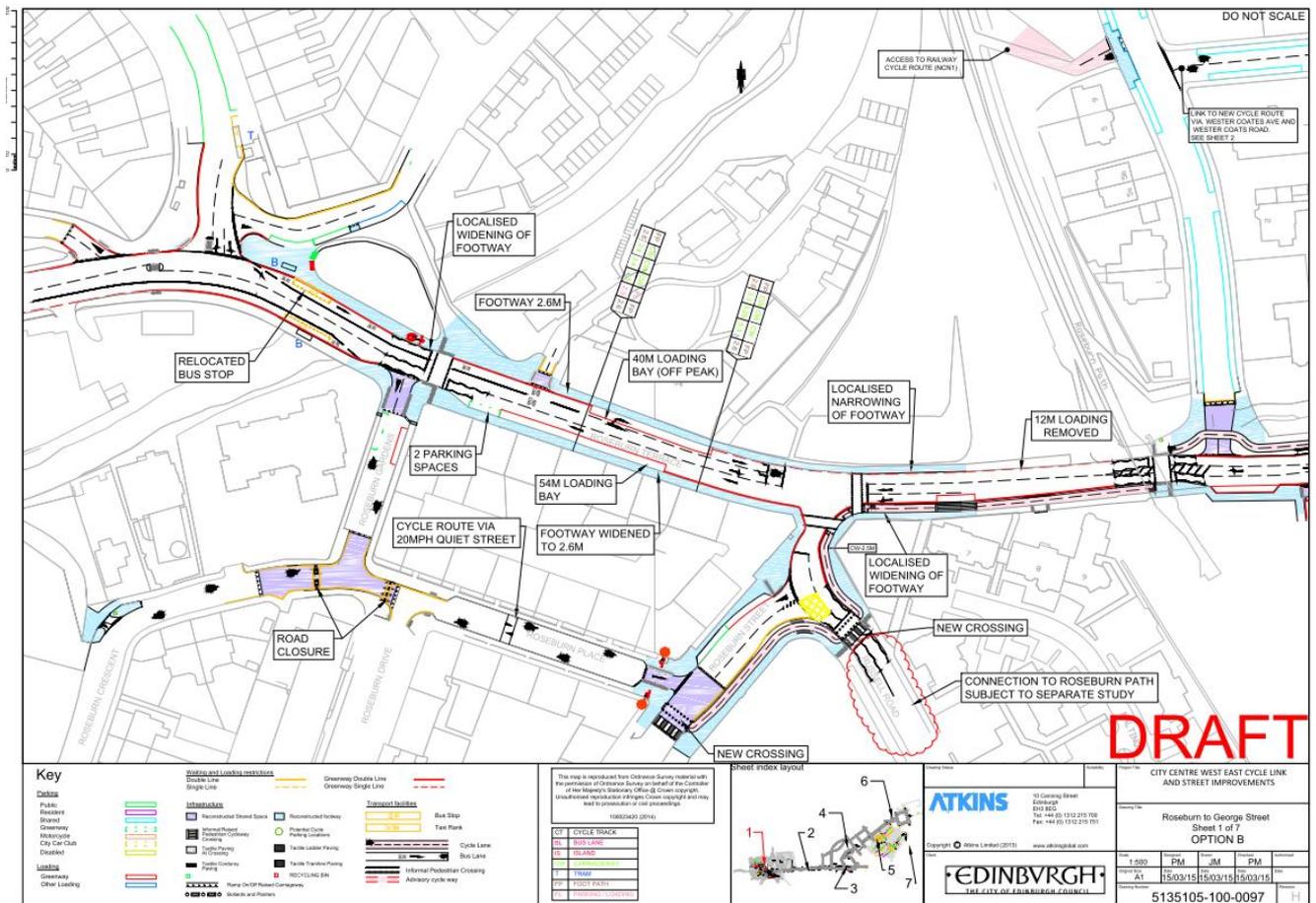


Figure 2.5: Option B – August 2016 (previously Scenario 4)

Enhanced Option B - 'Option B1' – November 2016

Enhanced Option B (now re-named Option B1) is shown in Figure 2.6 below and also includes all relevant changes made to enhanced option A. The cycleway route follows the east side of Roseburn Street before emerging onto the south side of Roseburn Terrace's westbound carriageway via a crossing point on Russell Road. The main change has seen the zebra crossing on Russell Road replaced with a toucan crossing.

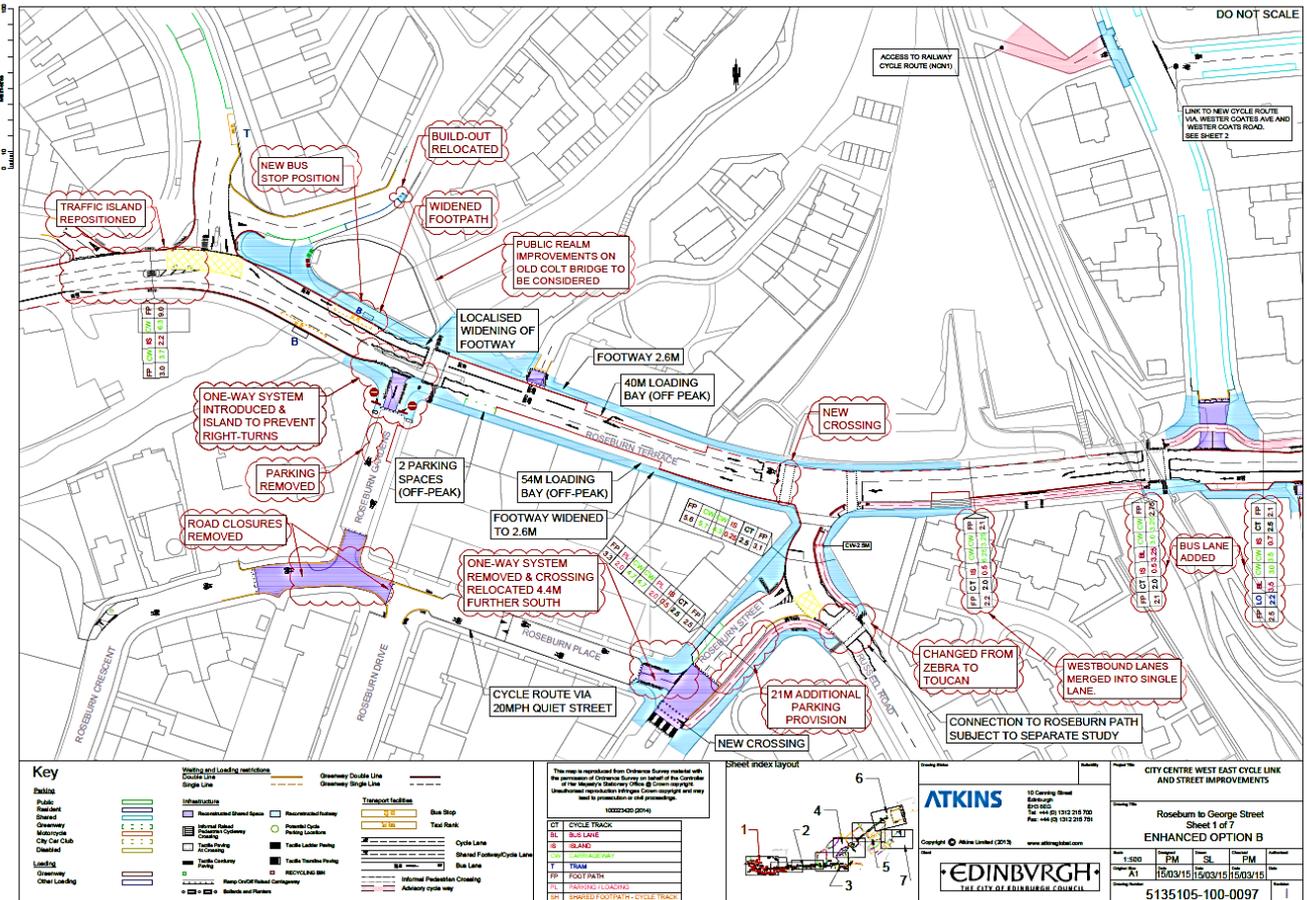


Figure 2.6: Option B 1 – November 2016

Option B2

Option B2 is a new sub-option for Option B which has been developed following discussions during the Stakeholder Workshops. The segregated cycle track runs alongside the northbound carriageway on Roseburn Street with wide toucan crossings at the junction with Roseburn Terrace linking it to the segregated cycle track on the north side of Roseburn Terrace. The proposed Toucan Crossing on Russell Road in Option B has been changed back to a zebra crossing but with the location moved further south along Russell Road. All the other generic changes are also made to this option. Figure 2.7 below outlines all the changes mentioned.

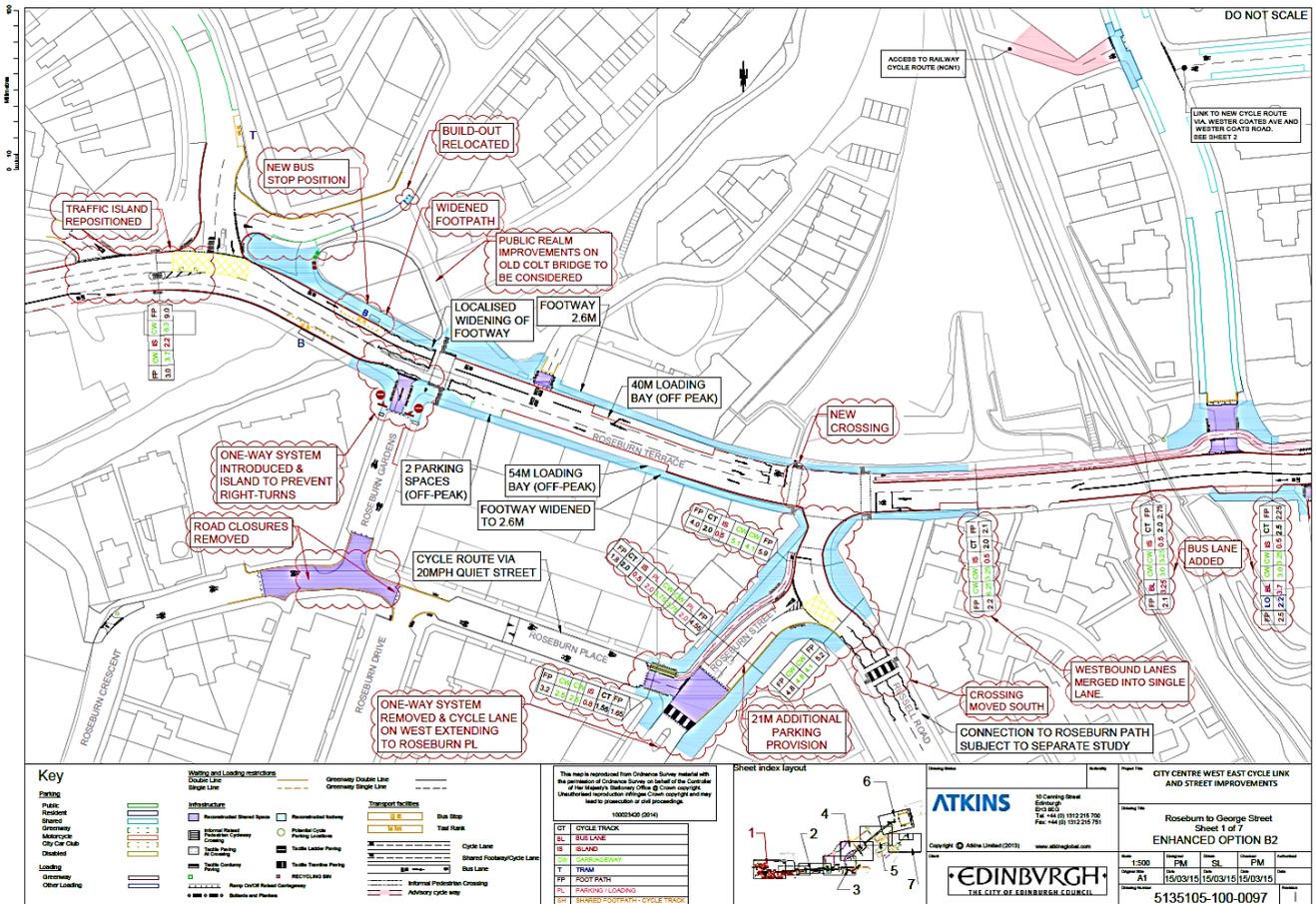


Figure 2.7: Option B2

2.3 Network performance

The enhanced options have been assessed in terms of their impact on vehicle journey times and queue lengths.

2.3.1 Journey times

Journey time paths have been defined in each VISSIM model in order to assess network performance, as shown in Figure 2.9. The different paths are:

- A8 eastbound and westbound between Magdala Crescent and Balgreen Road
- A8 eastbound and westbound between Balgreen Road and Roseburn St.
- A8 eastbound and westbound between Balgreen Road and Russell Road

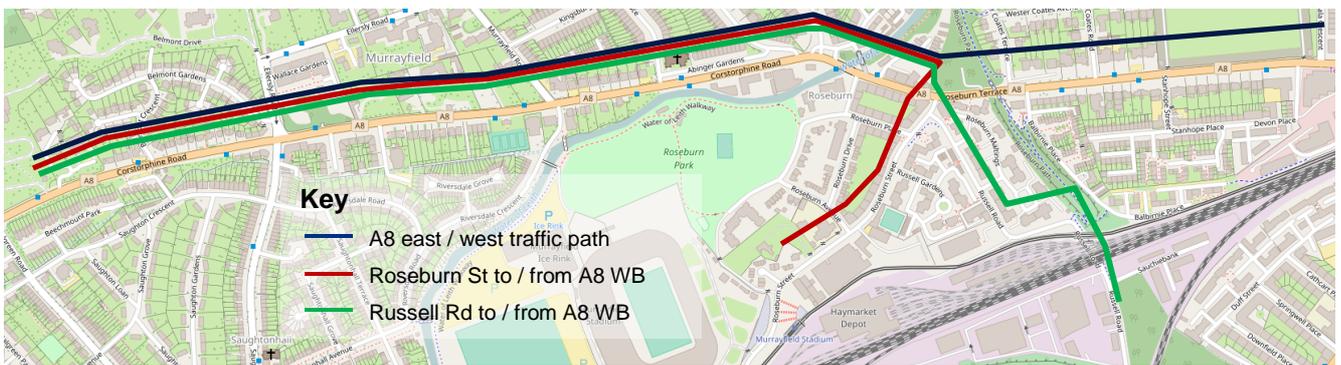


Figure 2.9: Journey time routes

a. AM peak journey times

Morning peak journey times for each path have been recorded for each enhanced option between 08:00 – 09:00. They are tabulated in **Error! Reference source not found.** with the nine highest journey time variances highlighted in red and the nine lowest highlighted in green. The journey times for each option are also represented in Figure 2.10.

Models	A8 WB Magdala Cres to A8 at Balgreen Rd	A8 EB at Balgreen Rd to A8 at Magdala Cres	Roseburn St to A8 at Balgreen Road	A8 EB at Balgreen Rd to Roseburn St	Russell Rd to A8 WB at Balgreen Rd	A8 EB at Balgreen Rd to Russell Rd
Base	223	200	147	172	193	175
Option A	354	328	1,007	326	1,154	332
Option B	296	335	990	297	919	302
Option B2	370	307	946	259	1,037	266
Change from Base						
Option A	131	128	860	153	961	156
Option B	74	135	843	125	726	127
Option B2	147	107	800	87	843	90
% Change from Base						
Option A	59%	64%	587%	89%	497%	89%
Option B	33%	68%	576%	73%	376%	73%
Option B2	66%	53%	546%	50%	437%	52%

Table 2.1 : AM journey times (seconds)

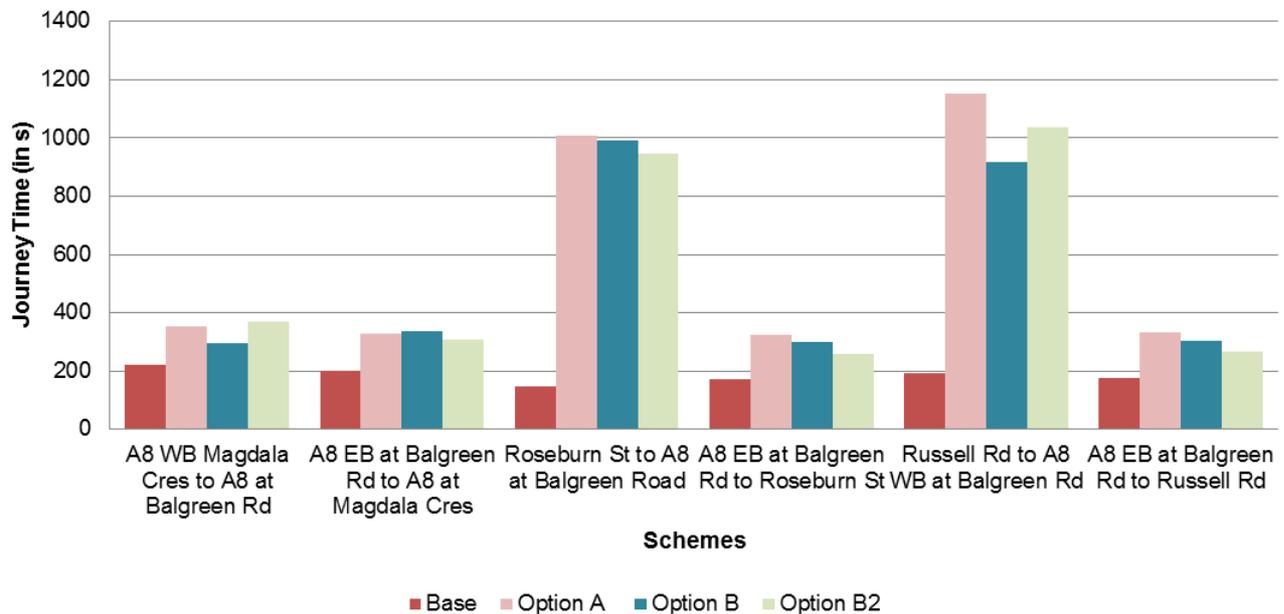


Figure 2.10: AM journey times

From the above, it can be seen that average journey times westbound and eastbound along the A8 corridor are broadly consistent across the different options. Westbound journey times vary between 296 and 370 seconds. Eastbound journey times vary between 307 and 335 seconds. Increases in journey times along the A* are largely as a result of the introduction of an all green pedestrian stage.

The greatest change in journey times is seen on Roseburn Street and Russell Road approaches to the junction with Roseburn Terrace. This is as a result of a combination of the all green pedestrian stage and also due to the closure northbound of Roseburn Gardens which was often used as a rat-run by vehicles heading west along the A8.

As discussed in 1.2, it is important to note that VISSIM is a 'fixed trip matrix' model. In the case of the current modelling, this means that there is no potential for any traffic to re-route in response to proposed changes. In reality, a degree of re-routing would be expected, especially in response to the removal of 'rat-running' opportunities as is proposed for Roseburn Gardens. Such re-routing would be likely to reduce the level of traffic on the streets concerned and consequently to reduce the additional delays and queuing induced by the proposals.

See paragraph 2.3.1c for further commentary on these forecasts, causative factors and potential to ameliorate.

b. PM peak journey times

Evening peak journey times have been captured between 17:00 – 18:00, they are summarised in Table 2.2 and Figure 2.11 below.

As in the morning peak, journey times eastbound along the A8 are only modestly increased over base observed values. Option A, B, and B2 westbound journey times have had a greater increase compared to base of 219, 151 and 202 seconds respectively. As before the increased journey times are as a result of the introduction of an all green pedestrian stage.

Again, similar to the morning peak journey times on Roseburn St and Russell Rd approaches to the junction with Roseburn Terrace have increased significantly in all options.

The points made in 2.3.1a re the 'fixed trip matrix' nature of the VISSIM model also apply to the evening peak. See paragraph 2.3.1c for further commentary on these forecasts, causative factors and potential to ameliorate.

Table 2.2 : PM journey times (seconds)

Models	A8 WB Magdala Cres to A8 at Balgreen Rd	A8 EB at Balgreen Rd to A8 at Magdala Cres	Roseburn St to A8 at Balgreen Road	A8 EB at Balgreen Rd to Roseburn St	Russell Rd to A8 WB at Balgreen Rd	A8 EB at Balgreen Rd to Russell Rd
Base	215	204	144	208	174	218
Option A	434	248	1,092	226	1,334	233
Option B	366	278	1,273	277	1,386	280
Option B2	417	232	1,213	229	1,143	234
Change from Base						
Option A	219	44	947	17	1159	14
Option B	151	74	1129	69	1212	62
Option B2	202	28	1069	21	969	16
% Change from base						
Option A	102%	22%	657%	8%	666%	7%
Option B	70%	36%	783%	33%	696%	28%
Option B2	94%	14%	741%	10%	556%	7%

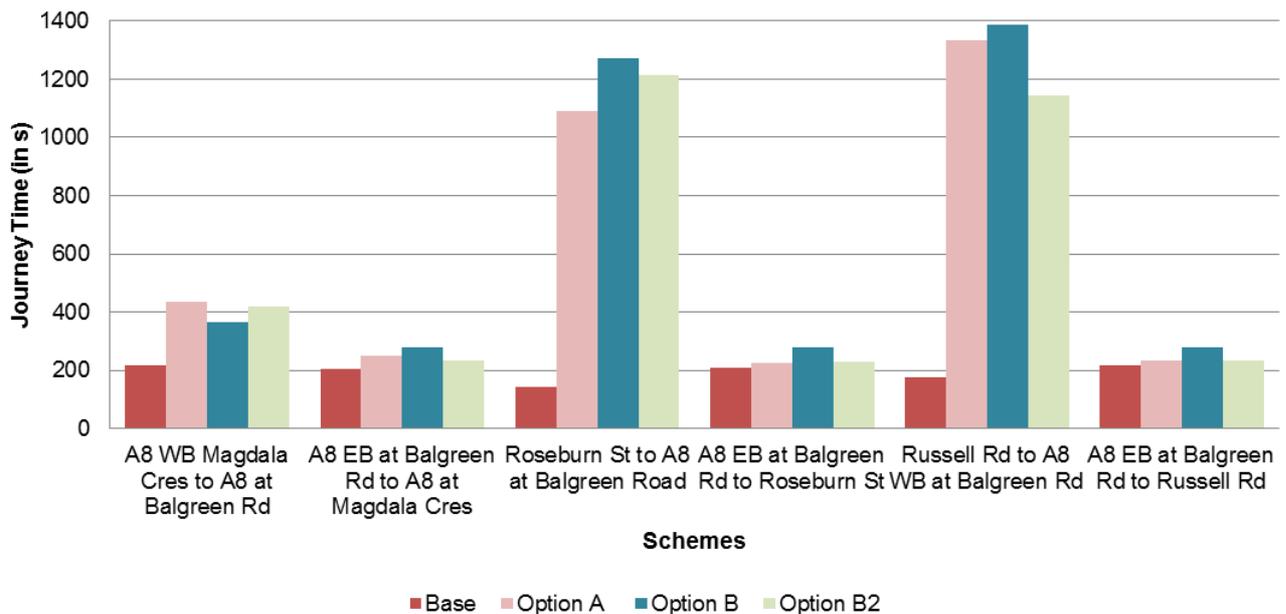


Figure 2.11: PM Journey Times

c. Bus Journey Times

Figures 2.12 and 2.13 represent bus journey times in both directions along the A8 for all models. The results indicate that journey times are slightly affected.

In the morning peak eastbound journey times are slightly quicker compared to base with westbound journey times much higher. This is likely as a result of the introduction of the all green pedestrian stage leading to changes in signal timings compared to base. In the evening peak again westbound journey time increases are higher with eastbound journey times only slightly increasing compared to base.

Models	A8 WB Magdala Cres to A8 at Balgreen Rd	A8 EB at Balgreen Rd to A8 at Magdala Cres
Base	351	365
Option A	425	340
Option B	399	355
Option B2	429	347
Change from Base		
Option A	73	-24
Option B	48	-9
Option B2	78	-18
% Change from Base		
Option A	21%	-7%
Option B	14%	-2%
Option B2	22%	-5%

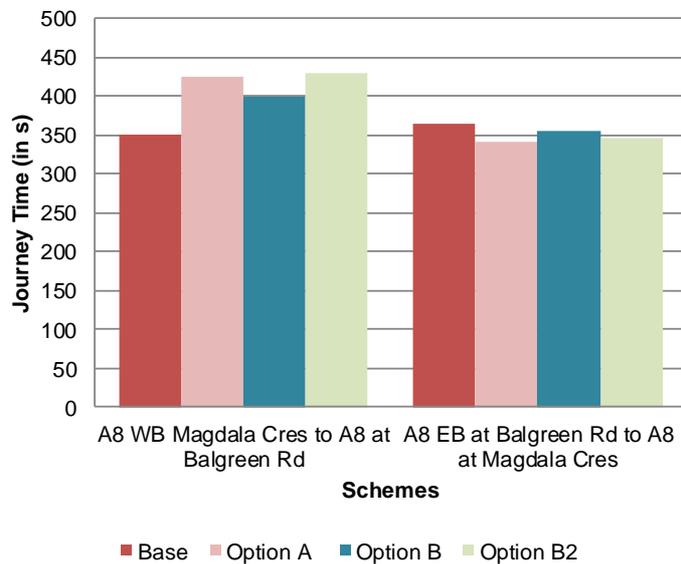


Figure 2.12: AM Bus Journey Times (seconds)

Models	A8 WB Magdala Cres to A8 at Balgreen Rd	A8 EB at Balgreen Rd to A8 at Magdala Cres
Base	345	306
Option A	404	318
Option B	395	348
Option B2	394	318
Change from Base		
Option A	59	11
Option B	50	42
Option B2	48	12
% Change from Base		
Option A	17%	4%
Option B	14%	14%
Option B2	14%	4%

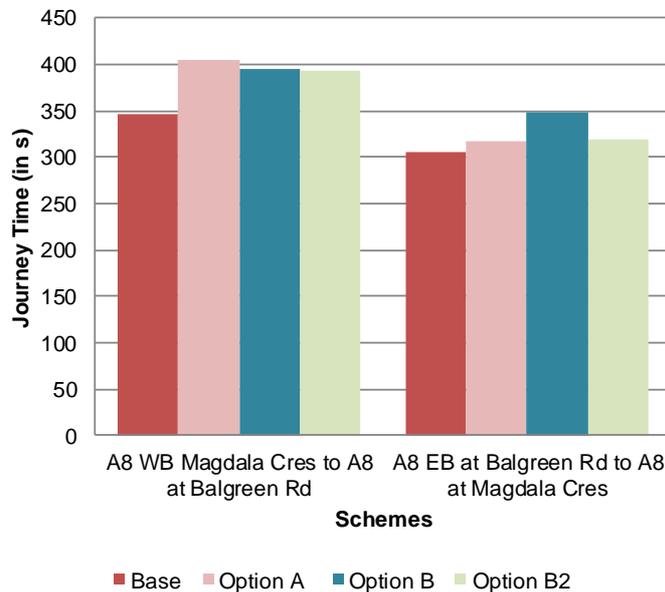


Figure 2.13: PM Bus Journey Times (seconds)

d. Commentary on forecasts, including impact of closure of Roseburn Gardens and the proposed new pedestrian crossing of Roseburn Terrace

The current proposals include two interventions that should provide significant benefits to both pedestrians and cyclists in Roseburn and to local residents' amenity, the northbound closure of Roseburn Gardens and a new all green pedestrian stage on each arm of the Roseburn Street junction with Roseburn Terrace.

The VISSIM model forecasts are likely to be a worst case scenario for reasons discussed in 1.2.

The model forecasts modest additional journey times on the A8 east and significant additional delays north/westbound from both Russell Rd and Roseburn St. The proposed northbound closure of Roseburn Gardens is the key factor in these forecast extra delays, with the new all green stage pedestrian crossings also contributing, though to a lesser extent. The Roseburn Gardens closure is proposed in all options, because without it the level of traffic on Roseburn Place/ Roseburn Gardens is incompatible with the standard of provision for cyclists being sought as part of the wider project. This could be ameliorated by the introduction of a segregated cycle track on Roseburn Gardens or Roseburn Place in Option A/Option B respectively. In either case this would require removal of parking from one side of the street and making the street concerned one way. In the case of Roseburn Gardens the latter would lead to significant difficulties for residents attempting to access and park in the street from the west.

Survey data shows that over 200 vehicles turn from Roseburn Place into Roseburn Gardens and then towards the A8 westbound in both the morning and evening peaks. The closure of this significant rat-run necessitates that traffic returns to adjacent strategic links and, as a consequence, additional queues on Roseburn St and Russell Rd occur.

The provision of the pedestrian crossings, across the A8, to the east and west side of the Roseburn Terrace junction also impacts on junction performance. While this element of the design is not integral to the cycling scheme, it improves access to local shops and commercial businesses. This element of the design has been generally welcomed by stakeholders and it is recommended that it is retained given the small overall impact on journey time.

Model runs adding the Roseburn Gardens Closure and the new pedestrian crossings at the Roseburn St junction to the base model indicate that these two interventions, rather than the proposed cycle provision are the principal causes of the additional delays forecast by the model.

As noted in 2.3.1, the VISSIM model does not allow traffic to re-route in response to proposed changes. In a scenario such as that being modelled here, a degree of re-routing would be expected. Such re-routing would be likely to reduce the level of traffic on the streets concerned and consequently lessen the additional delays and queuing induced by the proposals. As a consequence, journey times forecast here will not be experienced in reality.

Furthermore, the detailed design process for the project will afford opportunities to minimise delays, for example by considering the detail of the Roseburn St/Russell Rd junction in relation to lane widths and features such as yellow box markings.

2.3.2 Queue lengths

Forecast morning and evening peak queue lengths are shown for each option. Queue lengths have not been reported in greater detail due to the high level of observed variability. VISSIM's queue length parameters are also inconsistent with survey information making comparison difficult.

Queues observed in the AM peak, at 08:30

Modelled queues at Roseburn Terrace / Roseburn Street / Russell Road junction during the AM peak, at 08:30, for each option are shown in this section.

Figure 2.14 illustrates base queues and shows only limited queuing midway during the morning peak. It should be noted that on the day of the survey no vehicles were parked in the eastbound A8 loading bays for the majority of the morning peak period resulting in smooth operation and limited congestion.

Figure 2.15 to 2.17 show that in all options, A8 traffic queues have been minimised in order to limit the impact of each option on public transport.

With the change in priority for Russell Road over Roseburn St in Options A, B and B2 there is more even queuing on Roseburn St and Russell Rd. As a consequence journey times are more consistent across both routes as shown previously in Table 2.1 and 2.2.

Base



Figure 2.14: Queues observed in Base

Option A

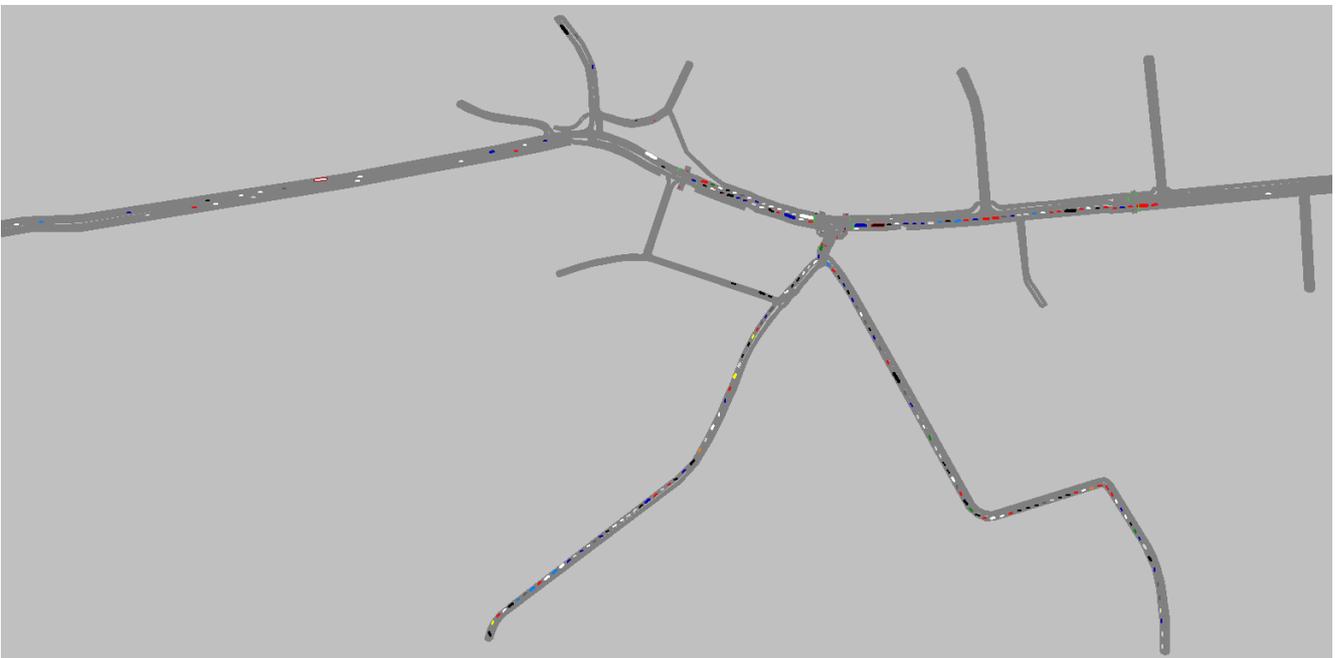


Figure 2.15: Queues observed in Option A

Option B

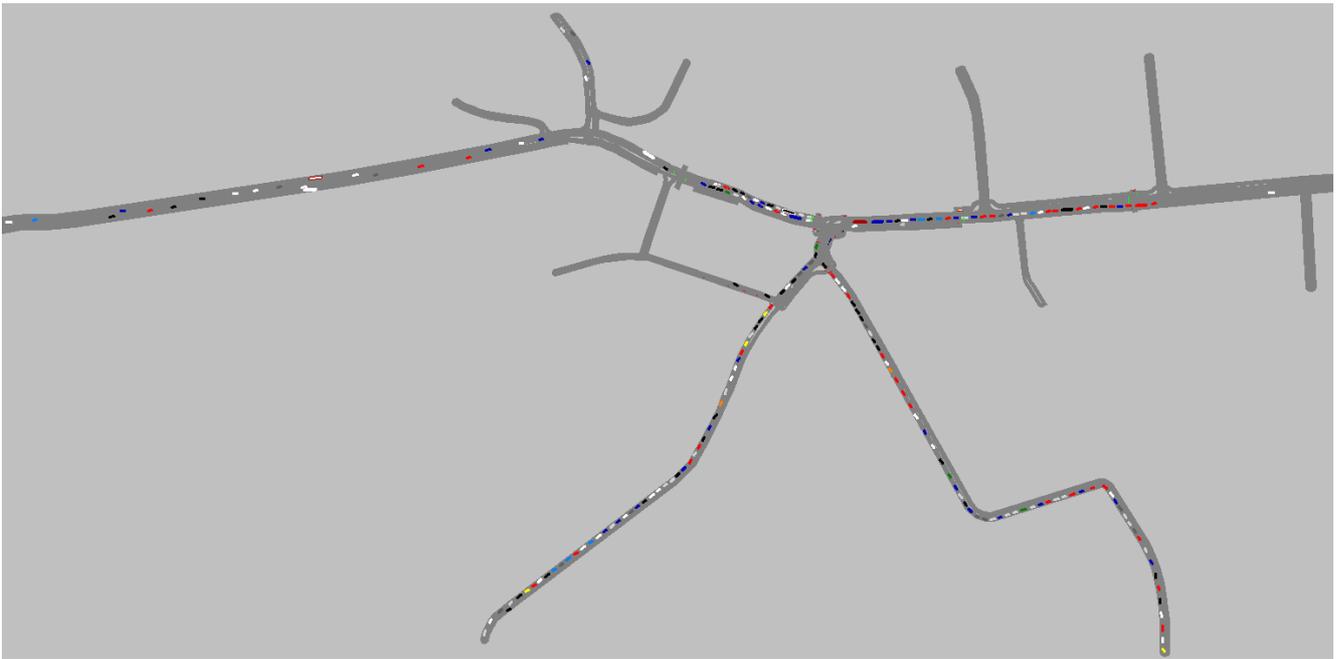


Figure 2.16: Queues observed in Option B

Option B2

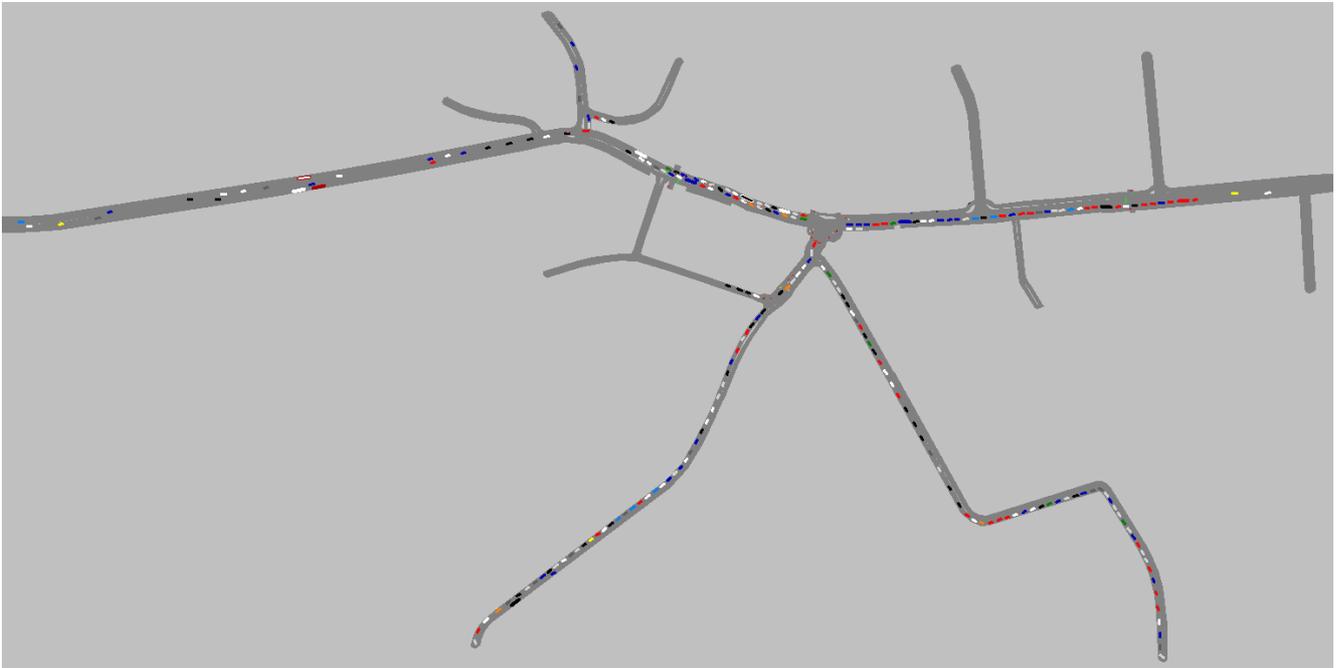


Figure 2.17: Queues observed in Option B2

Queues observed in the PM peak, at 17:30

Queues observed at Roseburn Terrace / Roseburn Street / Russell Road junction during the PM peak, at 17:30, for each option are summarised below.

Base evening peak queues are again modest. Only one vehicle was observed to stop in the eastbound A8 loading bay during the baseline survey and so queues are modest. Nevertheless, traffic volumes calibrate to observed counts as summarised in Appendix A.

As in the morning peak, Figure 2.19 to 2.21 illustrate that A8 traffic queues have been minimised in order to limit public transport journey time increases. Westbound queues are slightly longer than in the morning peak.

Traffic impacts at Roseburn St and Russell Rd are also consistent with the morning analysis with similar journey times for both on approach to the junction with Roseburn Terrace.

Base



Figure 2.18: Queues observed in Base

Option A

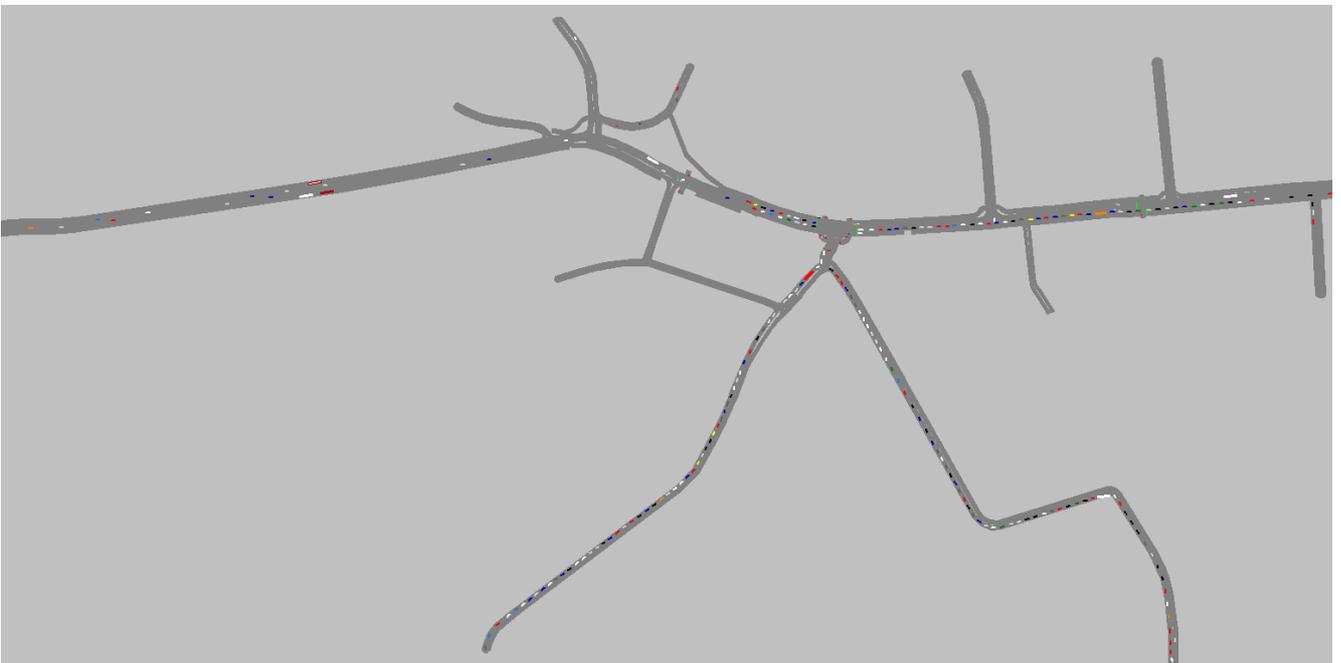


Figure 2.19: Queues observed in Option A

Option B



Figure 2.20: Queues observed in Option B

Option B2



Figure 2.21: Queues observed in Option B2

2.4 Summary

The project involves significant reallocation of road space in order to transform conditions for cycling on the corridor as well as improving the public realm and conditions for pedestrians. However, in the modelled options, journey times along the A8 corridor are only modestly increased from the base. Eastbound bus services should

be largely insulated from any increased journey times by the bus priority retained on West Coates while the introduction of a short section of bus lane on the westbound approach to the junction also minimises delays for buses. As a consequence, public transport should only be marginally affected by the proposals. A8 queue lengths are marginally longer in all options in particular with westbound queues.

Changing the priority of Russell Rd to be the main route in all proposed options resolves the difficult right turn from Russell Road to Roseburn Street and the A8. Journey times and queue lengths between both streets are more consistent as a result, albeit with significantly increased delays.

Further optimisation of traffic signals would likely result in a similar level of network performance between Options A and B.

3. Haymarket to the West End

3.1 Scheme proposals

The segregated cycle route continues eastbound past Haymarket Yards before turning into Rosebery Crescent, as shown in Figure 3.1. By avoiding Haymarket, impacts on general traffic, bus and tram are minimised, whilst providing a safe 'QuietRoutes' cycling route towards Palmerston Place and George St.

A relocated east facing taxi rank is provided on Haymarket Terrace. This extends from the bus stop, east of Rosebery Crescent, to the stop line at the Haymarket junction. Two lanes of general traffic on the approach are maintained by continuing the shared tram / traffic area to the stop line.

DECEMBER 2016 NOTE: This report reflects the August 2016 proposals - see below.

The Haymarket area modelling has not been re-run with the revised proposals following the Stakeholder Workshops in autumn 2016. This is because the impact of the scheme revisions now being pursued, particularly the partial or total relocation of the proposed taxi rank from Clifton Terrace to Morrison St, is expected to have either positive or neutral impacts on delays.

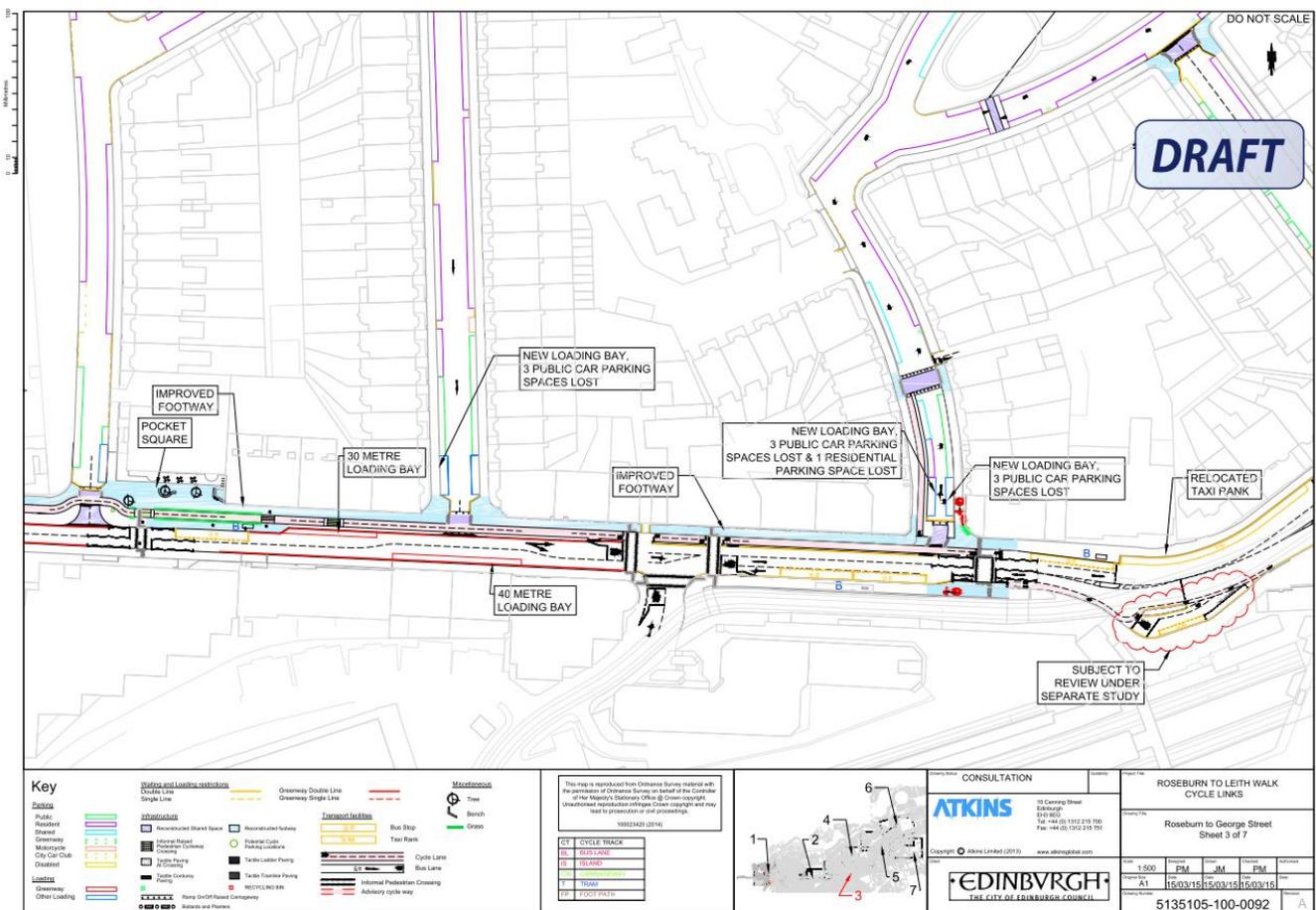


Figure 3.1: Haymarket Terrace area scheme layout

At Palmerston Place, a short section of segregated cycleway is provided before the route crosses the main carriageway into the pedestrian route adjacent to St Mary's Cathedral (Figure 3.2).

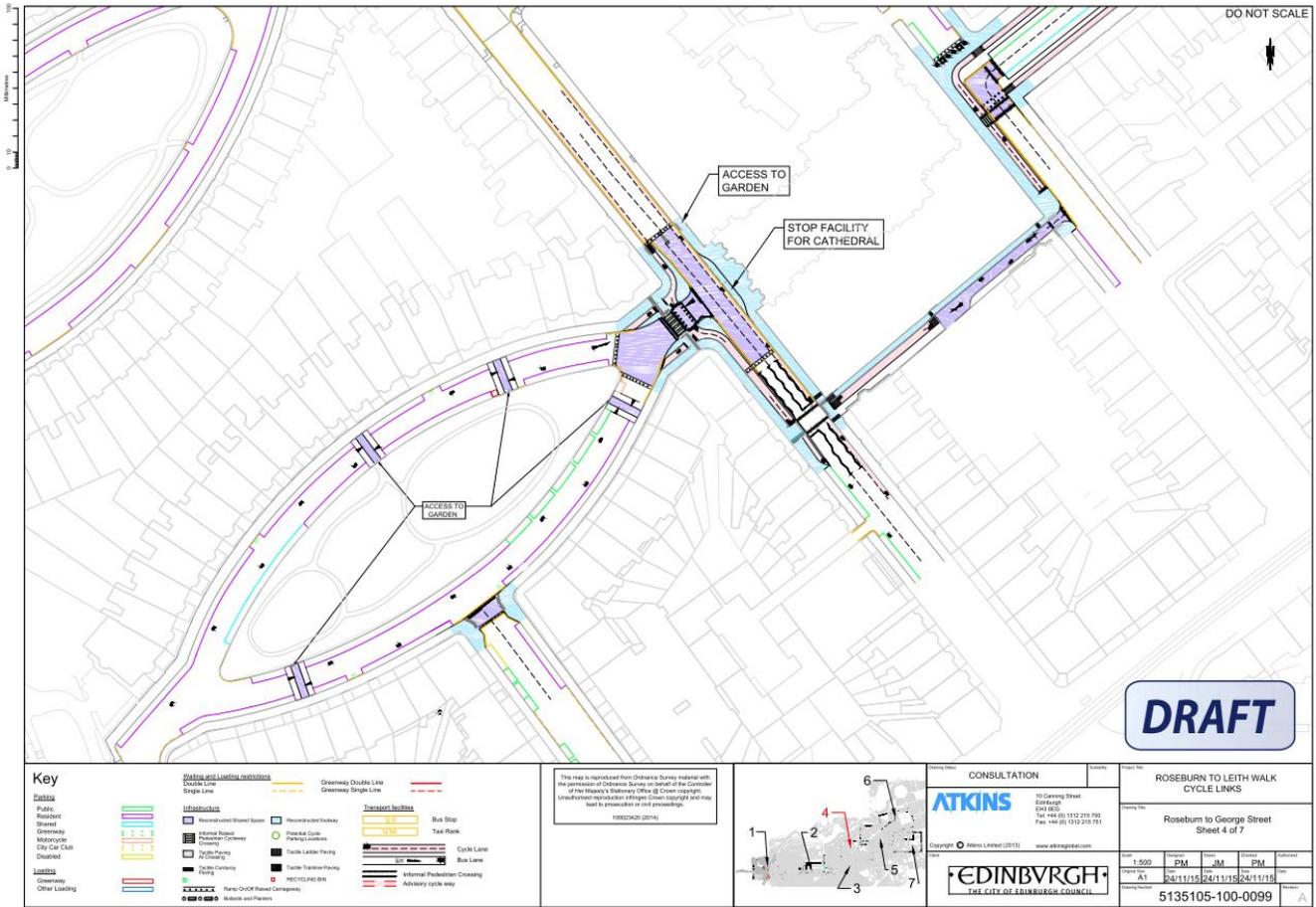


Figure 3.2: St Mary's Cathedral area scheme layout

Figure 3.3 and Figure show the proposed cycle arrangement in Melville St and Charlotte Square.

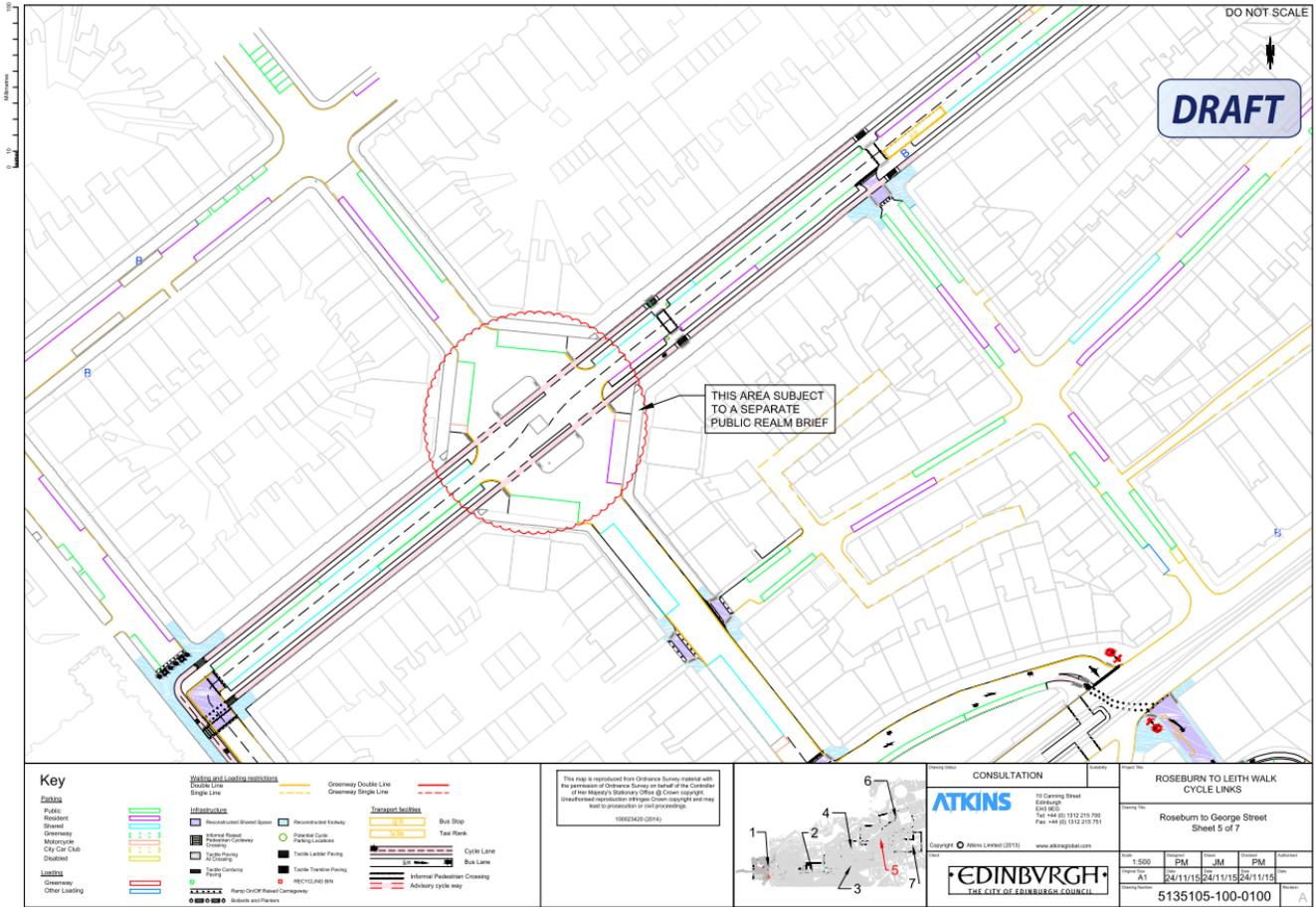


Figure 3.3: Melville Street scheme layout

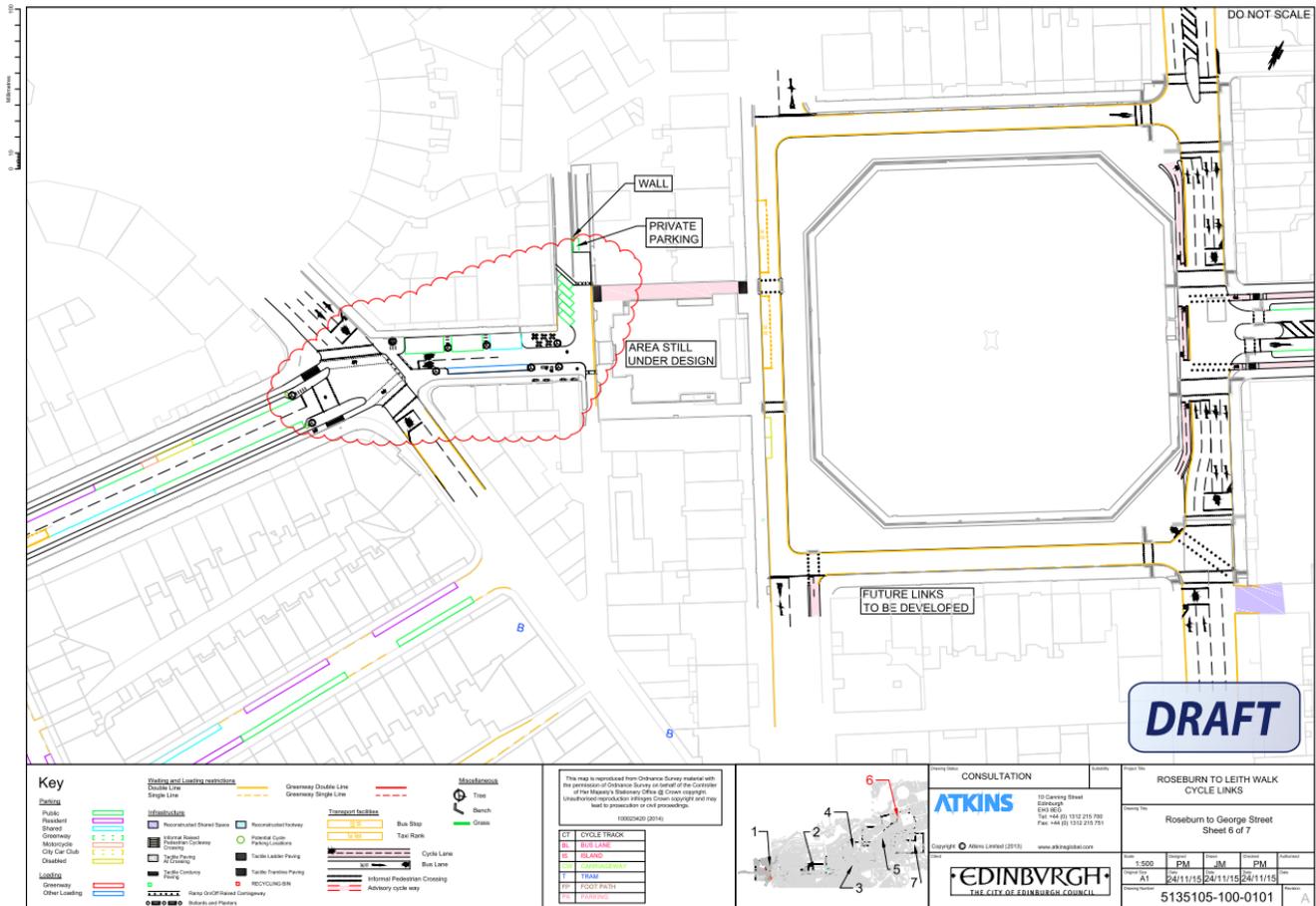


Figure 3.4: Charlotte Square area scheme layout

The proposed layout at Palmerston Place has been modelled in VISSIM but the layout through Melville St to Palmerston Place to Charlotte Square is considered to have no significant potential traffic impact and has been omitted from the modelling analysis. Any issues at the Melville St/Queensferry St junction should be resolvable at the detailed design stage.

3.2 Haymarket performance

Initial appraisal of alternative cycle route options illustrated that routing the cycle lane through the Haymarket Junction itself and eastwards along Shandwick Place would result in major delays to general traffic, buses and trams. Routing the cycleway via Rosebery Crescent significantly reduces its impacts.

Provision of the cycle lane necessitates the relocation of the taxi rank from east of Coates Gardens to east of Rosebery Crescent. This extends from the relocated bus stop to the junction stop line at the Haymarket. Two lanes of general traffic on the approach are maintained by continuing the shared tram / traffic area to the stop line.

Figure 3.5 and Figure 3.6 below show the modelled traffic conditions around Haymarket in the morning and evening peaks (at 08:45 and 17:30) following the addition of the cycle scheme.

In the morning peak, queue lengths extend beyond Magdala Crescent to the former Donaldson's school. Queues are in part caused by the Haymarket junction and in part by the fact that one eastbound bus stop is located within the main traffic lane (at Magdala). Evening peak queues are shorter, extending no further than Coates Gardens.

Forecast AM journey times increase on Haymarket Terrace (by 90 seconds) and no significant increase is forecast in the evening period (Table 3.1.). It may be that morning peak delays are overestimated by the model, given the relatively light use of the bus stop at Magdala. If detailed work suggests that such delays are likely, it should be possible to reduce or eliminate them by amending the bus stop details during the detailed design stage.



Figure 3.5: Area 2 (Haymarket) traffic conditions and queues (morning peak – 08:45)



Figure 3.6: Area 2 (Haymarket) traffic conditions and queues (evening peak – 17:30)

Table 3.1: Journey times eastbound on Haymarket Terrace

	AM	PM
Base	2:12	2:06
With cycle scheme	3:33	2:22
Additional delay	1:21	0:16

No increase in delay is forecast in either the morning or evening peak as the cycle scheme will only have a nominal impact on westbound capacity. Nevertheless, care will need to be taken in designing the westbound Haymarket bus stops in order to minimise the impact of multiple buses queuing at stops for an extended period.

3.3 West End performance

The proposed cycle measures have no impact on Palmerston Place, Melville St or across Queensferry St in either model period but Figure 3.7 and Figure 3.8 show the modelled traffic conditions around the West End in the morning and evening peaks.



Figure 3.7: Area 2 (West End) traffic conditions and queues (morning peak – 08:45)



Figure 3.8: Area 2 (West End) traffic conditions and queues (evening peak – 17:30)

4. East End

4.1 Scheme proposals

4.1.1 St Andrew Square / West Register St

Initial designs have been developed for a cycle route through St Andrew Square and West Register St towards Princes St. The general layout is shown in 4.1 but no significant potential traffic impacts are likely to result from the scheme. For this reason, it has been omitted from the VISSIM modelling analysis

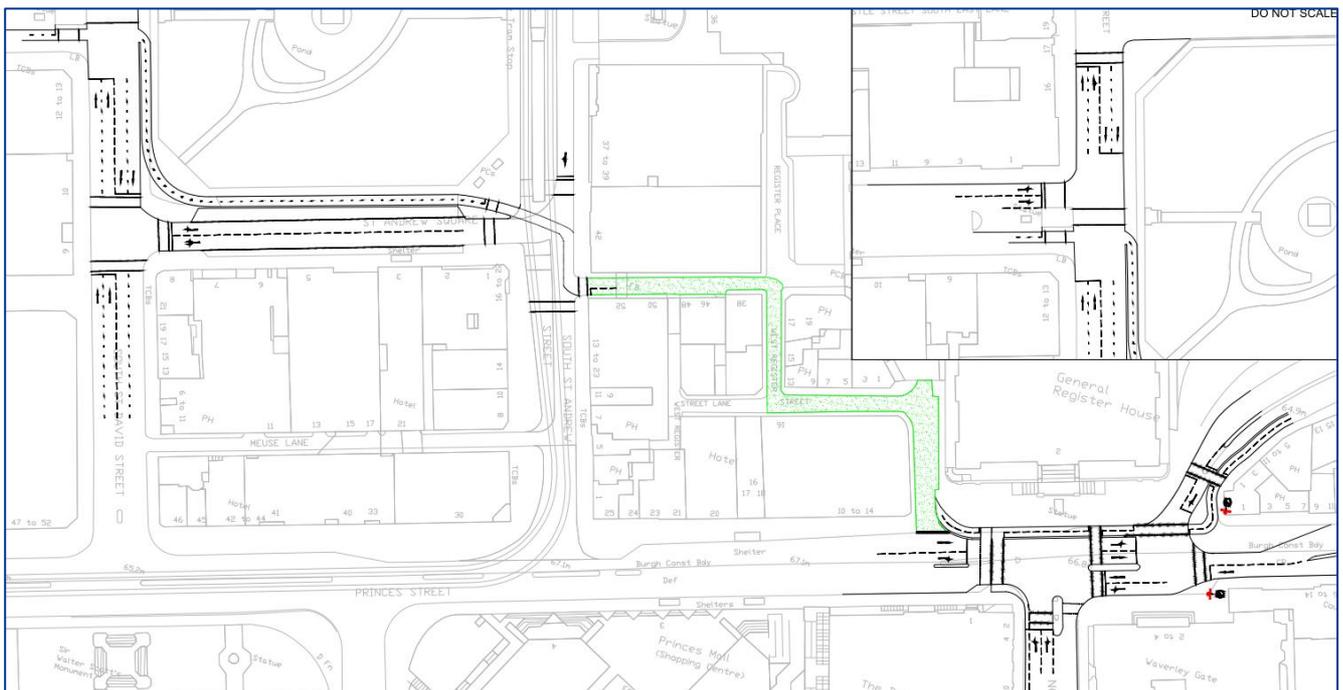


Figure 4.1: St Andrew Square / West Register St scheme layout

4.1.2 South St David St

A cycle route via South St David St and Princes St is also being considered. An indicative layout, from VISSIM, is given in Figure 9. Two alternative options have been tested:

- 1) One southbound lane on the South St David St approach to Princes St / two northbound lanes
- 2) As 1) with the addition of a short southbound flare on the South St David St approach to Princes St / one northbound lane, widening to accommodate the existing bus stop

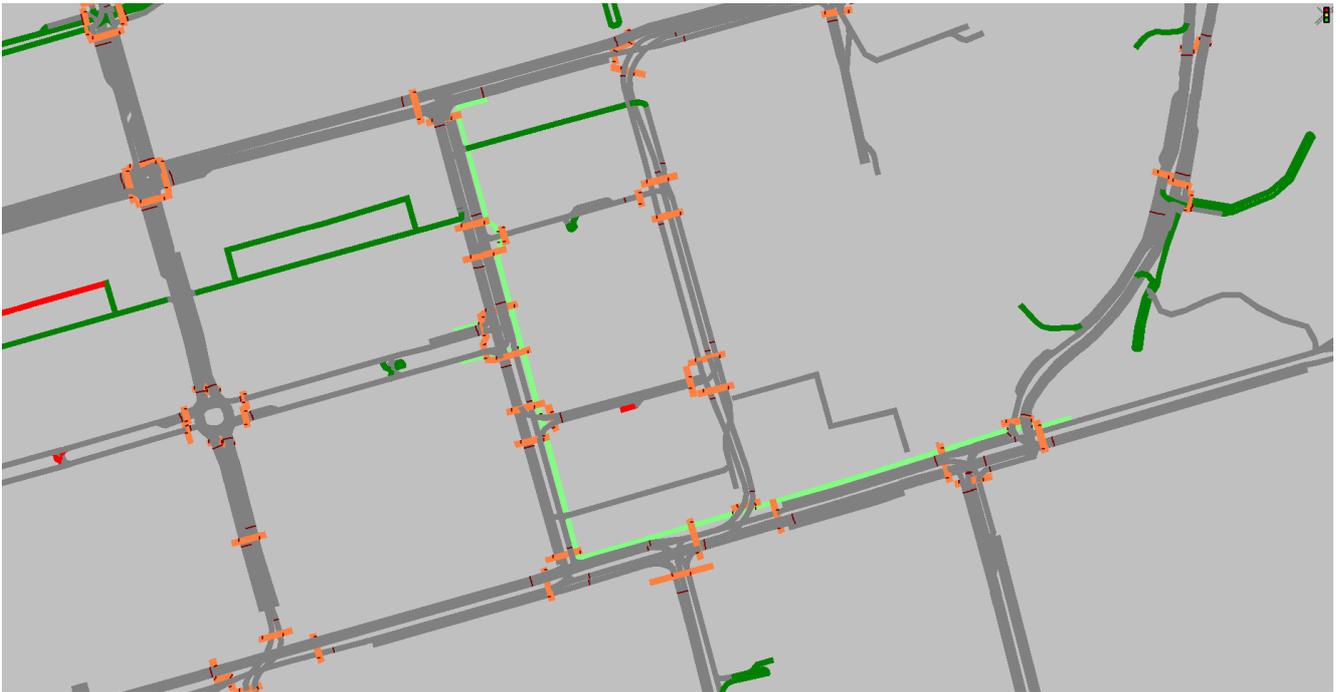


Figure 4.2: South St David St VISSIM cycle lane layout

4.1.3 East End (Princes St / North Bridge / Leith St / Waterloo Place)

An initial design has been provided by CEC for improved cycle provision at the East End. At this stage, the proposals are in sketch form and have been modelled as illustrated in Figure 4.3. In accordance with best practice, the design seeks to avoid cycle and pedestrian conflicts while maximising cyclist green times.

Key elements of the scheme are:

- A segregated two way cycle lane across the north side of the junction linking West Register Street with Waterloo Place.
- A central cycle approach lane on the North Bridge approach to Princes St, improving safety for cyclists entering the segregated cycle route and turning left towards the city centre and right to Leith St and Waterloo Place.
- Low level cycle signals at the eastbound approach to Leith St, with separate green stages, maximising cyclist green time into Leith St and across the Leith St approach towards Waterloo Place. Note that low level cycle signals have not been applied in this manner and government permission may be required.



Figure 4.3: East End scheme layout

4.1.4 York Place

A number of design options have been developed for York Place. Initial VISSIM modelling indicated that these had no impact on general traffic. Further work on this element of the scheme is being taken forward in conjunction with the Edinburgh St James Centre development.

4.1.5 St Andrew Square / West Register St and York Place

Initial testing of these proposals has been undertaken but these are now being progressed in conjunction with the Edinburgh St James development.

4.2 South St David St performance

The provision of a cycle lane on South St David St would require the removal of one southbound traffic lane. As a further option, the addition of a short southbound flare on the South St David St approach to Princes St / has also been tested. The northbound carriageway would be reduced to one lane over a short section, widening to accommodate the existing bus stop in advance of Rose St.

Figures 4.4 and 4.5 show traffic conditions in the base scenario with two full southbound lanes on the approach to Princes St. Generally, queues extend no further than the south side of St Andrew Square.

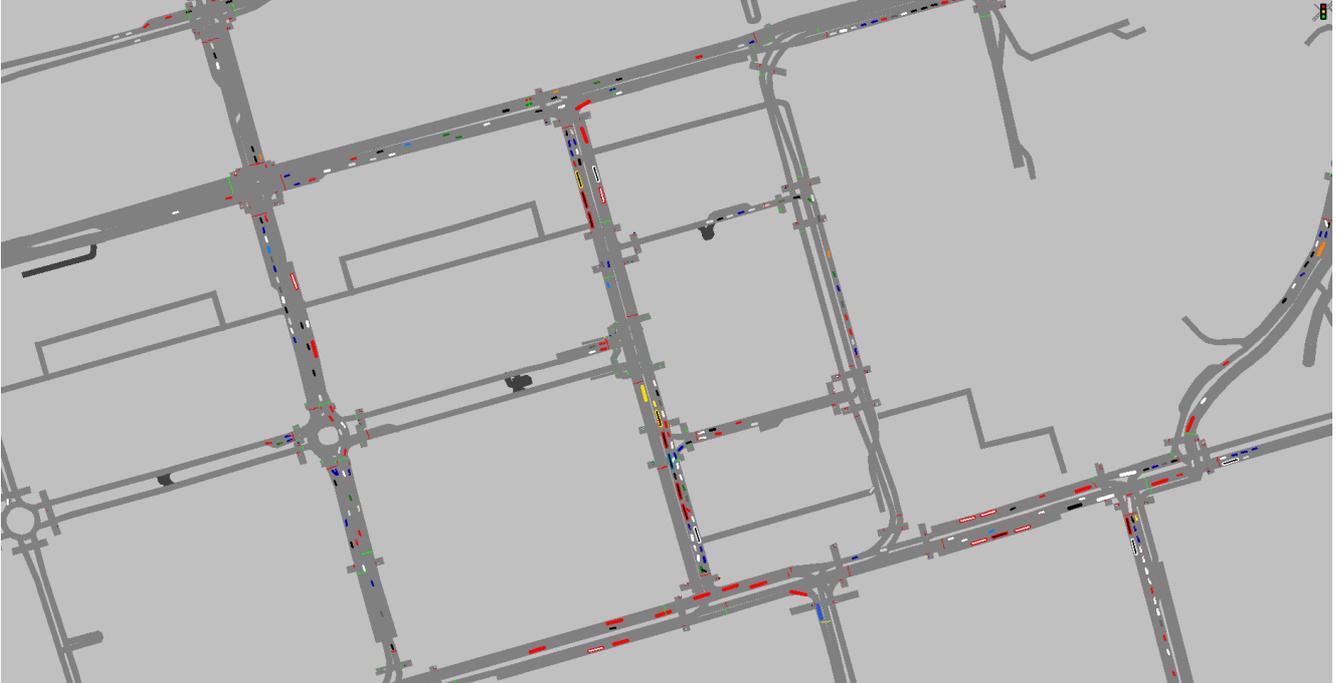


Figure 4.4: South St David St – 2 lanes 08:45

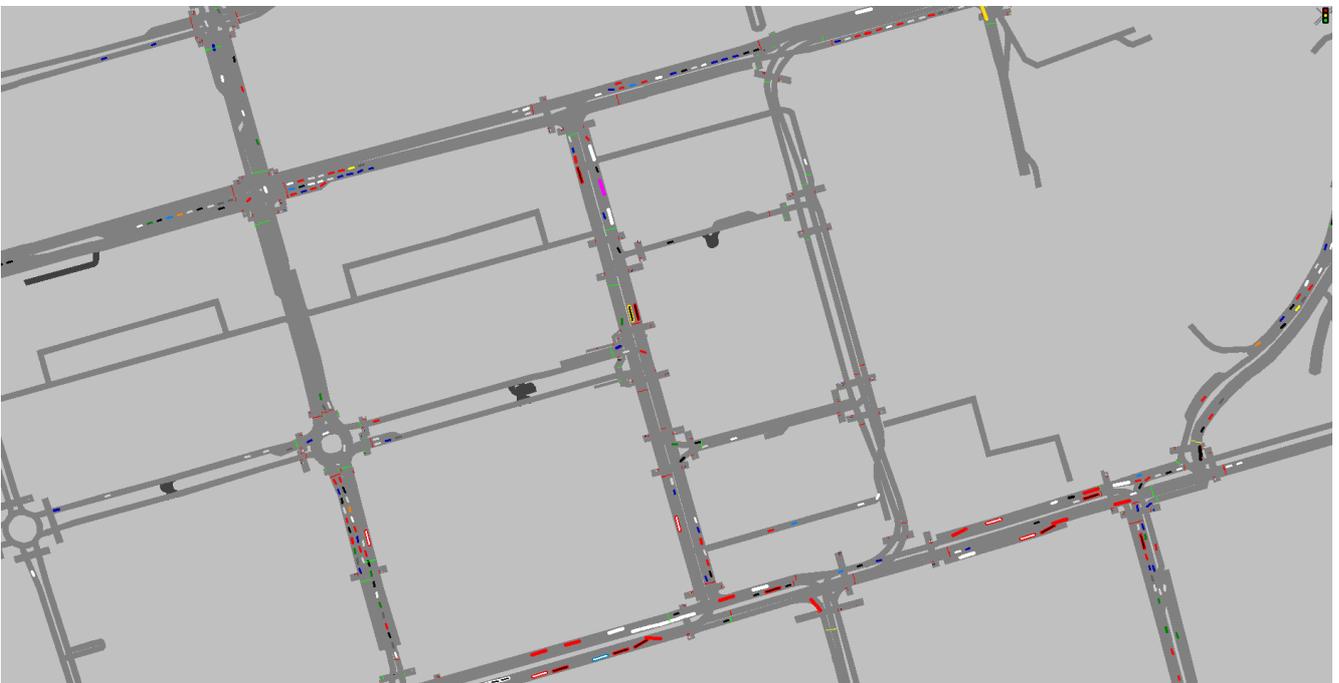


Figure 4.5: South St David St – 2 lanes 17:30

Providing only one traffic lane increases queue and delays on South St David St markedly. Unfortunately the green time available at the Princes St / South St David St junction is limited by the need to maintain tram performance.

In the morning peak, queues extend beyond the north side of St Andrew Square. The route is a major bus route and average journey times increase by 3-4 minutes.

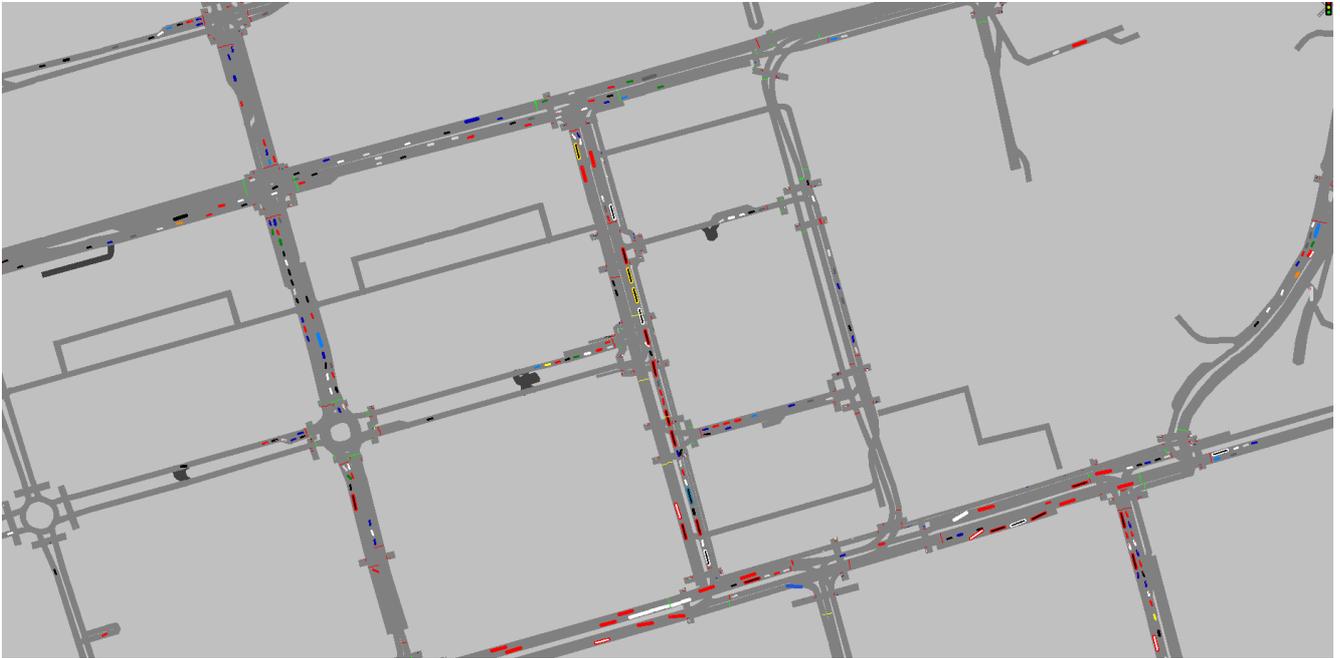


Figure 4.6: South St David St – 1 lane 08:15

Evening peak network performance is similar to the morning with long queues and delays again occurring. The green time available to South St David St traffic is again limited and bus journey times increase by in excess of 4 minutes.

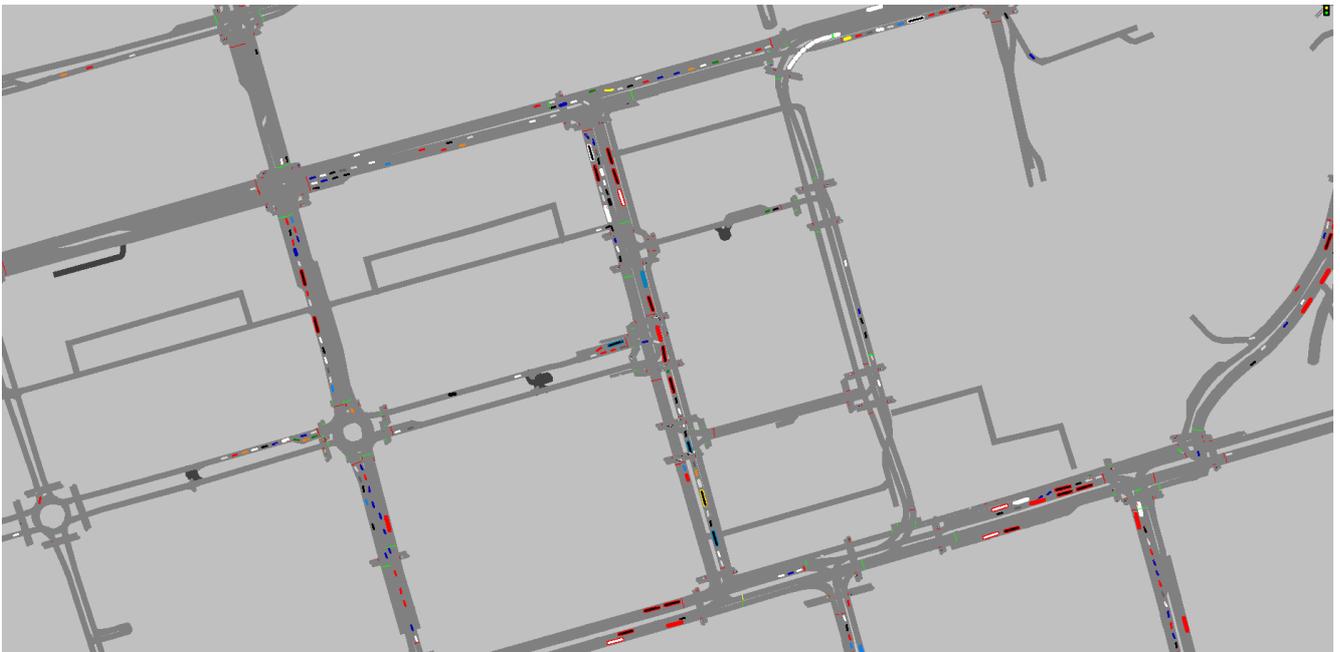


Figure 4.7: South St David St – 1 lane 17:30

The provision of a short flare length does not provide significant additional capacity. Stacking space is limited to effectively one bus length. As a result, queues and delays are largely similar to the single lane only option.

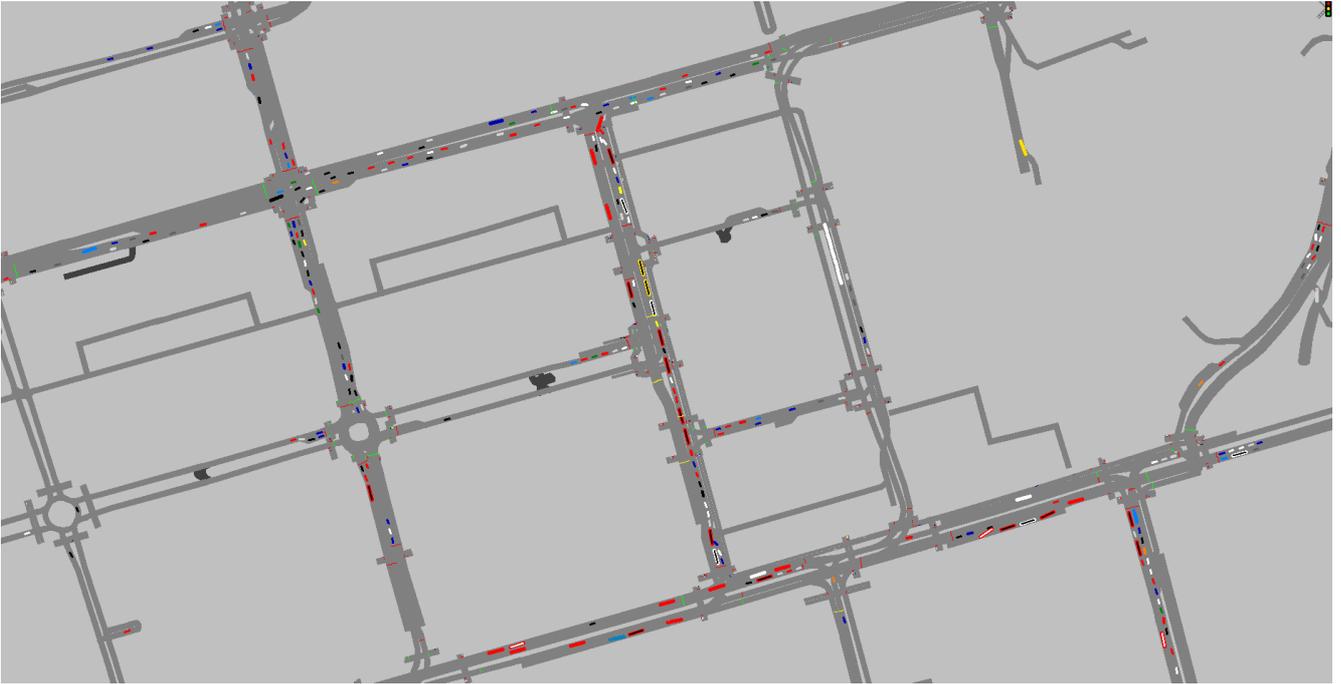


Figure 4.8: South St David St – 1 lane + flare 08:15

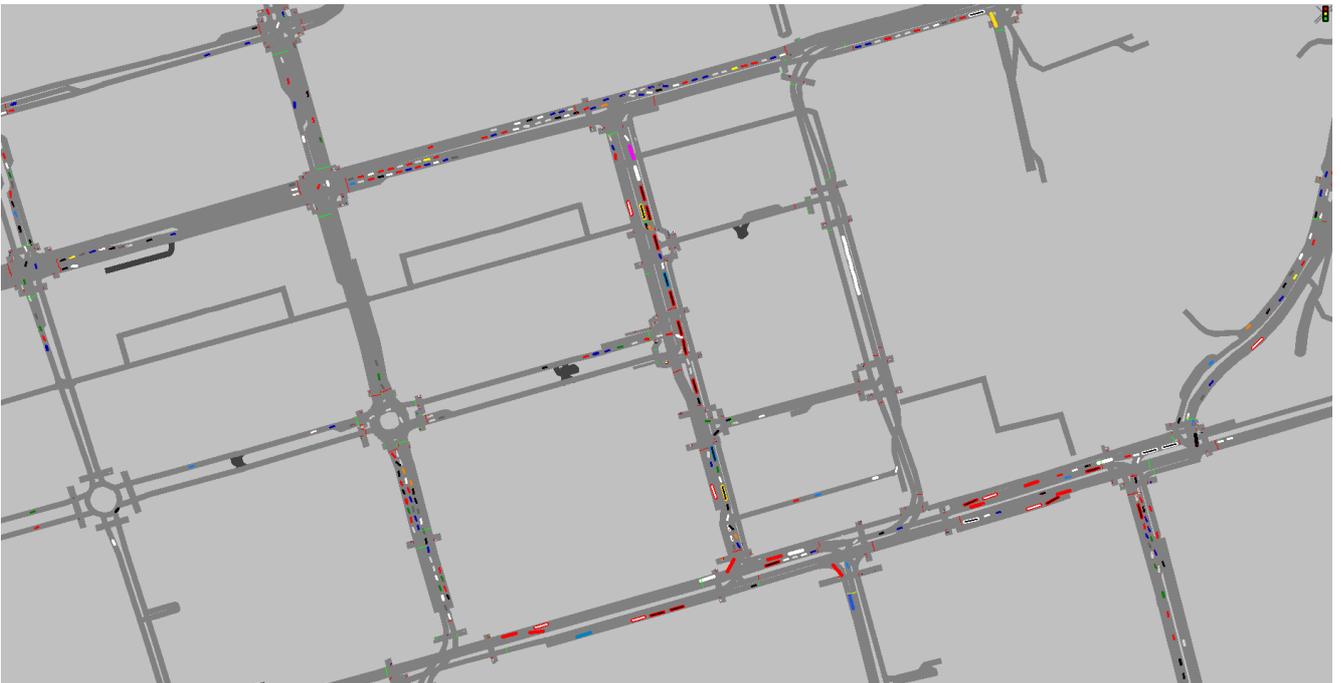


Figure 4.9: South St David St – 1 lane + flare 17:30

If the provision of a cycle lane on South St David St is to be taken forward, consideration will need to be given to reducing traffic volumes - potentially by making the link bus and local access only. This would improve locally both bus journey times and tram performance.

Previous SDS designs limited general access eastbound on Queen St and George St in order to maintain sufficient capacity at South St David St / Princes St / Waverley Bridge – see Figure 4.10. Existing traffic regulation orders support this layout and the proposal could be implemented quickly, subject to stakeholder agreement.

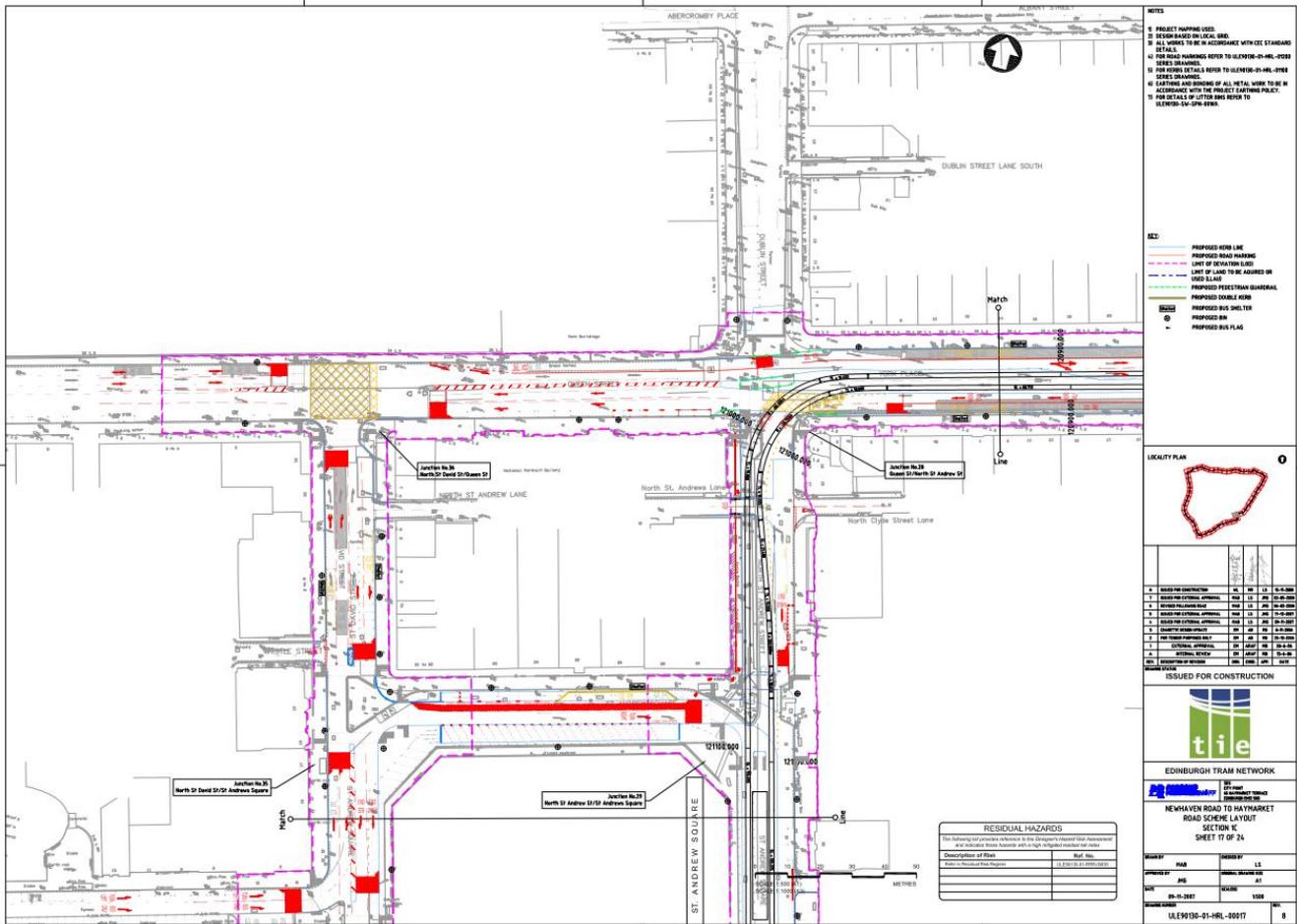


Figure 4.10: SDS design for Queen St / York Place / North St David St and George St

4.3 East End performance

These proposals have been tested in the evening peak only.

The initial designs included a pedestrian crossing across Princes St on the eastern side of North. This crossing has been omitted from the preferred design as its location severely impacts junction staging and resulting traffic capacity.

All other elements of the design can be accommodated with no significant impact on junction capacity. Figure 4.11 shows traffic conditions in the evening peak (at 17:30). Generally, the junction operates without issue; any queuing over multiple cycles results from congestion at the Princes St bus stops in front of Princes Mall, rather than as a direct result of junction capacity issues.

Queues on Princes St, North Bridge, Leith St and Waterloo Place are all similar in length to those in the base model.



Figure 4.11: SDS design for Queen St / York Place / North St David St and George St

As a sensitivity, a cycle early release test was undertaken. Cycles were given a 5 second early release on each approach. The resulting reduction in traffic capacity generated large queues on all approaches leading to model gridlock before the end of the simulation period. Consequently, this option was not explored further.

Note that it is not clear whether a 5 second cycle early release would be sufficient from a safety perspective. Instead, the test was undertaken to get an understanding of the likely impact on general traffic. Further work would be required to determine appropriate timings based on junction dimensions were this option to be pursued.

5. Summary

The design of the proposed cycle route between Roseburn and Leith walk has been developed in three sections:

- Roseburn to Haymarket
- Haymarket to the West End
- East End

Jacobs has modelled the traffic impacts of each section, helping to inform the detailed design of each area. All transport modelling has been undertaken using VISSIM software, consistent with other modelling analysis across the city centre.

In this iteration of the design, a 'QuietRoutes' compatible cycle route can be created through the city centre with only minor impacts on buses, trams and general traffic.

The main traffic impact in the Roseburn area is on Roseburn Street and Russell Rd. There is a significant increase in journey time travelling toward the A8, primarily as a result of the northbound closure of Roseburn Gardens, a busy and intended rat-run. Nevertheless, evidence from recent long periods of closure of Russell Road suggests that a high proportion of traffic is able to divert to alternative routes. Any consequential reduction in traffic on Russell Road and Roseburn Street will improve conditions for local residents, for walking and cycling, and for children accessing Roseburn Primary School.

Along West Coates, the proposed scheme has been refined with local narrowing of the two-way cycleway. Although the existing westbound bus lane now only starts from Wester Coates Road through to the Roseburn terrace junction with Roseburn Street, sufficient width is retained beyond this to allow cars and light goods vehicles to pass stationary buses, largely minimising further increases in journey times. The revised design also accommodates overnight loading.

At the Haymarket junction, forecast delays on the Haymarket Terrace approach increase by 1 minute in the morning peak; there is no significant impact in the evening peak. In order to minimise delay and congestion, two lanes of general traffic on the approach are maintained by continuing the shared tram / traffic area to the stop line. Implementation of the change will require discussion with the tram operator.

Generally, it is anticipated that forecast morning peak delays can be mitigated around Haymarket during the detailed design process, in consultation with tram and bus operators and local stakeholders.

The impact of providing a cycle lane on South St David St has been assessed. Reducing the available road space results in long queues and delays in both model periods. The route is an important bus corridor and journey times increase by 3-4 minutes. The provision of a flare lane on the approach to Princes St is ineffective as the available length is too short.

If a cycle lane on South St David St is to be pursued, it will be necessary to reduce general traffic volumes, possibly by making the link bus and local access only. This would improve both bus journey times and tram performance, although, access to the station would be reduced. An assessment of the wider impacts of the scheme may need to be considered as part of a wider city centre traffic strategy.

Initial designs for improved cycling provision at the East End have been tested and these can be implemented while maintaining adequate junction capacity. Further design and modelling is required to determine the benefit and impact of a cycle early release stage.

Appendix A. Roseburn model calibration and validation

A.1 Traffic demand

Model demands have been created from a programme of classified turning count surveys undertaken in 17 March 2016. Counts were undertaken at:

- A8 Corstorphine Rd / Murrayfield Avenue / Murrayfield Place / A8 Roseburn Terrace
- A8 Roseburn Terrace W / A8 Roseburn Terrace E / Russell Road / Roseburn Street
- Roseburn Street N / Roseburn Street S / Roseburn Place
- Roseburn Place W / Roseburn Gardens / Roseburn Place E

Separate Car, LGV and HGV matrices have been derived from the data, disaggregated by 15 minute period. The applied profile of demand is consistent with the previously developed city centre and Leith Walk VISSIM models.

In developing the model, effort has been made to represent peak hour loading which is permitted on the north side of Roseburn Terrace. Kerbside loading has been split into 5 blocks as shown in Figure 2.2. Observed loading durations on 17 March are given in Table 2.1.

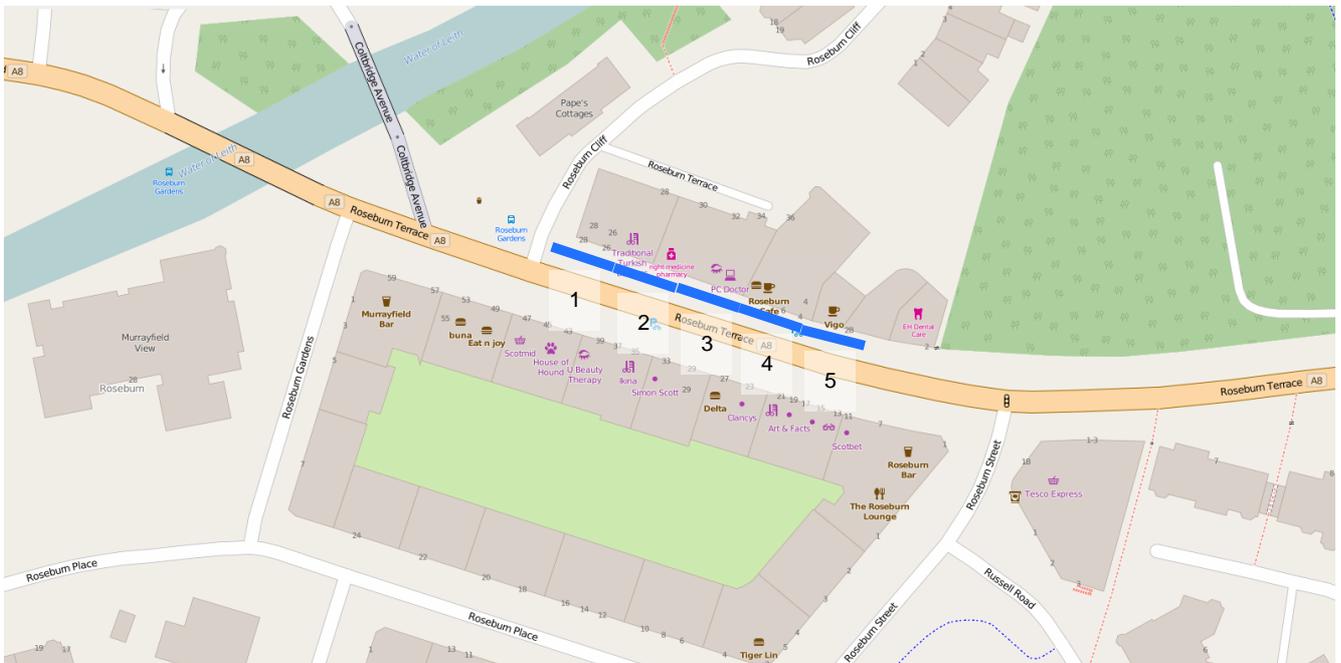


Figure A.1: Roseburn kerbside loading

Table A.1: Observed loading durations

	1	2	3	4	5
17.03.16 AM	07:45 – 07:54	08:36 - 08:40	07:45 - 07:49	07:45 - 07:52	
			08:02 - 08:03	07:56 - 08:05	
17.03.16 PM					17:28 - 17:30

A.2 Base model calibration

The adequacy of the VISSIM Model calibration has been measured against the following guidance and standards document:

- Web-based Transport Appraisal Guidance (WebTAG) unit M3.1 Highway Assignment Modelling Criteria (January 2014)¹.

Two guidance criteria measures are used:

- The GEH statistic, which is useful in comparing two different values of flow on a link. The GEH statistic is defined as:

$$GEH = \sqrt{ [(Modelled-Observed) / \{ (Observed + Modelled) / 2 \}] }.$$

- The absolute and percentage differences between modelled flows and counts.

Both measures are broadly consistent, and link and turning flows that meet either criterion should be regarded as satisfactory.

Morning and evening peak models have been calibrated to the survey data, as summarised in Tables A.2 and A.3 below.

Generally, a high level of correlation between observed and modelled values has been achieved. All turning counts meet Percentage Difference criteria in both model periods. Approximately 97% of turning counts meet the GEH criteria in the morning peak, 91% meet the same criteria in the evening.

A.3 Base model validation

Models have validated to queue length surveys undertaken on the same day as the turning counts – Tables A.4 and A.5. Comparing observed and modelled queue lengths is difficult as there are not set criteria to define a queue. As an example, a rolling queue may be observed as a queue along its full length, while the model outputs will ignore it as the speed criteria is too fast.

In VISSIM, a queue is registered once vehicle speeds drop before 5kph and ends once its speed exceeds 10kph.

¹ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/427124/webtag-tag-unit-m3-1-highway-assignment-modelling.pdf#nameddest=chptr03

Table A.2 : AM model calibration

			Observed		Modelled		Difference		GEH					
			Car	Total	Car	Total	Car	Total	Car	Total	Car	Total	Car	Total
Roseburn Terrace	to	Murrayfield Pl	1	1	6	5.8	480%	480%	✓	✓	2.6	2.6	✓	✓
Roseburn Terrace	to	Murrayfield Ave	246	267	185	197	-25%	-26%	✓	✓	4.1	4.6	✓	✓
Roseburn Terrace	to	Corstorphine Rd	519	624	578	707	11%	13%	✓	✓	2.5	3.2	✓	✓
Murrayfield Pl	to	Roseburn Terrace	76	80	79	79	4%	-2%	✓	✓	0.3	0.1	✓	✓
Murrayfield Pl	to	Murrayfield Ave	16	17	3	3	-79%	-80%	✓	✓	4.0	4.3	✓	✓
Murrayfield Pl	to	Corstorphine Rd	12	14	9	10	-23%	-30%	✓	✓	0.9	1.2	✓	✓
Murrayfield Ave	to	Roseburn Terrace	172	190	122	134	-29%	-29%	✓	✓	4.1	4.4	✓	✓
Murrayfield Ave	to	Murrayfield Pl	30	33	32	32.4	8%	-2%	✓	✓	0.4	0.1	✓	✓
Murrayfield Ave	to	Corstorphine Rd	45	46	46	53	2%	16%	✓	✓	0.1	1.0	✓	✓
Corstorphine Rd	to	Roseburn Terrace	562	732	628	788	12%	8%	✓	✓	2.7	2.0	✓	✓
Corstorphine Rd	to	Murrayfield Pl	3	3	0	0	-100%	-100%	✓	✓	2.4	2.4	✓	✓
Corstorphine Rd	to	Murrayfield Ave	108	115	115	135	6%	17%	✓	✓	0.6	1.8	✓	✓
Roseburn Terrace (East)	to	Russell Rd	24	31	49	50.4	105%	63%	✓	✓	4.2	3.0	✓	✓
Roseburn Terrace (East)	to	Roseburn St	52	60	45	55	-14%	-8%	✓	✓	1.0	0.7	✓	✓
Roseburn Terrace (East)	to	Roseburn Terrace (West)	350	435	369	471	5%	8%	✓	✓	1.0	1.7	✓	✓
Russell Rd	to	Roseburn Terrace (East)	39	51	24	28	-37%	-45%	✓	✓	2.6	3.7	✓	✓
Russell Rd	to	Roseburn St	228	263	193	211	-15%	-20%	✓	✓	2.4	3.4	✓	✓
Russell Rd	to	Roseburn Terrace (West)	78	89	81	84	3%	-6%	✓	✓	0.3	0.6	✓	✓
Roseburn St	to	Roseburn Terrace (East)	120	142	115	155.8	-5%	10%	✓	✓	0.5	1.1	✓	✓
Roseburn St	to	Russell Rd	31	45	38	37.8	22%	-16%	✓	✓	1.2	1.1	✓	✓
Roseburn St	to	Roseburn Terrace (West)	99	108	60	68	-39%	-37%	✓	✓	4.3	4.3	✓	✓
Roseburn Terrace (West)	to	Roseburn Terrace (East)	478	629	503	643	5%	2%	✓	✓	1.1	0.5	✓	✓
Roseburn Terrace (West)	to	Russell Rd	192	221	183	197	-5%	-11%	✓	✓	0.7	1.7	✓	✓
Roseburn Terrace (West)	to	Roseburn St	150	162	142	159	-5%	-2%	✓	✓	0.7	0.3	✓	✓
Roseburn St N	to	Roseburn Pl	196	220	162	173.2	-17%	-21%	✓	✓	2.6	3.3	✓	✓
Roseburn St N	to	Roseburn St S	229	258	219	252	-5%	-2%	✓	✓	0.7	0.4	✓	✓
Roseburn Pl	to	Roseburn St N	12	12	10	10	-15%	-15%	✓	✓	0.5	0.5	✓	✓
Roseburn Pl	to	Roseburn St S	6	6	2	3	-67%	-43%	✓	✓	2.0	1.2	✓	✓
Roseburn St S	to	Roseburn St N	234	277	203	251	-13%	-9%	✓	✓	2.1	1.6	✓	✓
Roseburn St S	to	Roseburn Pl	51	54	103	113	101%	109%	✓	✓	5.9	6.4	✗	✗
Roseburn Pl E	to	Roseburn Gdns	228	252	241	255.4	6%	1%	✓	✓	0.9	0.2	✓	✓
Roseburn Pl E	to	Roseburn Pl W	26	26	23	30	-12%	16%	✓	✓	0.6	0.8	✓	✓
Roseburn Gdns	to	Roseburn Pl E	7	7	0	0	-100%	-100%	✓	✓	3.7	3.7	✓	✓
Roseburn Gdns	to	Roseburn Pl W	5	5	2	3	-60%	-32%	✓	✓	1.6	0.8	✓	✓
Roseburn Pl W	to	Roseburn Pl E	18	18	12	14	-32%	-24%	✓	✓	1.5	1.1	✓	✓
Roseburn Pl W	to	Roseburn Gdns	19	19	20	35	3%	82%	✓	✓	0.1	3.0	✓	✓

Table A.3 : PM model calibration

			Observed		Modelled		Difference		GEH					
			Car	Total	Car	Total	Car	Total	Car	Total	Car	Total	Car	Total
Roseburn Terrace	to	Murrayfield Pl	5	5	6.6	6.6	32%	32%	✓	✓	0.7	0.7	✓	✓
Roseburn Terrace	to	Murrayfield Ave	186	194	190.8	192.8	3%	-1%	✓	✓	0.3	0.1	✓	✓
Roseburn Terrace	to	Corstorphine Rd	731	851	738.8	866.4	1%	2%	✓	✓	0.3	0.5	✓	✓
Murrayfield Pl	to	Roseburn Terrace	58	59	57	58	-2%	-2%	✓	✓	0.1	0.1	✓	✓
Murrayfield Pl	to	Murrayfield Ave	13	13	9	9	-31%	-31%	✓	✓	1.2	1.2	✓	✓
Murrayfield Pl	to	Corstorphine Rd	13	14	9.2	10	-29%	-29%	✓	✓	1.1	1.2	✓	✓
Murrayfield Ave	to	Roseburn Terrace	156	159	127.8	137.8	-18%	-13%	✓	✓	2.4	1.7	✓	✓
Murrayfield Ave	to	Murrayfield Pl	18	20	8	8	-56%	-60%	✓	✓	2.8	3.2	✓	✓
Murrayfield Ave	to	Corstorphine Rd	36	40	39.8	46.2	11%	16%	✓	✓	0.6	0.9	✓	✓
Corstorphine Rd	to	Roseburn Terrace	481	550	524.6	617.4	9%	12%	✓	✓	1.9	2.8	✓	✓
Corstorphine Rd	to	Murrayfield Pl	7	7	0	0	-100%	-100%	✓	✓	3.7	3.7	✓	✓
Corstorphine Rd	to	Murrayfield Ave	71	76	90.6	101.6	28%	34%	✓	✓	2.2	2.7	✓	✓
Roseburn Terrace (East)	to	Russell Rd	45	50	31.6	32.6	-30%	-35%	✓	✓	2.2	2.7	✓	✓
Roseburn Terrace (East)	to	Roseburn St	69	77	85.8	100	24%	30%	✓	✓	1.9	2.4	✓	✓
Roseburn Terrace (East)	to	Roseburn Terrace (West)	469	560	530.2	639.8	13%	14%	✓	✓	2.7	3.3	✓	✓
Russell Rd	to	Roseburn Terrace (East)	31	35	12.2	13.2	-61%	-62%	✓	✓	4.0	4.4	✓	✓
Russell Rd	to	Roseburn St	202	225	181.2	186	-10%	-17%	✓	✓	1.5	2.7	✓	✓
Russell Rd	to	Roseburn Terrace (West)	78	88	93.2	94	19%	7%	✓	✓	1.6	0.6	✓	✓
Roseburn St	to	Roseburn Terrace (East)	84	88	81.4	97.8	-3%	11%	✓	✓	0.3	1.0	✓	✓
Roseburn St	to	Russell Rd	43	46	56.8	58	32%	26%	✓	✓	2.0	1.7	✓	✓
Roseburn St	to	Roseburn Terrace (West)	158	168	82.4	86.6	-48%	-48%	✓	✓	6.9	7.2	✗	✗
Roseburn Terrace (West)	to	Roseburn Terrace (East)	386	439	392.8	480.8	2%	10%	✓	✓	0.3	1.9	✓	✓
Roseburn Terrace (West)	to	Russell Rd	214	220	223.8	229	5%	4%	✓	✓	0.7	0.6	✓	✓
Roseburn Terrace (West)	to	Roseburn St	84	95	89	100	6%	5%	✓	✓	0.5	0.5	✓	✓
Roseburn St N	to	Roseburn Pl	186	200	136.2	142.6	-27%	-29%	✓	✓	3.9	4.4	✓	✓
Roseburn St N	to	Roseburn St S	166	195	220.2	243.8	33%	25%	✓	✓	3.9	3.3	✓	✓
Roseburn Pl	to	Roseburn St N	16	17	1	2.4	-94%	-86%	✓	✓	5.1	4.7	✗	✓
Roseburn Pl	to	Roseburn St S	9	9	4.2	5.6	-53%	-38%	✓	✓	1.9	1.3	✓	✓
Roseburn St S	to	Roseburn St N	264	280	219.8	240	-17%	-14%	✓	✓	2.8	2.5	✓	✓
Roseburn St S	to	Roseburn Pl	51	54	93	96.8	82%	79%	✓	✓	4.9	4.9	✓	✓
Roseburn Pl E	to	Roseburn Gdns	225	244	213.8	219.8	-5%	-10%	✓	✓	0.8	1.6	✓	✓
Roseburn Pl E	to	Roseburn Pl W	9	9	15	19.2	67%	113%	✓	✓	1.7	2.7	✓	✓
Roseburn Gdns	to	Roseburn Pl E	12	13	0	0	-100%	-100%	✓	✓	4.9	5.1	✓	✗
Roseburn Gdns	to	Roseburn Pl W	3	3	1	2	-67%	-33%	✓	✓	1.4	0.6	✓	✓
Roseburn Pl W	to	Roseburn Pl E	8	9	5.2	8	-35%	-11%	✓	✓	1.1	0.3	✓	✓
Roseburn Pl W	to	Roseburn Gdns	13	13	17.8	27.8	37%	114%	✓	✓	1.2	3.3	✓	✓

Table A.4 : AM observed and modelled queue lengths (vehicles)

	Roseburn Ter / Roseburn St				Roseburn Ter / Murrayfield Ave				
	Roseburn Street	Roseburn Terrace West (Eastbound)	Roseburn Terrace East (Westbound)	Russell Road	Roseburn Terrace (Westbound)	Corstorphine Road (Eastbound)	Murrayfield Avenue (Southbound)	Murrayfield Place (Westbound)	
Observed									
08:15	1	4	19	3	2	5	18	5	
08:30	2	3	11	3	3	7	8	8	
08:45	3	2	11	3	1	5	5	8	
09:00	4	3	5	3	1	2	1	3	
Modelled									
08:15	1	5	9	7	6	5	8	7	
08:30	2	4	11	9	6	9	8	10	
08:45	3	3	11	5	7	6	17	16	
09:00	4	2	8	5	3	3	19	9	

Table A.5 : PM observed and modelled queue lengths (vehicles)

	Roseburn Ter / Roseburn St				Roseburn Ter / Murrayfield Ave				
	Roseburn Street	Roseburn Terrace West (Eastbound)	Roseburn Terrace East (Westbound)	Russell Road	Roseburn Terrace (Westbound)	Corstorphine Road (Eastbound)	Murrayfield Avenue (Southbound)	Murrayfield Place (Westbound)	
Observed									
17:15	3	10	3	2	1	0	0	0	
17:30	3	12	5	1	3	1	1	0	
17:45	3	19	3	3	3	3	1	0	
18:00	2	12	4	1	2	0	0	0	
Modelled									
17:15	3	9	6	7	3	3	7	1	
17:30	2	10	6	7	6	9	10	1	
17:45	4	9	5	4	3	13	12	2	
18:00	4	8	5	6	3	15	2	1	