Aberdeen Access from the South Appendix C

Aberdeen City Council, Aberdeenshire Council, Nestrans

Short Term (2008) S-Paramics Testing

SHORT TERM (2008) S-PARAMICS TESTING

Description:

Aberdeen Access from the South Appendix C

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1 INTRODUCTION

1.1 Purpose of Report

SIAS Limited was commissioned by Aberdeen City Council (ACC) to provide traffic modelling support and advice with regard to Aberdeen Access from the South Study.

This technical report details the short term option testing considered for the Aberdeen Access from the South Study.

The short term testing forms the initial part of a structured testing regime to consider measures to improve access to Aberdeen from the South for:

- Short term testing – 2008

The following stages will be considered in future technical reports:

- Medium term testing – 2012 with Aberdeen Western Peripheral Route (Appendix D)
- Long term testing – 2027 with Aberdeen Western Peripheral Route (Appendix E)

1.2 Structure of Report

Following this brief introduction, Chapter 2 discusses the development of the short term 2008 Do-Minimum model and the schedule of short term testing. Chapters 3 and 4 provide initial results for the packages of measures considered with Chapter 5 providing more detailed statistics. Chapter 6 provides the short term summary and conclusions.

2 DEVELOPMENT OF SHORT TERM OPTIONS 2008

2.1 Short Term Do-Minimum Model

The short term Do-Minimum model is based on the 2004 Base model infrastructure, with the addition of dualling from Charleston to Souterhead on the A956 which is under construction at time of writing.

The short term Do-Minimum model represents an assessment year of 2008 and growth was derived from the Aberdeen Sub Area Model (ASAM3b) model using an interpolation procedure between 2005 and 2012. Details of growth are reported in the ASAM3b iteration technical report (Appendix A).

The growth from the 2004 base model applied using ASAM3b forecasts to form the 2008 future year models is summarised as follows for the AM and PM peak periods:

- AM Peak 2004 Base 31475 vehicles growth of 3.7% (1175 vehicles) to 2008 giving 32650 vehicles in 2008
- PM peak 2004 base 40496 vehicles with growth of 3.2% (1292 vehicles) to 2008 giving 41788 vehicles in 2008

2.2 Schedule of Short Term Option Testing

A workshop, involving key stakeholders, was held on 6th March 2007 to develop further ideas for short, medium and long term options. An option sifting process was then carried out which involved scoring each of the possible options generated at the workshop against the key planning objectives, to ascertain which options met the objectives.

Options were then assessed for their ability to be tested using the S-Paramics models, and short term options which met the appropriate criteria were grouped into work packages.

The packages of short term (2008) option testing for application within the S-Paramics model were discussed between Aberdeen City Council, Nestrans and SIAS to ensure focused testing and agreement, prior to undertaking any network evaluation.

The meeting was conducted at St Nicholas House, Aberdeen on 12th July 2007 and resulted in three key short term packages being outlined for consideration. This study focuses mainly on traffic modelling output and to that end, options identified at the stakeholder workshops were considered initially as to whether they could be modelled or not.

Packages have been developed in a layered approach aiming, in the first instance, to assess key areas, and evaluate the performance/success of options considered, before progressing to the next package which will seek benefits in additional areas of the network.

The options which could be considered for short term improvements and traffic modelling were combined into four packages as described in Table 2.1 below.

Table 2.1 : Short Term Packages Considered

Reference	Package	Description	Rationale
Base	Base 04	JMP Validated Base 04	Provides a comparitive base to existing conditions
Do-Min	Do Min 2008	2008 forecast demand	Provides an assessment baseline for comparison
1	P 1	Local junction improvements. Signalisation, Left slip lanes, remarking	Completed over a number of sensitivity tests to evaluate the merits of each measure considered. Designed to improve the use of existing road capacity.
2	P2	Lane reduction on Bridge of Dee Southbound.	To aid HGV flow from Great Southern Road to Stonehaven Road through managing the circulating flow from Bridge of Dee into a single lane
3	P3	HGV/Bus lane on Great Southern Road between Bridge of Dee and King George VI Bridge	To reduce delay to freight traffic as a result of the existing width restriction on Bridge of Dee in the short term
4	P4	Increased roundabout diameter on Northside of King George VI Bridge	To aid HGVs having to route away from Bridge of Dee due to the width restriction make the right turn from Riverside Drive to King George VUI Bridge as efficiently as possible

- Package 1 forms the main package and investigates a range of measures designed to improve use of existing road capacity, such as signalisation of roundabouts, increased signalisation at junctions, segregated left turn lanes and remarking of roundabout lanes
- Package 2 carries forward measures considered successful from the Package 1 testing and investigates measures to provide easier egress for HGVs from Great Southern Road (southbound) through managing the circulating flow from Bridge of Dee into a single lane
- Package 3 carries forward the best from the Package 1 and Package 2 testing and assesses the performance of an HGV/Bus lane on Great Southern Road between Bridge of Dee and King George VI Bridge
- Package 4 adopts the best performing option from the previous packages to assess the performance of a new large roundabout on the northern side of King George VI Bridge to aid the movement of commercial traffic

Figure 2.1 identifies the bridges, roundabouts and roads which are the subject of the short term measures.

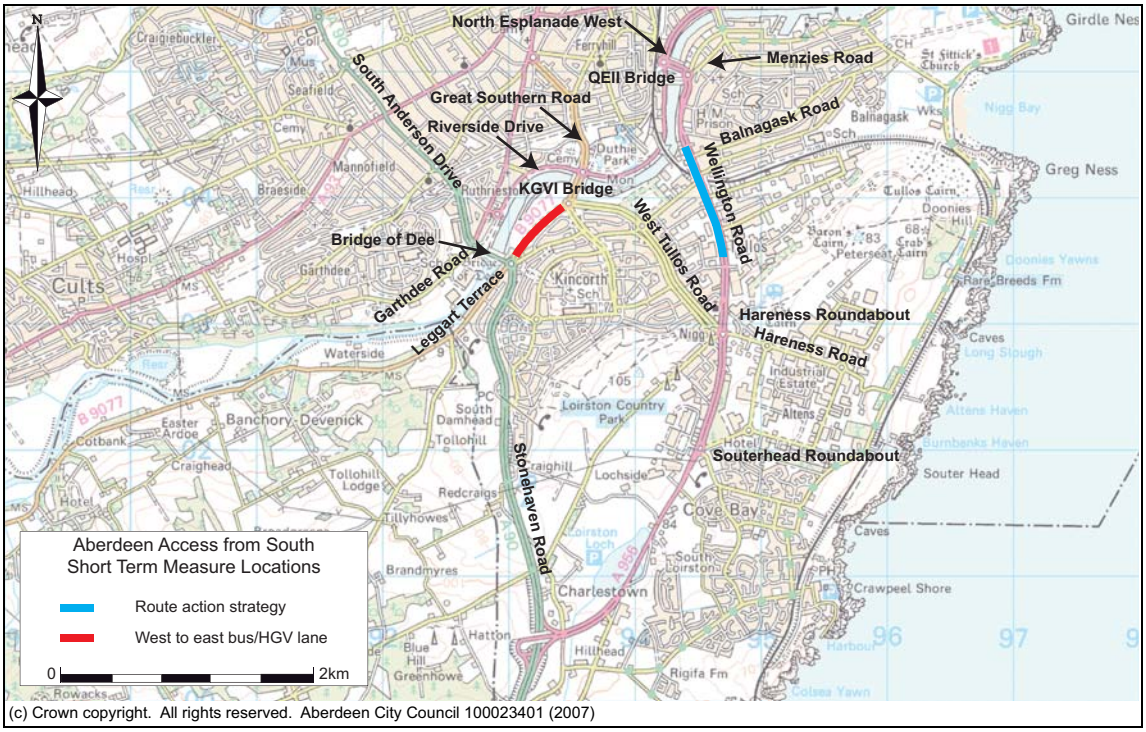

Figure 2.1 : Locations of Short Term Measures

2.3 Additional Short Term Measures not Modelled

Additional measures, which were unsuitable for model testing, were suggested by stakeholders during the workshops. These have been initially scored in the option appraisal tables (some positive, some negative) in Appendix B but excluded from the overall appraisal. The measures for the medium term include::

- Public transport subsidy at peak times
- Prevent rat running through Torry and other residential areas
- Improve public transport access to East and West Tullos Industrial estates
- Travel management organisation for the Altens, Tullos and Cove areas to implement green travel plan initiatives
- Westbound Trinity Quay traffic signals. Maintain Trinity Quay southbound phase even when Guild Street has green
- Wellington Road Southbound, consider signal adjustment to allow for speed and acceleration of HGVs

Some of these additional suggestions are reflective of other elements within the Regional and Local Transport Strategies and the delivery of these strategies can provide additional benefit.

3 PACKAGE 1

3.1 Introduction

Package 1 combines a range of short term measures designed to try to improve the operation of the road network by improved use of the existing road capacity, such as part signalisation of roundabouts, increased signalisation at junctions, segregated left turn lanes, and remarking of roundabout lanes.

3.2 Aims

Package 1 consists of seven key measures, each with a specific aim:

- Part signalisation of Bridge of Dee roundabouts

  This measure aims to improve the priority of traffic flow through the Bridge of Dee roundabouts using part time signals on key arms to control traffic flow.

- Segregated left turn lanes from Great Southern Road to King George VI Bridge, and other roundabouts

  This measure aims to improve the flow at the southern bridges of the Bridge of Dee and King George VI Bridge by removing an element of circulating traffic.

- Hareness Roundabout segregated left turn lanes

  This measure aims to improve the flow at Hareness roundabout by removing an element of circulating traffic.

- Abbotswell Crescent left in/left out to Wellington rd and West Tullos Rd

  This measure aims to improve the operation of the existing Abbotswell Crescent junction with West Tullos Rd making easier egress for public transport.

- Souterhead Roundabout increased signalisation

  This measure aims to improve pedestrian crossing provision and also improve traffic flow at this location.

- Remark QEII Bridge southern roundabout to be dedicated left and right turn lanes across bridge

  This measure aims to improve egress from Menzies Road through allowing only a single lane to cut across from QEII Bridge to Wellington Road.

- Wellington Road route action strategy

  This measure aims to resolve any signal timing details or junction configurations and identify any opportunities for further optimisation.

3.3 Package 1 Model Testing

Due to the number of different measures involved, a total of nine tests were carried out for Package 1, as shown in Table 3.1.

Package 1 incorporated the small scale short term measures which, on an initial desktop evaluation, were judged as likely to provide some benefits at key locations. The operation of Package 1 was evaluated and the areas which were shown to provide no benefit were removed from the model incrementally. This resulted in a total of nine scenarios for Package 1.

Table 3.1 : Package 1 Tests

Package 1	Scenario
Package 1-1	All Package 1 components
Package 1-2	As 1-1, with signals at BOD South rdbt, Bridge arm signals removed
Package 1-3	As 1-1, with signals at BOD South rdbt, A90 arm signals removed
Package 1-4	As 1-1, with all signals at BOD South rdbt removed
Package 1-5	As 1-4, with segregated left turn from Riverside Drive to KGVI Bridge removed
Package 1-6	As 1-5, with signals at Wellington Rd northbound at Souterhead rdbt removed
Package 1-7	As 1-6, with no remarking of QEII South rdbt lanes
Package 1-8	As 1-7 with signal optimisation at Souterhead rdbt and Balnagask Rd, PM peak
Package 1-9	As 1-8 with signals at BOD North rdt removed

3.3.1 Part Signalisation of Bridge of Dee Roundabouts (Package 1-1 to 1-4)

Part time traffic signals were considered for key arms on the Bridge of Dee Roundabouts in order to improve the priority of movements through the Bridge of Dee. However, the size of the roundabouts restricts the number of arms which can be signalised due to the lack of stacking capacity on the circulating carriageway. For this reason the A90 and Bridge of Dee arms of both roundabouts were identified as the most suitable for signalisation.

Signal timings were calculated from forecast demand traffic flows, shown in Figure 3.1 and Figure 3.2. These demand traffic flows are calculated from the traffic matrices applied within the model. These flows assume the network is operating at its optimum and each junction can accommodate the predicted traffic flows. There is no influence of congestion, or rerouting away from congested areas, accounted for within these forecast demand flows.

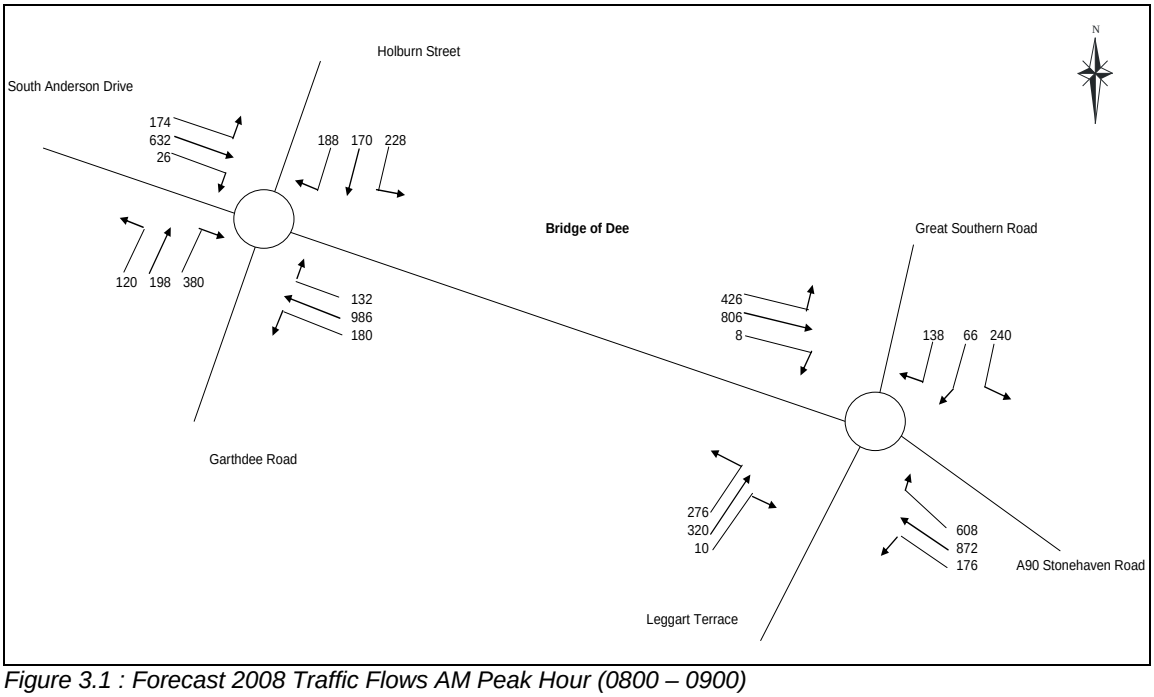

Figure 3.1 : Forecast 2008 Traffic Flows AM Peak Hour (0800 – 0900)

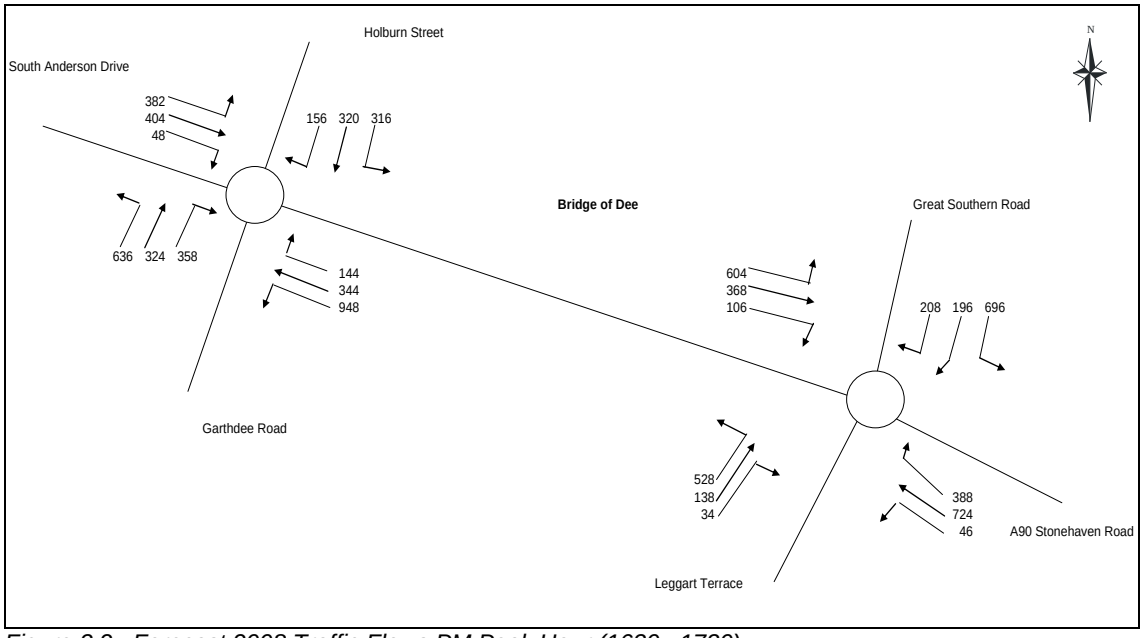

Figure 3.2 : Forecast 2008 Traffic Flows PM Peak Hour (1630 –1730)

To accommodate the part signalisation of the southern roundabout of the Bridge of Dee, the following lane allocations were assumed for Leggart Terrace and the A90 northbound. Additional pedestrian crossings could not be facilitated at either roundabout due to the partial signal control.

- Leggart Terrace : lane 1 left turn only; lane 2 ahead and right
- A90 from Stonehaven : lane 1 left and ahead; lane 2 right turn only

Initial testing (Package 1-1) included traffic signals on the A90, and Bridge of Dee arms of both Bridge of Dee roundabouts. In the AM period this resulted in significant queueing on Leggart Terrace, Holburn Street and the A90 Northbound from the Bridge of Dee. In the PM period queueing is observed on Leggart Terrace and A90 Northbound.

The effect of traffic signals at the Northern Roundabout of the Bridge of Dee is that the A90 Southbound queue can be better managed, but queueing is observed on Holburn Street extending back to Riverside Drive and on Garthdee Road. The release of the southbound queue results in traffic reaching the Southern Roundabout with less delay and causes increased congestion in that area.

The signals on the Bridge of Dee arm of the Southern Roundabout were removed (Package 1-2) and the model operation observed. In the AM period significant queueing is observed on Leggart Terrace and the A90 Northbound and on Holburn Street extending back to Riverside Drive. Queueing is also observed on Garthdee Road. In the PM period queueing is observed on Leggart Terrace, the A90 Northbound, and on Holburn Street extending back to Riverside Drive.

Traffic signals were then modelled on the Bridge of Dee arm instead of the A90 arm of the Southern Roundabout (Package 1-3). In the AM period significant queueing was observed on Leggart Terrace and the A90 Northbound, and on Holburn Street extending back to Riverside Drive and on Garthdee Road. In the PM period queueing was observed on the A90 Northbound and Leggart Terrace.

Traffic signals were then completely removed from the Southern Roundabout (Package 1-4) as no benefit was observed from their introduction. In the AM period queueing is still observed on Leggart Terrace, Garthdee Road and A90 northbound but not to the same degree as when the southern roundabout was signalised, as the lane markings were returned to their original layout allowing two lanes ahead from Leggart Terrace to Great Southern Road. In the PM period queueing is observed on Leggart Terrace.

Traffic signals were then removed from the north roundabout of the Bridge of Dee. Although signals at this location did help the southbound flow of traffic from South Anderson Drive, significant congestion was caused on Garthdee Road and Holburn Street. It is concluded that within the current road geometry no signals should be introduced at the Bridge of Dee. Package 1-9 accounts for this.

3.3.2 Segregated Left Turn Lanes

Predicted traffic flows were analysed to assess which turns would benefit from a segregated left turn lane. All segregated left turn lanes were included from Package 1-1 to Package 1-4. The turns which, based on flow, a segregated left turn lane could be considered to benefit were:

- Great Southern Rd to Stonehaven Rd at Bridge of Dee
- Great Southern Rd to King George VI Bridge
- King George VI Bridge to West Tullos Rd
- Riverside Drive to King George VI Bridge

Forecast 2008 demand traffic flows for the selected four locations are shown in Figures 3.3 to 3.5.

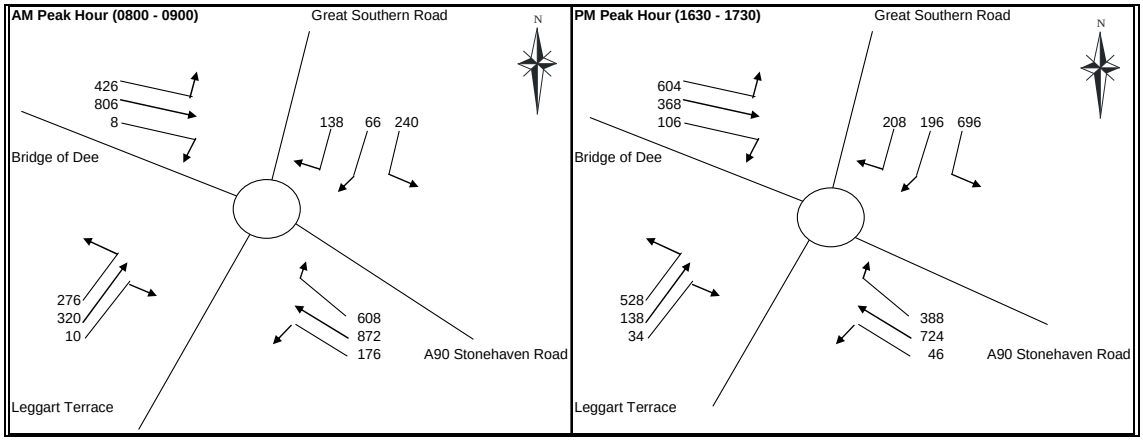

Figure 3.3 : Traffic flows for Great Southern Rd to Stonehaven Rd at Bridge of Dee

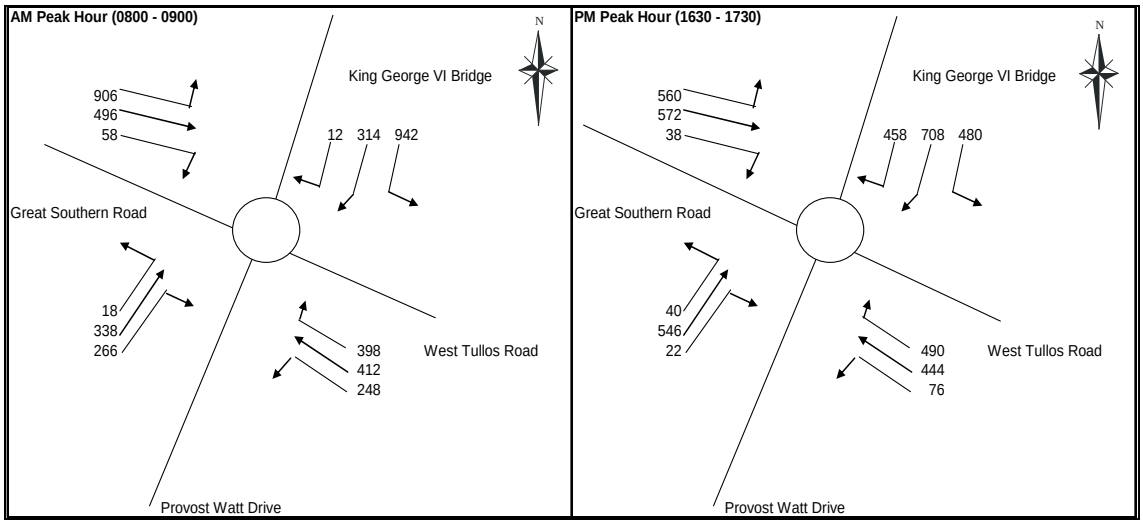

Figure 3.4 : Traffic flows for Great Southern Rd to KGVI Bridge and KGVI Bridge to West Tullos Rd

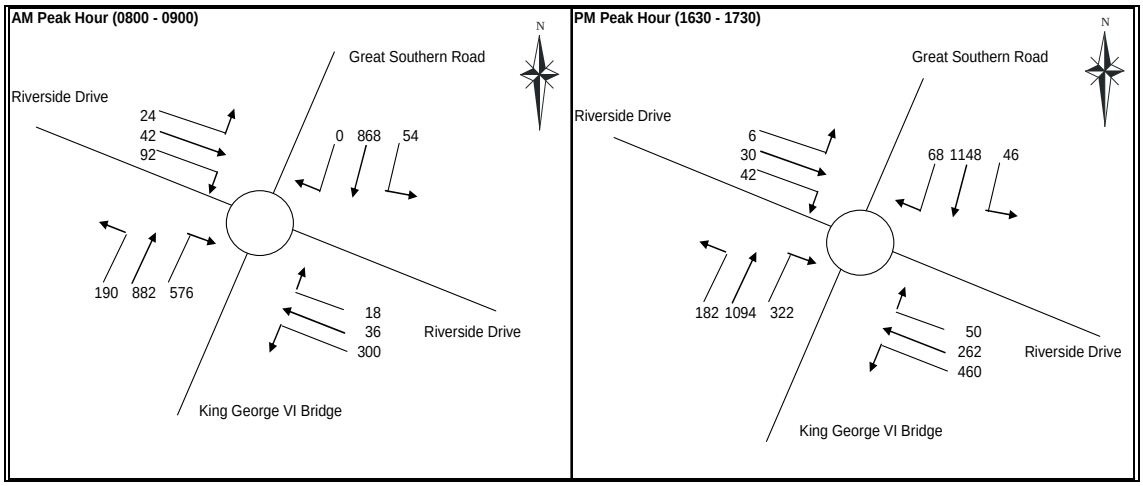

Figure 3.5 : Traffic flows for Riverside Drive to KGVI Bridge

Land restrictions were considered using OS maps and a site visit. Two of the suggested four left turn lanes appear to have the available land capacity for a segregated left turn as an additional lane. Figure 3.6 to Figure 3.9 illustrates the preliminary designs.

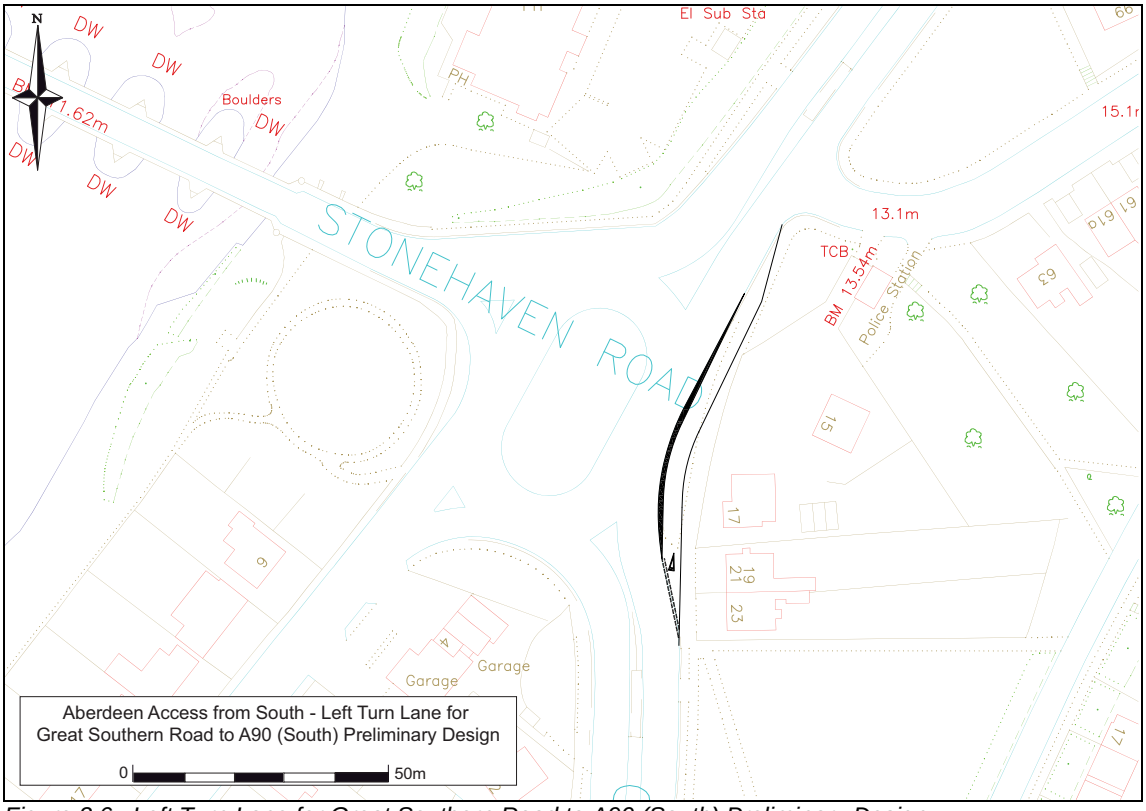

Figure 3.6 : Left Turn Lane for Great Southern Road to A90 (South) Preliminary Design

Figure 3.6 illustrates that fitting a left turn lane within the exiting highway boundary is difficult. In order to maintain footway widths land may be required from existing property.

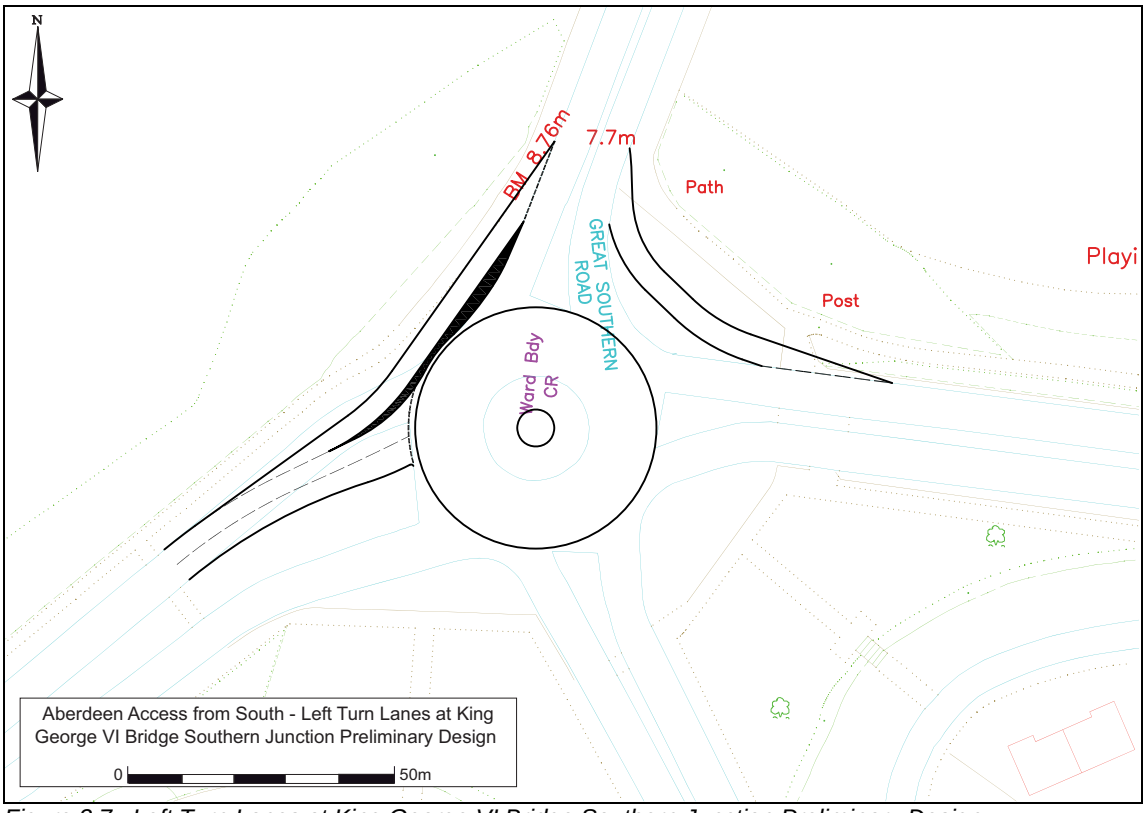

Figure 3.7 : Left Turn Lanes at King George VI Bridge Southern Junction Preliminary Design

At the Great Southern Road to King George VI Bridge southern junction, the left turn lane could be accommodated in the available space. In order to keep a two lane exit onto the bridge, the left turn lane would be a give way when it joins the bridge. Without a two lane exit significant queueing is observed on Provost Watt Drive northbound.

There also appears to be space to accommodate a segregated left turn lane from King George VI Bridge to West Tullos Road. The pedestrian crossing facilities on West Tullos Road would require to be moved further east.

A segregated left turn lane from Great Southern Road to Stonehaven Road may require some land currently occupied by a property. The merge with Stonehaven Road is a give way junction. The pedestrian crossing facilities on Stonehaven Road would require to be moved further south. Where the left turn lane joins Stonehaven Road is a give way junction. This design is similar to Broxden Roundabout in Perth.

The final location, Riverside Drive to King George VI Bridge, is restricted by the bridge and would need to accommodate the segregated left turn lane in the existing road capacity. This left turn lane would require the southbound traffic on Great Southern Road approach to the roundabout to be restricted to one lane, due to one of the exit lanes on King George VI Bridge being used for the left turn lane. The pedestrian crossing facilities on Riverside Drive would be required to move further east. It is not considered viable to incorporate a segregated left turn lane at this location without a significant re-design of the junction and it has been omitted from future modelling consideration.

The first three segregated left turn lanes were observed to provide benefits to the network. The fourth (Riverside Drive to KGVI Bridge) resulted in significant queueing on Great Southern Road due to this southbound movement through the roundabout being reduced to one lane. It was concluded that the segregated left turn lane from Riverside Drive to King George the VI Bridge provided no benefits and should not be carried forward to the next stage of testing (Package 1-5). The remaining three segregated left turn lanes were incorporated into all remaining test scenarios.

3.3.3 Hareness Roundabout – Segregated Left Turn Lanes and Increased Flare (All Packages)

In order to improve the flow at Hareness Roundabout, a segregated left turn lane from Wellington Road southbound to Hareness Road has been introduced. Desired peak hour traffic flows for this location are shown in Figure 3.8.

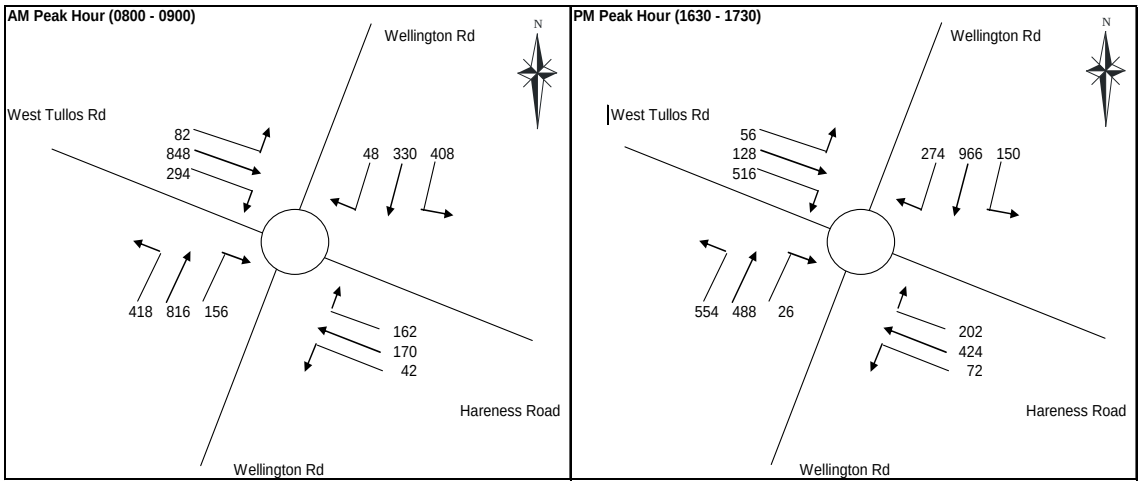

Figure 3.8 : Hareness Peak Hour Traffic Flows

Due to safety concerns over the point at which the slip lane merges with Hareness Road (the exit from the roundabout is two lanes), the preliminary design has been designed as a give way. Figure 3.9 illustrates the space a left turn slip from Wellington Rd (North) to Hareness Road would take.

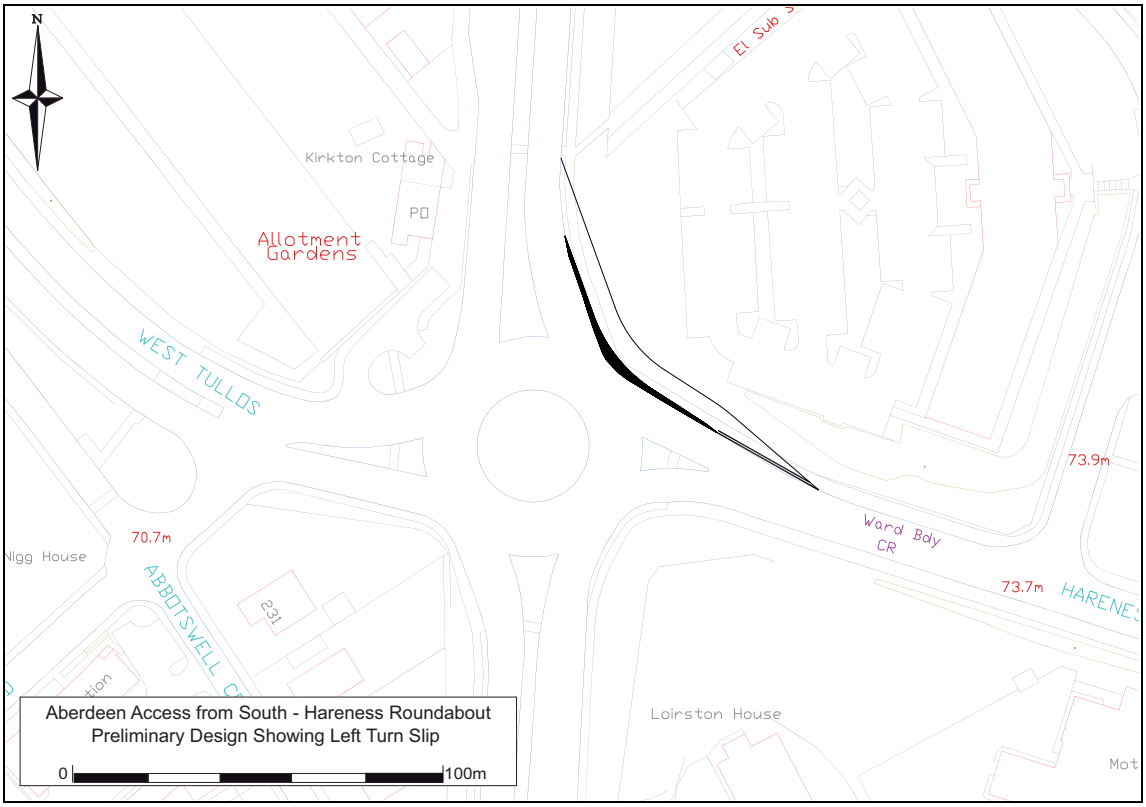

Figure 3.9 : Hareness Roundabout Preliminary Design Showing Left Turn Slip

The segregated left turn lane reduces queueing on Wellington Road southbound, and as a result some queueing is observed on Hareness Road in the PM peak due to an increased southbound cutting movement.

A segregated left turn lane from Wellington Road to West Tullos Road is not possible due to the proximity of the junction with Abbotswell Crescent. However, the three lane section of the Wellington Road northbound approach to the roundabout has been lengthened by approximately 30m.

3.3.4 Abbotswell Crescent Left In/ Left Out to Wellington Rd and West Tullos Rd (All Packages)

In order to improve the operation of the existing Abbotswell junction with West Tullos Road, particularly for easier public transport egress, the junction has been changed to left in and left out from West Tullos Road. The current problem with buses blocking the West Tullos Road exit from the roundabout is shown in Figure 3.10.

Figure 3.10 : Current Problem on West Tullos Road

The cul-de-sac at the south end of Abbotswell Crescent was tested as being opened to allow a left in and left out junction with Wellington Road. This new through section to the south east of Redmoss Road has been modelled as bus only.

There are several concerns associated with this element of Package 1:

- Local residents concern over buses using this section of Abbotswell Crescent
- The width of this section of Abbotswell Crescent may not be suitable for buses
- The height difference between the end of Abbotswell Crescent and Wellington Road
- There is currently a pedestrian/cycle link between Abbotswell Crescent and Wellington Road at this location that would require to be retained

As a result of Abbotswell Crescent being left in/ left out to West Tullos Road some queueing is observed on Redmoss Road in the AM period.

3.3.5 Souterhead Roundabout (Package 1-6)

Traffic signals have been introduced on Wellington Road northbound at Souterhead Roundabout (Southern Arm) in Package 1-6 to improve traffic flow at this location, particularly in the AM peak. Providing traffic signals at this point, in addition to the existing part time traffic signals on the roundabout would allow pedestrian movement across the roundabout from east to west.

Traffic signals at this location result in a modelled queue of approximately 600m on Wellington Road at 08:30, which reduces to approximately 300m when the signals are removed and as a result the measure has been omitted from future tests.

3.3.6 QEII Bridge, Southern Roundabout (Package 1-7)

In Package 1-7, lanes were remarked to allow left and ahead in left lane and right only in right lane off bridge, in order to improve egress from Menzies Road through allowing only a single lane to cut across from QEII Bridge to Wellington Road.

This lane remarking results in significant queueing on North Esplanade West and South College Street, reaching a modelled peak of approximately 600 unreleased vehicles in the AM peak and 60 unreleased vehicles in the PM peak. It has not been considered for future option testing.

3.3.7 Wellington Road (Package 1-8)

A site visit was undertaken on Tuesday 24th July 2007 to identify any opportunities for optimisation of the Wellington Road corridor. Due to the school holidays the area was not congested and fewer traffic problems than normal were observed.

At the junction of Wellington Road/ Balnagask Road/ Somerfield, the right turn phase for traffic turning from Wellington Road northbound to Balnagask Road or Wellington Road southbound to Somerfield is called every cycle, even when no traffic is waiting to turn right. Resolving this issue to make it an on-demand stage would give more time to the main Wellington Road movement when possible.

At the junction of Wellington Road/ Glencraft (Aberdeen Royal Workshops for the Blind), the right turns from Wellington Road southbound to Glencraft and Wellington Road northbound to Greenbank Road come on together as stage 2 every cycle. As the volume of traffic turning into Glencraft is small, if no traffic is waiting to turn right into Glencraft the time could be given to the entire northbound flow. This would allow the right turn into Greenbank Road and also give some additional green time to the northbound Wellington Road traffic.

Some benefits could be realised through the removal of local accesses off Wellington Road i.e. the access to the garage opposite Somerfield has been noted to cause delays during peak periods. Access at this location could be contained within Balnagask Road.

The bus lanes on Wellington Road were seen to be used by other vehicles. Clearer marking may help prevent this.

Package 1-8 was observed to see if any additional improvements could be made. As a result, optimisation of signal timings in the model was undertaken at two locations in the PM peak:

- Balnagask Road/ Wellington Road/ Somerfield Junction
- Souterhead Roundabout, existing signalised arms

At the junction of Balnagask Road/ Wellington Road/ Somerfield, in the model the northbound stage had an early cut off. In the PM peak this was changed so that the southbound stage had the early cut off, as the northbound flow is higher than the southbound flow in the PM peak.

At Souterhead Roundabout signal timings were adjusted to allow more time to Souterhead Road, in order to reduce the significant queueing on this arm.

3.4 Package 1-9, Removal of Bridge of Dee/Holburn Street Signal Control

Package 1-9 was the final test for Package 1. The feasibility of options on Wellington Road and King George VI Bridge were evaluated during Packages 1-1 to 1-8. Packages 1-5 to 1-8 had retained traffic signals at the northern roundabout of Bridge of Dee. Observations of Package 1-8 highlighted significant queueing and congestion on both Holburn Street and Garthdee Road as a result of the signal operation. It is concluded that no signals be introduced at the Bridge of Dee and Package 1-9 accounts for there removal.

The final schedule of testing undertaken for Package 1 is provided in Table 3.2 to clarify where specific options were included or omitted.

Table 3.2 : Package 1 Schedule of Testing

Short Term Package Components	**1**-1	**1**-2	**1**-3	**1**-4	**1**-5	**1**-6	**1**-7	**1**-8	**1**-9
Traffic Signals on A90 NB approach to BOD North Rdbt	✓	✓	✓	✓	✓	✓	✓	✓	
Traffic Signals on A90 SB approach to BOD North Rdbt	✓	✓	✓	✓	✓	✓	✓	✓	
Traffic Signals on A90 NB approach to BOD South Rdbt	✓	✓							
Traffic Signals on A90 SB approach to BOD South Rdbt	✓		✓						
Segregated left turn lane Great Southern Road to Stonehaven Road	✓	✓	✓	✓	✓	✓	✓	✓	✓
Segregated left turn lane Great Southern Road to KGVI Bridge	✓	✓	✓	✓	✓	✓	✓	✓	✓
Segregated left turn lane KGVI Bridge to West Tullos Road	✓	✓	✓	✓	✓	✓	✓	✓	✓
Segregated left turn lane Riverside Drive to KGVI Bridge	✓	✓	✓	✓					
Segregated left turn lane Wellington Road to Hareness Road	✓	✓	✓	✓	✓	✓	✓	✓	✓
Extension of 3 lane Wellington Rd NB approach to Hareness Rdbt	✓	✓	✓	✓	✓	✓	✓	✓	✓
Abbotswell Crescent left in/ left out to Wellington and West Tullos Rd	✓	✓	✓	✓	✓	✓	✓	✓	✓
Souterhead Rdbt signals on Wellington Rd NB approach	✓	✓	✓	✓	✓				
Remarking of lanes QEII Bridge Southern Rdbt	✓	✓	✓	✓	✓	✓			
Signal adjustments at Souterhead Rdbt								✓	✓
Signal adjustments at Balnagask Rd/ Somerfield Junction								✓	✓

3.5 Network Performance (Package 1)

3.5.1 General Network Statistics

The mean travel time was extracted from all the scenarios tested, as a general indicator of network performance and congestion. Table 3.3 shows the mean travel time for the AM and PM peaks based on an average of five S-Paramics model runs.

Table 3.3 : General Network Statistics

AM Scenario	Mean Travel Time (min:sec)	Mean Speed (mph)
2004 Base	04:51	31.2
2008 Do Min	05:12	29.1
Package 1-1	07:44	19.9
Package 1-2	07:31	20.4
Package 1-3	08:08	19.0
Package 1-4	07:04	21.7
Package 1-5	06:29	23.6
Package 1-6	06:27	23.6
Package 1-7	05:27	27.8
Package 1-8	05:26	27.9
Package 1-9	05:13	29.1

PM Scenario	Mean Travel Time (min:sec)	Mean Speed (mph)
2004 Base	04:45	27.5
2008 Do Min	05:27	24.1
Package 1-1	06:07	21.4
Package 1-2	06:17	20.8
Package 1-3	06:15	21.0
Package 1-4	06:00	21.8
Package 1-5	05:34	23.6
Package 1-6	05:25	24.2
Package 1-7	05:27	24.1
Package 1-8	05:13	25.2
Package 1-9	04:51	27.0

It can be seen from Table 3.3 that in the AM peak, Package 1 with all the measures included (Package 1-1) is significantly more congested than the 2008 Do-Minimum model. Package 1-9 shows a similar mean travel time to the 2008 Do-Minimum and the same mean speed.

Table 3.3 shows that in the PM peak, mean travel times are lower in Package 1-8 and 1-9 than the 2008 Do-Minimum and mean speeds are increased, with Package 1-9 showing the greatest benefits.

3.5.2 Journey Time Comparisons

Journey times were extracted from the model output for four key routes:

- A90 South to South Anderson Drive
- A90 South to Great Southern Road
- A90 South to North Esplanade West
- A90 South to Altens Industrial Estate

Journey times were calculated as an average of five S-Paramics model runs for both directions. Table 3.4 shows the AM peak journey time comparison for all vehicles in Package 1 (1-9).

Table 3.4 : AM Peak Period Mean Journey Times – All Vehicles

Direction	Route	2004 Base	2008 Do Min	Package 1
Northbound	A90 South to South Anderson Drive	10:58	11:28	11:09
	A90 South to Great Southern Road	09:14	11:40	11:13
	A90 South to North Esplanade West	12:41	12:36	12:41
	A90 South to Altens Ind Estate	07:44	08:05	07:58
Southbound	South Anderson Drive to A90 South	11:15	11:28	12:15
	Great Southern Road to A90 South	10:29	11:40	09:21
	North Esplanade West to A90 South	12:34	12:36	12:50
	Altens Ind Estate to A90 South	06:51	08:05	07:13

Table 3.3 shows that for all vehicle types, in the majority of cases for key journey times, there is an improvement as a result of introducing the short term measures identified in Package 1. Table 3.5 shows the AM peak journey times for HGVs.

Table 3.5 : AM Peak Period Mean Journey Times – HGVs

Direction	Route	2004 Base	2008 Do Min	Package 1
Northbound	A90 South to South Anderson Drive	13:28	14:59	14:09
	A90 South to Great Southern Road	11:21	11:51	11:27
	A90 South to North Esplanade West	12:43	12:43	12:53
	A90 South to Altens Ind Estate	07:54	08:24	07:59
Southbound	South Anderson Drive to A90 South	11:46	12:41	13:00
	Great Southern Road to A90 South	none	none	none
	North Esplanade West to A90 South	12:34	13:43	12:50
	Altens Ind Estate to A90 South	07:11	07:30	07:23

As with Table 3.4, Table 3.5 shows that there are benefits for HGV traffic over the majority of key journey times assessed using the traffic model.

Table 3.6 shows the PM peak journey times for all vehicles.

Table 3.6 : PM Peak Period Mean Journey Times – All Vehicles

Direction	Route	2004 Base	2008 Do Min	Package 1
Northbound	A90 South to South Anderson Drive	09:05	11:28	09:20
	A90 South to Great Southern Road	09:14	11:40	09:26
	A90 South to North Esplanade West	13:04	12:36	12:32
	A90 South to Altens Ind Estate	07:26	08:05	07:44
Southbound	South Anderson Drive to A90 South	11:55	11:40	13:41
	Great Southern Road to A90 South	10:29	08:22	09:29
	North Esplanade West to A90 South	10:44	13:43	13:20
	Altens Ind Estate to A90 South	07:58	08:23	07:38

Table 3.7 shows the PM peak journey times for HGVs.

Table 3.7 : PM Peak Period Mean Journey Times – HGVs

Direction	Route	2004 Base	2008 Do Min	Package 1
Northbound	A90 South to South Anderson Drive	11:07	11:53	11:23
	A90 South to Great Southern Road	09:21	09:17	10:44
	A90 South to North Esplanade West	13:04	13:48	12:32
	A90 South to Altens Ind Estate	07:26	08:38	07:46
Southbound	South Anderson Drive to A90 South	16:06	20:19	17:01
	Great Southern Road to A90 South	10:34	10:44	09:53
	North Esplanade West to A90 South	13:23	13:27	13:28
	Altens Ind Estate to A90 South	10:14	10:16	07:53

Table 3.5 and Table 3.6 also show that the measures introduced through Package 1 have provided benefits over the majority of key journey routes. This is of particular note for HGV traffic from South Anderson Drive to the A90 south.

3.6 Findings from Package 1

After testing nine scenarios in Package 1, the findings suggest that Package 1-9 can be carried forward to the next package. The measures are:

- Segregated left turn lanes from Great Southern Road to Stonehaven Road, Great Southern Road to King George VI Bridge and King George VI Bridge to West Tullos Road
- Segregated left turn lane from Wellington Road Southbound to Hareness Road
- Extended 3 lanes on Wellington Road northbound approach to Hareness Roundabout
- Abbotswell Crescent left in/ left out to Wellington Road and West Tullos Road
- Minor adjustments to signals at Souterhead Roundabout and Balnagask Road/Somerfield junction

4 PACKAGES 2, 3 AND 4

4.1 Introduction

Due to the restriction on the Bridge of Dee, southbound HGV traffic from the A90 South Anderson Drive must reroute via Holburn Street, Riverside Drive and Great Southern Road to continue their journey on the A90 Stonehaven Road. The movement from Great Southern Road to Stonehaven Road is perceived to be made more difficult by the two lanes of circulating traffic from the Bridge of Dee.

4.2 Aims

Package 2 aims to provide easier egress for HGVs from Great Southern Road through reducing and managing the circulating flow from the Bridge of Dee into one lane.

Package 3 aims to improve HGV flow from the south by introducing an HGV lane on Great Southern Road between Bridge of Dee and King George VI Bridge eastbound.

Package 4 aims to provide a more HGV friendly roundabout at the north of King George VI Bridge at Riverside Drive.

4.3 Development of Package 2

4.3.1 Package 2 (Bridge of Dee Southbound reduced to One Lane ahead to A90)

Package 2 uses the preferred option from Package 1 as its starting point (Package 1-9). In order to try to improve the flow from Great Southern Road to Stonehaven Road the segregated left turn lane is changed to a left turn slip with a lane gain on exit (Package 2-1). The Bridge of Dee is restricted to one lane on entry to the roundabout with the aim of reducing the circulating flow from the bridge to one lane. This should in turn allow easier egress for HGVs from Great Southern Road.

A sensitivity test was assessed for Package 2, (Package 2-2) which involved the removal of the segregated left turn lane (introduced in Package 1) making lane 1 of Great Southern Road left only to the A90 south. The bridge is restricted to one lane as in the first test.

4.3.2 General Network Statistics

The mean travel time was extracted from all the scenarios tested, as a general indicator of network performance and congestion. Table 4.8 shows the mean travel time for the AM and PM peaks based on an average of five S-Paramics model runs.

Table 4.1 : General Network Statistics

AM Scenario	Mean Travel Time (min:sec)	Mean Speed (mph)
2004 Base	04:51	31.2
2008 Do Min	05:12	29.1
Package 1-9	05:13	29.1
Package 2-1	05:20	28.5
Package 2-2	05:41	26.6

PM Scenario	Mean Travel Time (min:sec)	Mean Speed (mph)
2004 Base	04:45	27.5
2008 Do Min	05:27	24.1
Package 1-9	04:51	27.0
Package 2-1	04:56	26.6
Package 2-2	05:55	22.2

In both the AM and PM peaks, the mean travel time in Package 2-1 is better than Package 2-2, indicating that 2-1 is more efficient over the modelled study area and further analysis will be undertaken on Package 2-1. Both package 2 tests are less efficient overall compared with Package 1-9.

One of the main problem areas identified through model observation was at Holburn Street where severe queuing occurs well in excess of that occurring in Package 1-9. This is due to the delays on the Bridge of Dee combined with the continuous flow from South Anderson Drive and Garthdee Road filling any gaps before at the end of the queue before the Holburn Street arm.

4.3.3 Journey Time Comparisons

Journey times were extracted from the model output for four key routes:

- A90 South to South Anderson Drive
- A90 South to Great Southern Road
- A90 South to North Esplanade West
- A90 South to Altens Industrial Estate

Journey times were calculated as an average of five S-Paramics model runs for both directions. Table 4.2 shows the AM peak journey time comparison for all vehicles in Package 1-9 and Package 2-1.

Table 4.2 : AM Peak Period Mean Journey Times – All Vehicles

Direction	Route	2004 Base	2008 Do-Min	P 1	P 2
Northbound	A90 South to South Anderson Drive	10:58	11:28	11:09	11:11
	A90 South to Great Southern Road	09:14	11:40	11:13	11:11
	A90 South to North Esplanade West	12:41	12:36	12:41	12:26
	A90 South to Altens Ind Estate	07:44	08:05	07:58	07:50
Southbound	South Anderson Drive to A90 South	11:15	11:28	12:15	12:01
	Great Southern Road to A90 South	10:29	11:40	09:21	21:03
	North Esplanade West to A90 South	12:34	12:36	12:50	12:12
	Altens Ind Estate to A90 South	06:51	08:05	07:13	07:06

Table 4.2 shows that during the AM peak there is actually a significant disbenefit to vehicles travelling southbound from Great Southern Road to the A90 south. The reduction to a single lane of the Bridge of Dee entry has caused a delay to upstream traffic, most notably on Holburn Street, whilst South Anderson Drive remains relatively unaffected.

Model observations show that, due to the queue on Bridge of Dee, Holburn Street has limited opportunity to progress. The effect of this is that the queue extends back to Riverside Drive and towards Great Southern Road. As delay builds, more traffic on an east to west movement routes away from Riverside Drive and Holburn Street and diverts to King George VI Bridge and Great Southern Road before seeking to make a right turn at Stonehaven Road to come back over the Bridge of Dee (northbound). The resultant queueing within the right turning lane quickly blocks back and affects the left turning lane, causing significant delays on Great Southern Road between King George VI Bridge and Stonehaven Road.

It is also notable that in Package 1-9, with two lanes operating from Bridge of Dee, suitable gaps in the cutting flow are produced which allow the Great Southern Road arm to flow, preventing the segregated left turn lane from becoming blocked. In Package 2, due to the constant demand for a single lane across the Bridge of Dee (Southbound) there is a continual stream of traffic, albeit in a single lane, cutting the Great Southern Road movement.

Package 2 has shown increase journey times within the AM peak and general disbenefit in mean travel times throughout both the AM and PM periods. For this reason no further detailed journey time analysis is presented for Package 2 as it is clear that there is no advantage to the efficiency of the network over Package 1-9.

4.3.4 Findings from Packages 2

Through analysis of general network performance statistics for the AM and PM peak periods and key journey times for the AM peak, neither of the options assessed for Package 2 offer any benefit over the network operation for Package 1-9. Package 1-9 will be adopted as the reference case to undertake the Package 3 testing.

4.4 Development and Analysis of Package 3

4.4.1 Package 3 (HGV/Bus Lane on Great Southern Road between A90 and King George VI Bridge)

Package 1 has been used as the reference option to gauge the performance of Package 3. The main measure introduced as part of Package 3 is a bus/HGV only lane on lane 1 of Great Southern Road eastbound between the Bridge of Dee and King George VI Bridge. At the King George VI Bridge end, the bus/HGV lane ends with sufficient distance to allow the weaving movement of vehicles to get into the correct lane for the roundabout.

4.4.2 General Network Statistics

The mean travel time was extracted from Package 3 and compared against the results from Package 1-9 as a general indicator of network performance and congestion. Table 4.3 shows the mean travel time for the AM and PM peaks based on an average of five S-Paramics model runs.

Table 4.3 : General Network Statistics

AM Scenario	Mean Travel Time (min:sec)	Mean Speed (mph)	PM Scenario	Mean Travel Time (min:sec)	Mean Speed (mph)
2004 Base	04:51	31.2	2004 Base	04:45	27.5
2008 Do Min	05:12	29.1	2008 Do Min	05:27	24.1
Package 1-9	05:13	29.1	Package 1-9	04:51	27.0
Package 3-1	05:22	28.2	Package 3-1	04:55	26.7

Table 4.3 shows that Package 3-1 has generally more delay across the network than Package 1. This is to be expected as the majority of vehicles are being restricted to a single lane between Bridge of Dee and King George VI Bridge.

4.4.3 Journey Time Comparisons

Journey times were extracted from the model output for four key routes:

- A90 South to South Anderson Drive
- A90 South to Great Southern Road
- A90 South to North Esplanade West
- A90 South to Altens Industrial Estate

Journey times were calculated as an average of five S-Paramics model runs for both directions. Table 4.4 shows the AM peak journey time comparison for all vehicles in Package 3 compared against Package 1-9.

Table 4.4 : AM Peak Period Mean Journey Times – All Vehicles

Direction	Route	2004 Base	2008 Do-Min	P 1	P 3
Northbound	A90 South to South Anderson Drive	10:58	11:28	11:09	11:15
	A90 South to Great Southern Road	09:14	11:40	11:13	11:22
	A90 South to North Esplanade West	12:41	12:36	12:41	12:40
	A90 South to Altens Ind Estate	07:44	08:05	07:58	08:00
Southbound	South Anderson Drive to A90 South	11:15	11:28	12:15	14:38
	Great Southern Road to A90 South	10:29	11:40	09:21	09:05
	North Esplanade West to A90 South	12:34	12:36	12:50	13:00
	Altens Ind Estate to A90 South	06:51	08:05	07:13	07:01

Table 4.10 shows the AM peak journey times for HGVs.

Table 4.5 : AM Peak Period Mean Journey Times – HGVs

Direction	Route	2004 Base	2008 Do-Min	P 1	P 3
Northbound	A90 South to South Anderson Drive	13:28	14:59	14:09	13:49
	A90 South to Great Southern Road	11:21	11:51	11:27	11:37
	A90 South to North Esplanade West	12:43	12:43	12:53	12:34
	A90 South to Altens Ind Estate	07:54	08:24	07:59	08:13
Southbound	South Anderson Drive to A90 South	11:46	12:41	13:00	15:30
	Great Southern Road to A90 South	none	none	none	none
	North Esplanade West to A90 South	12:34	13:43	12:50	13:00
	Altens Ind Estate to A90 South	07:11	07:30	07:23	07:24

Table 4.11 shows the PM peak journey times for all vehicles.

Table 4.6 : PM Peak Period Mean Journey Times – All Vehicles

Direction	Route	2004 Base	2008 Do Min	P 1	P 3
Northbound	A90 South to South Anderson Drive	09:05	11:28	09:20	09:18
	A90 South to Great Southern Road	09:14	11:40	09:26	09:14
	A90 South to North Esplanade West	13:04	12:36	12:32	12:29
	A90 South to Altens Ind Estate	07:26	08:05	07:44	07:58
Southbound	South Anderson Drive to A90 South	11:55	11:40	13:41	15:06
	Great Southern Road to A90 South	10:29	08:22	09:29	09:26
	North Esplanade West to A90 South	10:44	13:43	13:20	12:50
	Altens Ind Estate to A90 South	07:58	08:23	07:38	07:32

Table 4.12 shows the PM peak journey times for HGVs.

Table 4.7 : PM Peak Period Mean Journey Times – HGVs

Direction	Route	2004 Base	2008 Do Min	P 1	P 3
Northbound	A90 South to South Anderson Drive	11:07	11:53	11:23	10:43
	A90 South to Great Southern Road	09:21	09:17	10:44	09:27
	A90 South to North Esplanade West	13:04	13:48	12:32	12:29
	A90 South to Altens Ind Estate	07:26	08:38	07:46	08:00
Southbound	South Anderson Drive to A90 South	16:06	20:19	17:01	17:39
	Great Southern Road to A90 South	10:34	10:44	09:53	09:42
	North Esplanade West to A90 South	13:23	13:27	13:28	12:57
	Altens Ind Estate to A90 South	10:14	10:16	07:53	07:46

The key journey time comparisons shown in Table 4.4 to Table 4.7 show little difference between Package 1-9 and Package 3. The northbound route from the A90 South to Great Southern Road shows a slight increase in the AM and a slight decrease in the PM period. These results suggest that the benefits

accrued through a bus/HGV lane over this section are not sufficient to impact upon total delays experienced elsewhere in the network.

4.4.4 Findings from Packages 3

The Package 3 test results have shown little overall change to the network performance and efficiency for both general traffic and HGV traffic alike. As such, the provision of a bus/HGV lane has been omitted from future test scenarios though it may be worth further consideration as part of a package of HGV/Bus improvements.

4.5 Development and Analysis of Package 4

4.5.1 Package 4 (Large HGV friendly roundabout at King George VI Bridge/Riverside Drive Junction)

Using Package 1 as the reference condition, a preliminary conceptual design was developed and modelled, to provide a larger, HGV friendly roundabout at the north of King George VI Bridge.

The concept of making the roundabout HGV friendly aims to make the turning radius less onerous for large vehicles providing easier curves which should reduce delay in negotiating the junction as well as providing more opportunities to enter the junction due to increased gaps in circulating traffic.

Whilst a preliminary junction design has been evaluated it should be noted that facilitating a larger roundabout in this location would encroach on Cemetery land and possibly Duthie Park making delivery of a revised junction difficult in the short term. A preliminary design is illustrated in Figure 4.1 showing a 40m ICD roundabout.

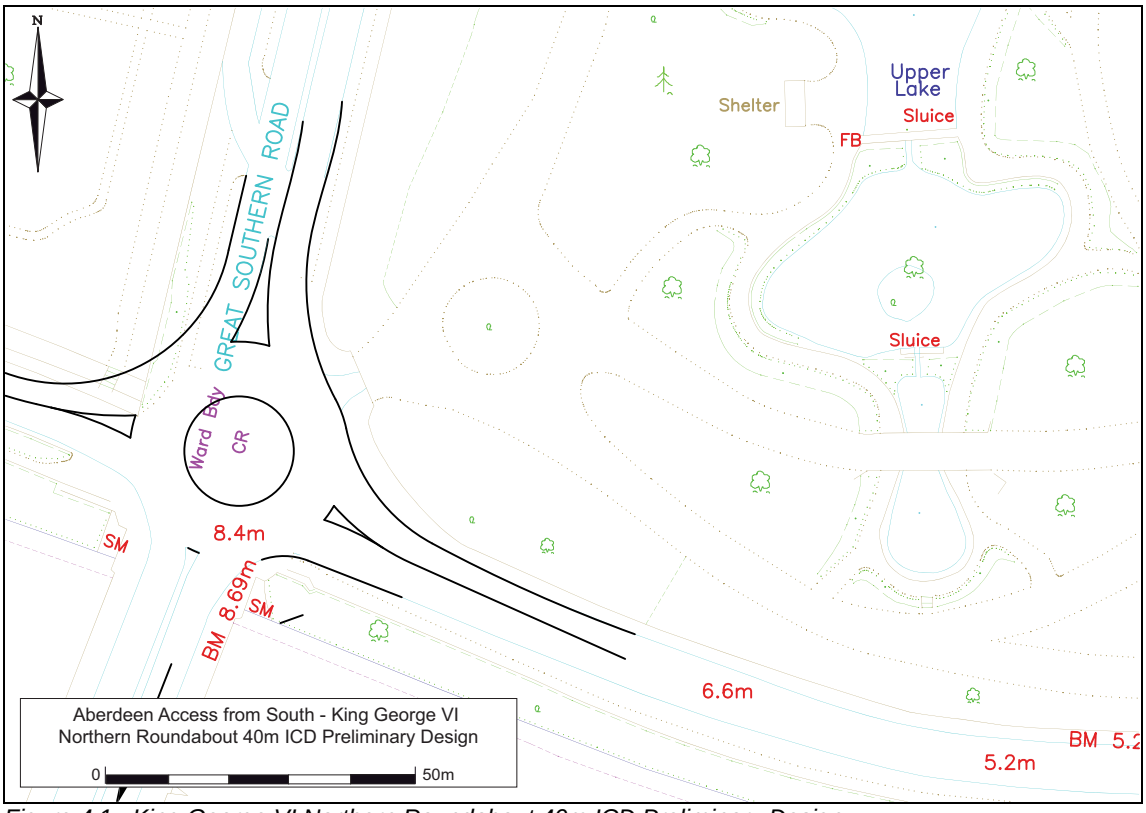

Figure 4.1 : King George VI Northern Roundabout 40m ICD Preliminary Design

Figure 4.1 shows that even with a 40 metre Inscriber Circle Diameter (ICD) a larger roundabout could have implications for both the Cemetery on the Northwest corner and Duthie Park on the Northeast corner. Any increase in the ICD would likely require additional land and a realignment of Riverside Drive in order to form entry and exit deflections.

4.5.2 General Network Statistics

The mean travel time was extracted from Package 4 and compared against Package 1-9, as a general indicator of network performance and congestion. Table 4.8 shows the mean travel time for the AM and PM peaks based on an average of five S-Paramics model runs.

Table 4.8 : General Network Statistics

AM Scenario	Mean Travel Time (min:sec)	Mean Speed (mph)
2004 Base	04:51	31.2
2008 Do Min	05:12	29.1
Package 1-9	05:13	29.1
Package 4-1	05:16	28.9

PM Scenario	Mean Travel Time (min:sec)	Mean Speed (mph)
2004 Base	04:45	27.5
2008 Do Min	05:27	24.1
Package 1-9	04:51	27.0
Package 4-1	05:11	25.3

Table 4.8 shows that Package 4-1 is performing relatively well in the AM peak and compares well with Package 1-9. In the PM peak, Package 4 is more congested on Great Southern Road as a result of clearing traffic from Riverside Drive (West) and it does not perform as well as Package 1-9 with a mean travel time of 05:11 compared to 04:51 in Package 1-9.

4.5.3 Journey Time Comparisons

Journey times were extracted from the model output for four key routes:

- A90 South to South Anderson Drive
- A90 South to Great Southern Road
- A90 South to North Esplanade West
- A90 South to Altens Industrial Estate

Journey times were calculated as an average of five S-Paramics model runs for both directions. Table 4.9 shows the AM peak journey time comparison for all vehicles in Packages 2 (2-1), 3 and 4.

Table 4.9 : AM Peak Period Mean Journey Times – All Vehicles

Direction	Route	2004 Base	2008 Do-Min	P 1	P 4
Northbound	A90 South to South Anderson Drive	10:58	11:28	11:09	11:23
	A90 South to Great Southern Road	09:14	11:40	11:13	11:27
	A90 South to North Esplanade West	12:41	12:36	12:41	12:53
	A90 South to Altens Ind Estate	07:44	08:05	07:58	08:09
Southbound	South Anderson Drive to A90 South	11:15	11:28	12:15	12:35
	Great Southern Road to A90 South	10:29	11:40	09:21	09:37
	North Esplanade West to A90 South	12:34	12:36	12:50	12:34
	Altens Ind Estate to A90 South	06:51	08:05	07:13	07:05

Table 4.10 shows the AM peak journey times for HGVs.

Table 4.10 : AM Peak Period Mean Journey Times – HGVs

Direction	Route	2004 Base	2008 Do-Min	P 1	P 4
Northbound	A90 South to South Anderson Drive	13:28	14:59	14:09	14:21
	A90 South to Great Southern Road	11:21	11:51	11:27	11:44
	A90 South to North Esplanade West	12:43	12:43	12:53	13:04
	A90 South to Altens Ind Estate	07:54	08:24	07:59	08:20
Southbound	South Anderson Drive to A90 South	11:46	12:41	13:00	13:23
	Great Southern Road to A90 South	none	none	none	none
	North Esplanade West to A90 South	12:34	13:43	12:50	12:34
	Altens Ind Estate to A90 South	07:11	07:30	07:23	07:18

Table 4.11 shows the PM peak journey times for all vehicles.

Table 4.11 : PM Peak Period Mean Journey Times – All Vehicles

Direction	Route	2004 Base	2008 Do Min	P 1	P 4
Northbound	A90 South to South Anderson Drive	09:05	11:28	09:20	09:55
	A90 South to Great Southern Road	09:14	11:40	09:26	09:38
	A90 South to North Esplanade West	13:04	12:36	12:32	13:22
	A90 South to Altens Ind Estate	07:26	08:05	07:44	08:17
Southbound	South Anderson Drive to A90 South	11:55	11:40	13:41	14:02
	Great Southern Road to A90 South	10:29	08:22	09:29	10:08
	North Esplanade West to A90 South	10:44	13:43	13:20	13:13
	Altens Ind Estate to A90 South	07:58	08:23	07:38	07:42

Table 4.12 shows the PM peak journey times for HGVs.

Table 4.12 : PM Peak Period Mean Journey Times – HGVs

Direction	Route	2004 Base	2008 Do Min	P 1	P 4
Northbound	A90 South to South Anderson Drive	11:07	11:53	11:23	11:09
	A90 South to Great Southern Road	09:21	09:17	10:44	09:46
	A90 South to North Esplanade West	13:04	13:48	12:32	13:22
	A90 South to Altens Ind Estate	07:26	08:38	07:46	08:04
Southbound	South Anderson Drive to A90 South	16:06	20:19	17:01	18:39
	Great Southern Road to A90 South	10:34	10:44	09:53	10:30
	North Esplanade West to A90 South	13:23	13:27	13:28	13:24
	Altens Ind Estate to A90 South	10:14	10:16	07:53	07:53

Table 4.9 to Table 4.12 show that most of the key journey times remain comparable between Package 1-9 and Package 4, with no significant changes. The South Anderson Drive to A90 (South) journey times show an increase in journey time for all vehicle types in all periods. This is a result of the transfer of congestion from the North side of King George VI Bridge to the southern junction with West Tullos Road and also to the Southern Bridge of Dee junction with Stonehaven Road.

4.6 Findings from Package 4

Based on the initial model findings and observations, although package 4 did show benefits of improved journey times for some routes in the AM peak, the release of traffic from Riverside Drive in the PM caused downstream congestion problems. It is also considered unlikely that this option would be built in the short term due to required acquisition of cemetery land and the potential requirement for land from Duthie Park and it has been omitted from future testing.

5 FURTHER ANALYSIS

5.1 Introduction

Chapter 5 provides an overview of key area queue length comparisons for Package 1, 2, 3 and 4 to allow, as a final comparison, the relative performance of the packages to be considered.

5.2 Queue Comparisons

As an additional comparison of model performance and in order to assess levels of queueing, model outputs were analysed using DAT (Data Analysis Tool). Cordons were set up for key areas and the average number of vehicles queueing within each cordon has been extracted and compared. A total of six cordons were used, as described in Table 5.1.

Table 5.1 : Cordons

Cordon	Area
Bridge of Dee	A90 from Charleston to South Anderson Drive
King George VI Bridge	Great Southern Road to West Tullos Road
QEII Bridge	South College St to Wellington Rd
Wellington Rd	Wellington Rd from Hareness Rd to Charleston
North of Bridges	Model area north of bridges
South of Bridges	Model area south of bridges

Figures 5.1 to 5.6 show the location of each of the cordons.

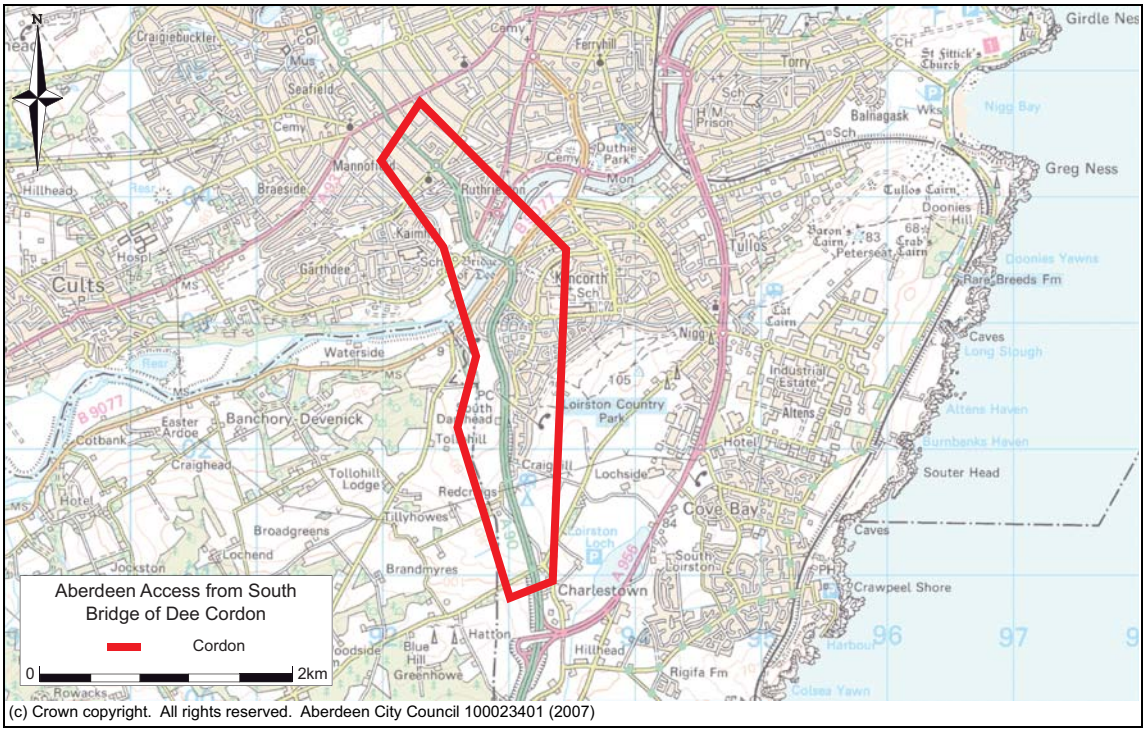

Figure 5.1 : Bridge of Dee Cordon

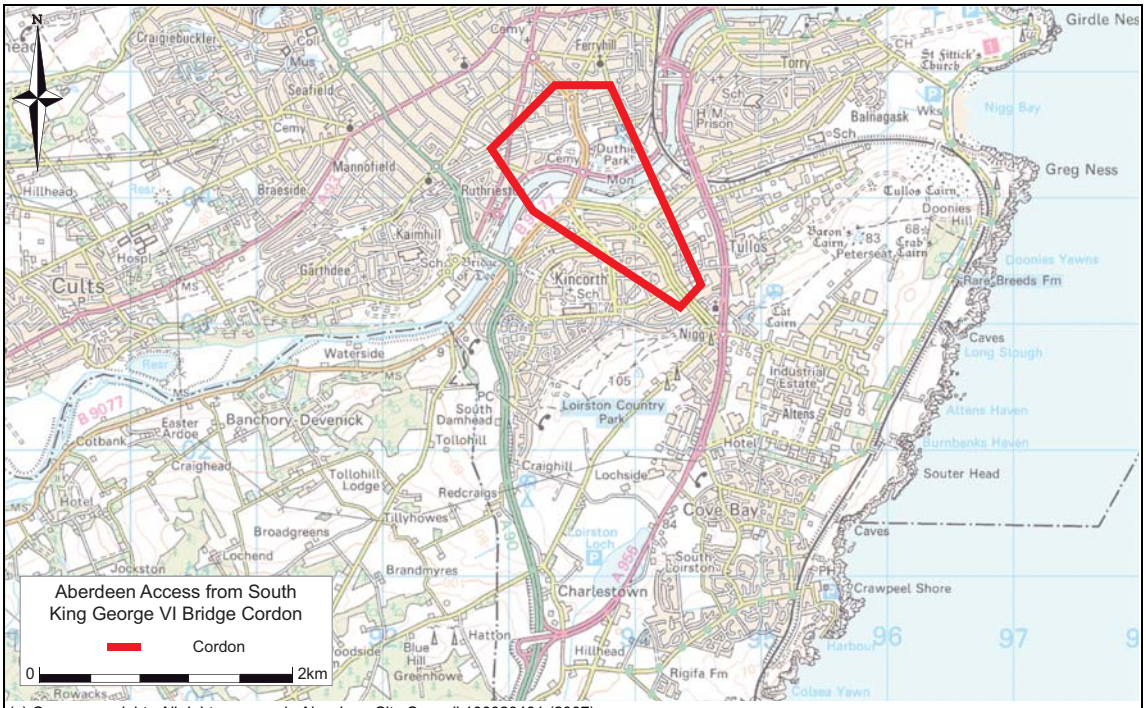

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Figure 5.2 : King George VI Bridge Cordon

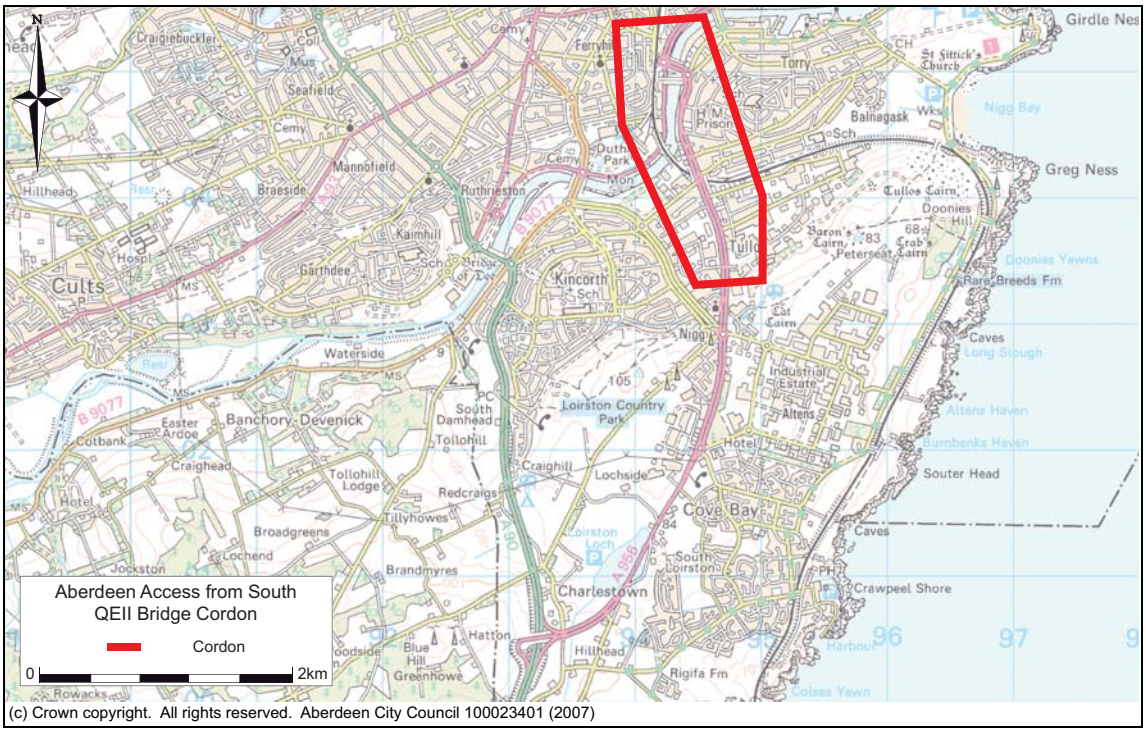

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Figure 5.3 : QEII Bridge Cordon

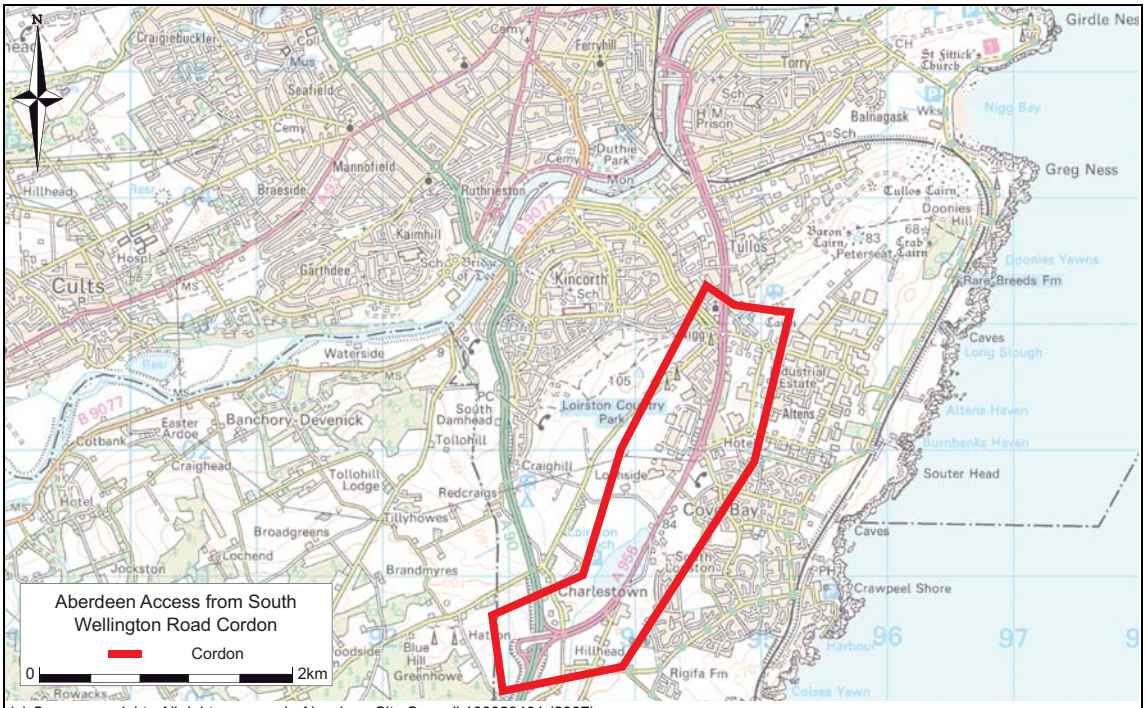

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Figure 5.4 : Wellington Road Cordon

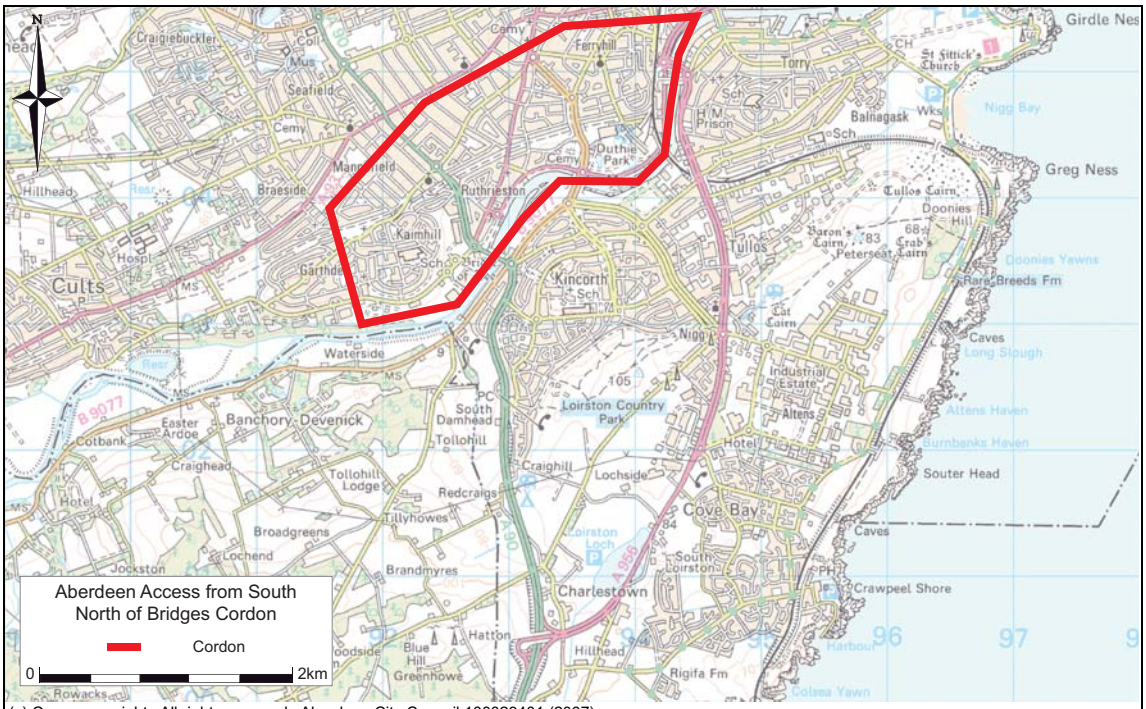

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Figure 5.5 : North of Bridges Cordon

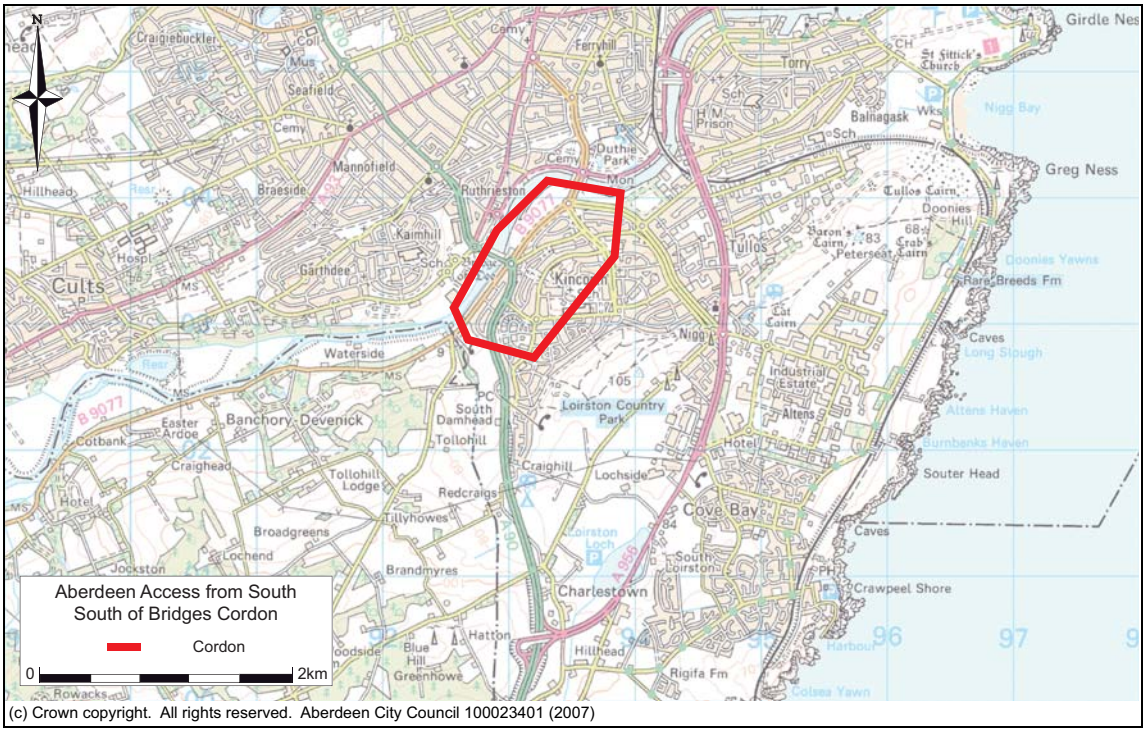

Figure 5.6 : South of Bridges Cordon

The average number of vehicles in a queue, in each cordon, in the AM peak, are shown in Figures 5.7 to 5.11. Results are an average of five S-Paramics model runs.

Figure 5.7 shows the AM results for the Bridge of Dee Cordon.

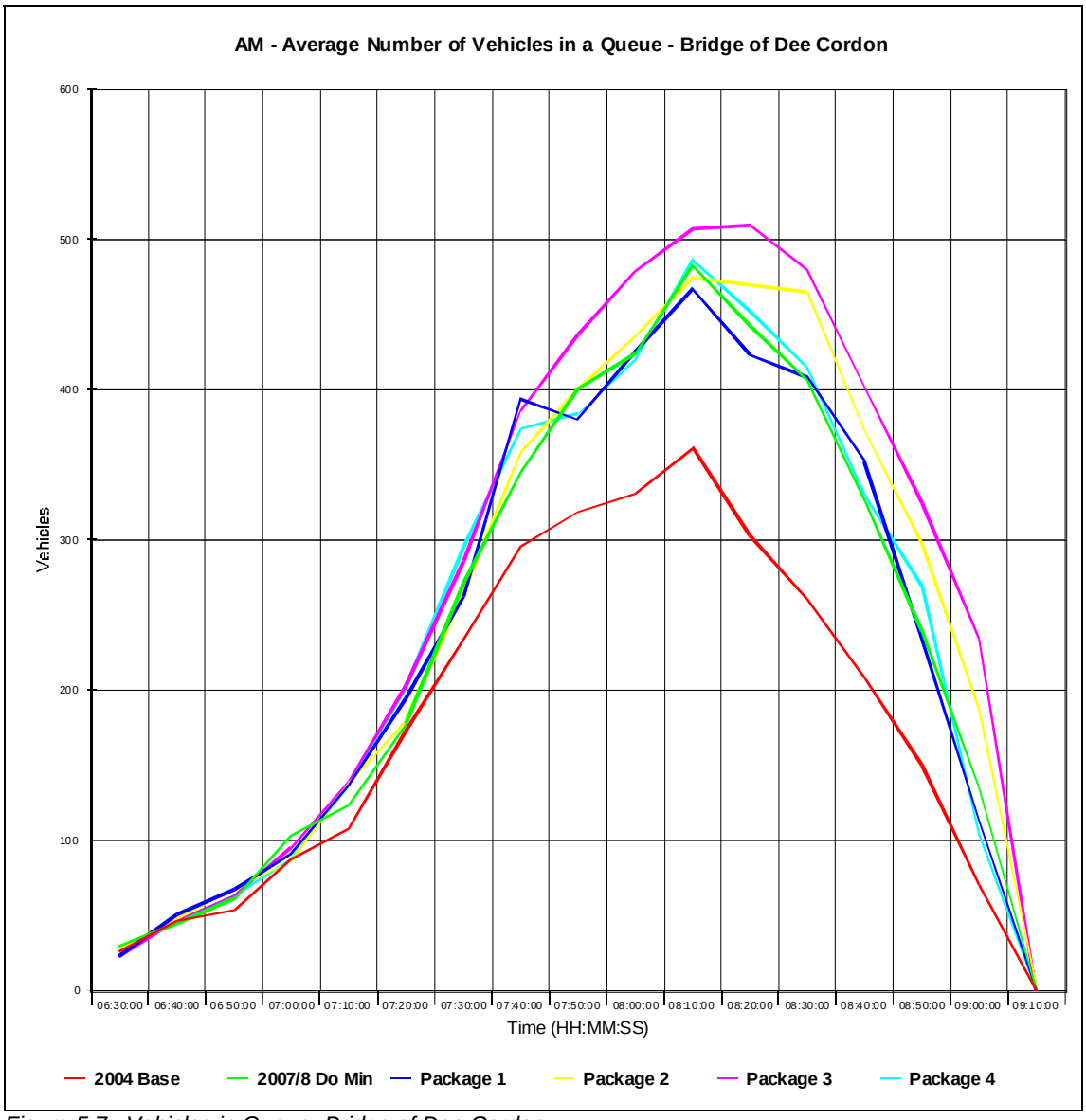

Figure 5.7 : Vehicles in Queue -Bridge of Dee Cordon

Figure 5.7 illustrates that for the AM peak within the Bridge of Dee cordon Package 1 has the most favourable levels of queued vehicles compared with the other 2008 scenarios.

Figure 5.8 shows the AM results for the King George VI cordon.

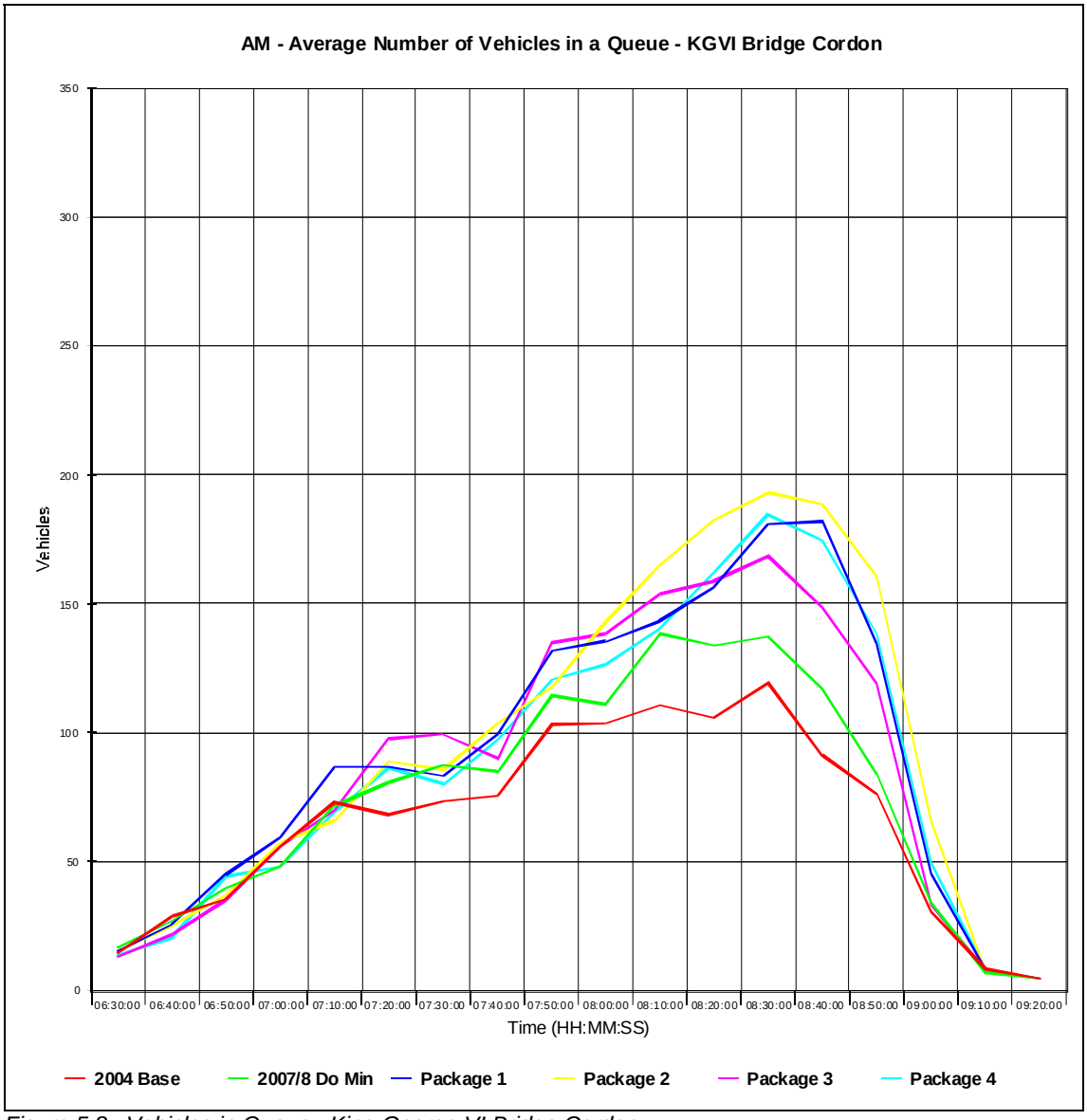

Figure 5.8 : Vehicles in Queue –King George VI Bridge Cordon

Figure 5.8 illustrates that there is very little difference between each of the 2008 scenarios modelled when considering the queueing within the King George VI cordon area.

Figure 5.9 shows the AM results for the QEII Bridge cordon.

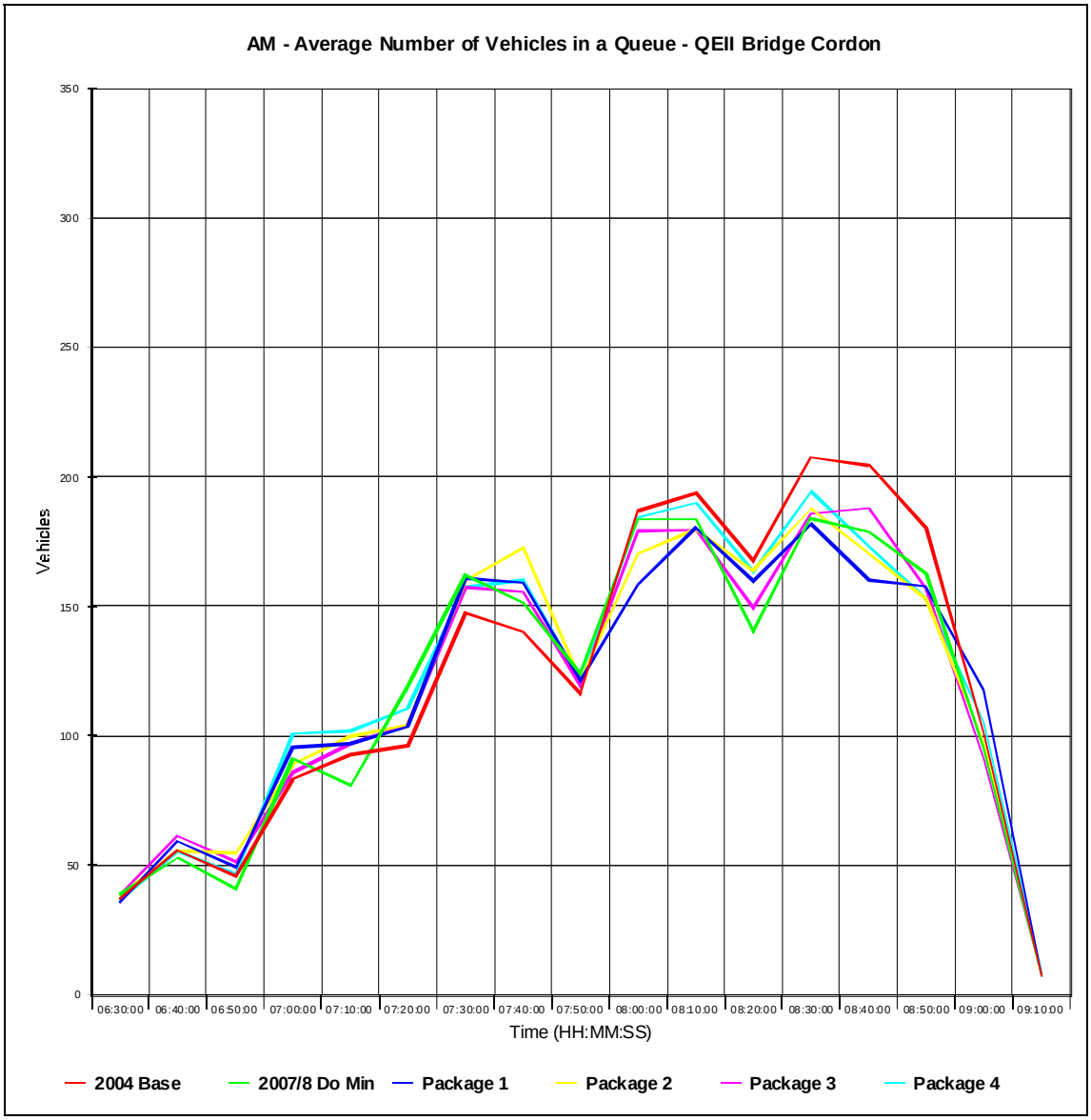

Figure 5.9 : Vehicles in Queue –QEII Bridge Cordon

Figure 5.9 illustrates that again there is little difference between the 2008 model scenarios within the QEII Bridge cordon.

Figure 5.10 shows the AM results for the Wellington Rd Cordon.

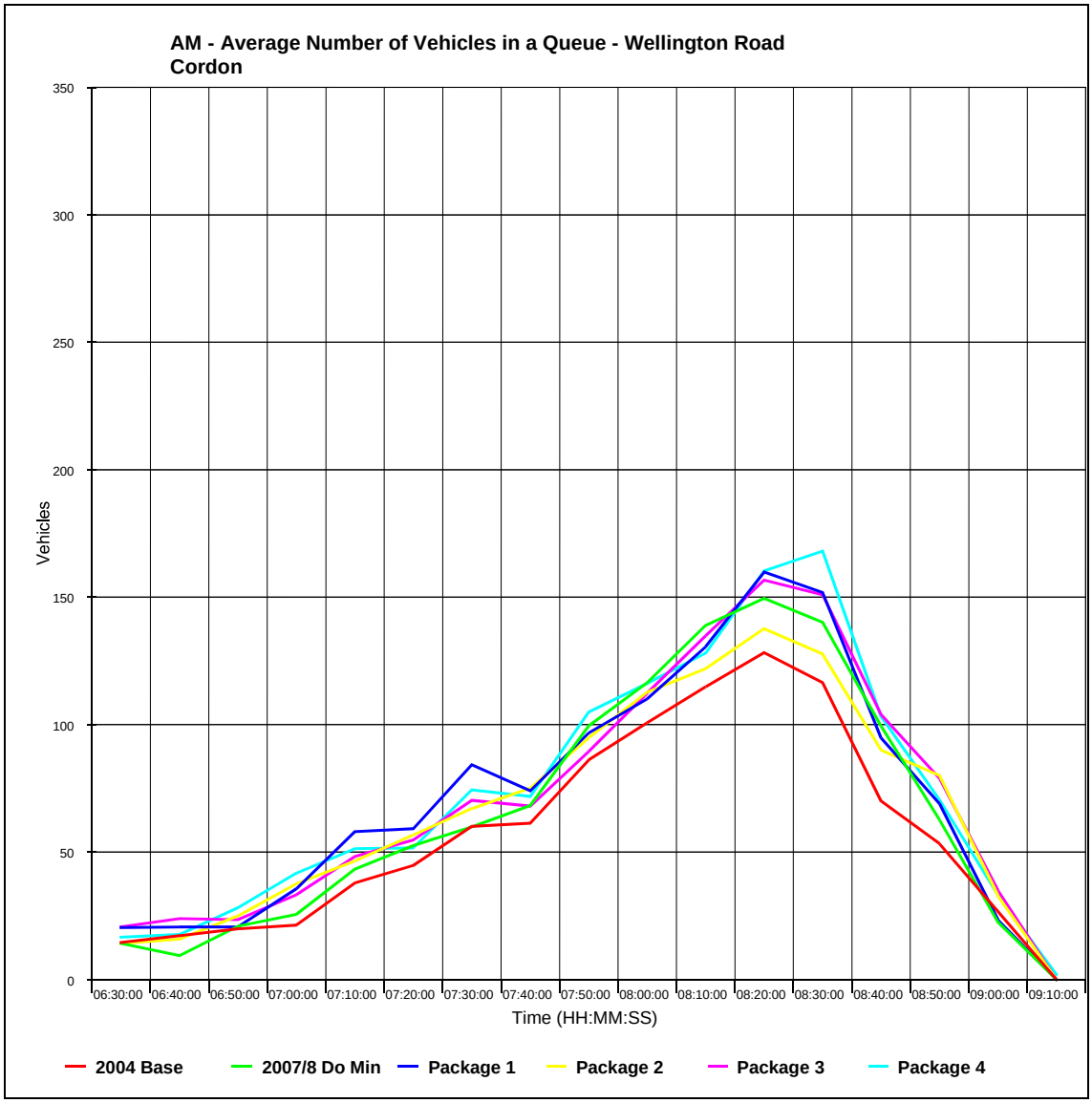

Figure 5.10 : Vehicles in Queue –Wellington Road Cordon

Figure 5.10 illustrates that again, on the Wellington Road cordon, there is very little difference between the 2008 scenarios considered.

Figure 5.11 shows the AM results for the South of Bridges Cordon.

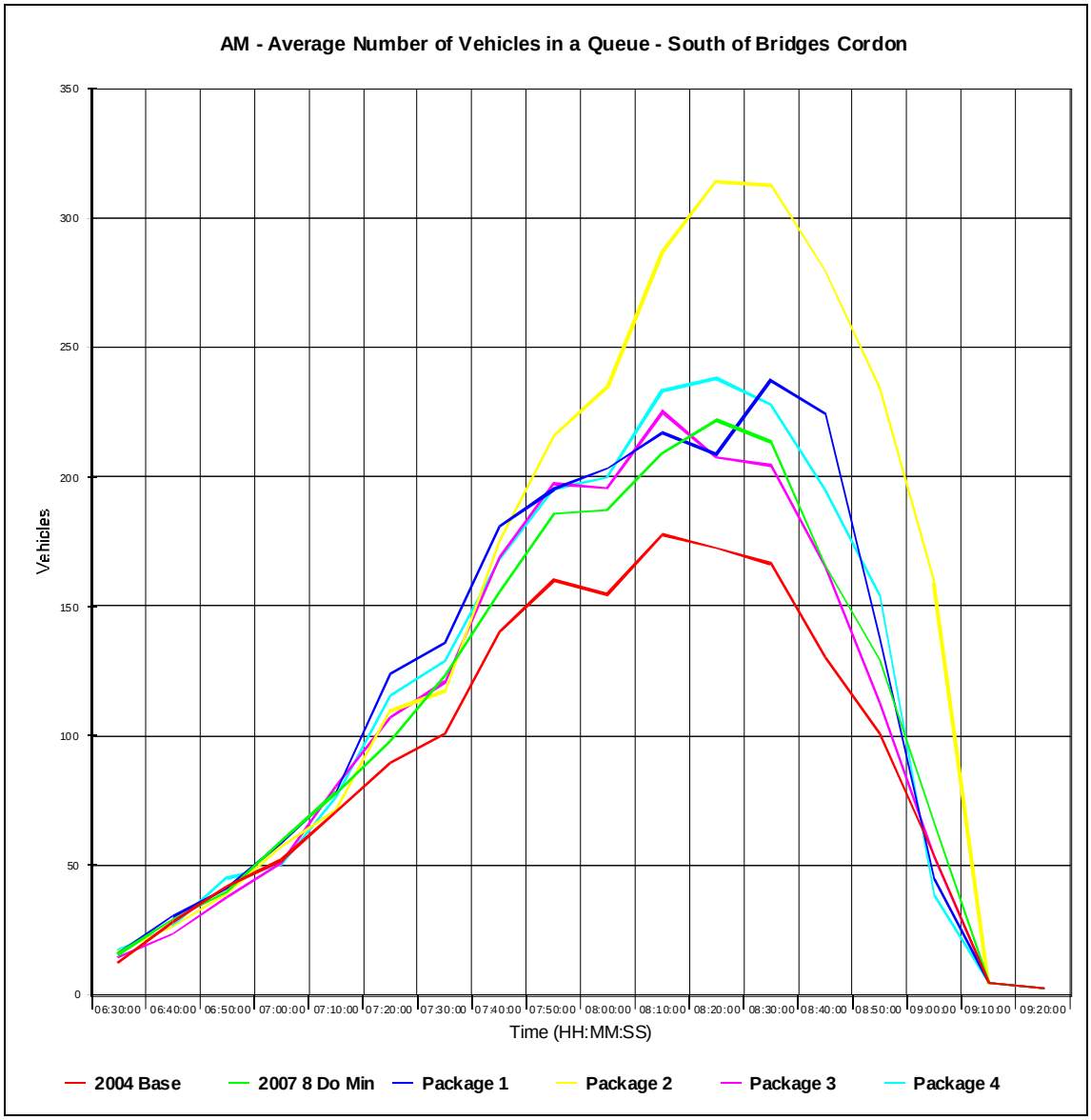

Figure 5.11 : Vehicles in Queue –South of Bridges Cordon

Figure 5.11 illustrates that for the South of Bridges cordon during the AM peak, Package 2 is less favourable with generally more vehicles queued than the other 2008 scenarios.

When queueing in the model reaches the extents of the network, vehicles cannot be released into the model. These vehicles are queued off the network and are a good indication of the networks ability to cater for the predicted travel demand. Table 5.2 shows the maximum number of vehicles in a queue off the network at any one time (in the AM period), at key locations in the model.

Table 5.2 : AM Period – Max Queue off Network

Scenario / Location	Leggart Terrace	North Esp West	South College St	Great Northern Rd	Holburn St	Asda	Langdykes Rd	Redmoss Rd
2004 Base	0	0	0	0	0	0	0	0
2008 Do Min	0	0	0	0	20	0	0	0
Package 1-1	777	513	68	212	20	6	51	55
Package 1-2	130	459	99	386	41	124	18	20
Package 1-3	812	477	86	184	8	0	0	78
Package 1-4	45	475	99	381	59	98	9	36
Package 1-5	71	584	81	0	38	103	34	9
Package 1-6	78	459	127	0	68	122	0	35
Package 1-7	34	0	0	0	98	128	0	24
Package 1-8	32	0	5	0	29	107	0	26
Package 1-9	44	0	0	0	4	0	0	15
Package 2-1	36	2	0	0	0	0	0	20
Package 2-2	44	0	0	0	0	0	0	10
Package 3-1	30	0	0	0	0	0	0	26
Package 4-1	61	7	0	0	0	0	0	15

Table 5.2 shows that in the AM peak there are significant numbers of vehicles waiting to be released onto the network within Packages 1-1 to 1-8.

The average number of vehicles in a queue, in each cordon, in the PM peak, are shown in Figures 5.12 to 5.17.

Figure 5.12 shows the PM results for the Bridge of Dee Cordon.

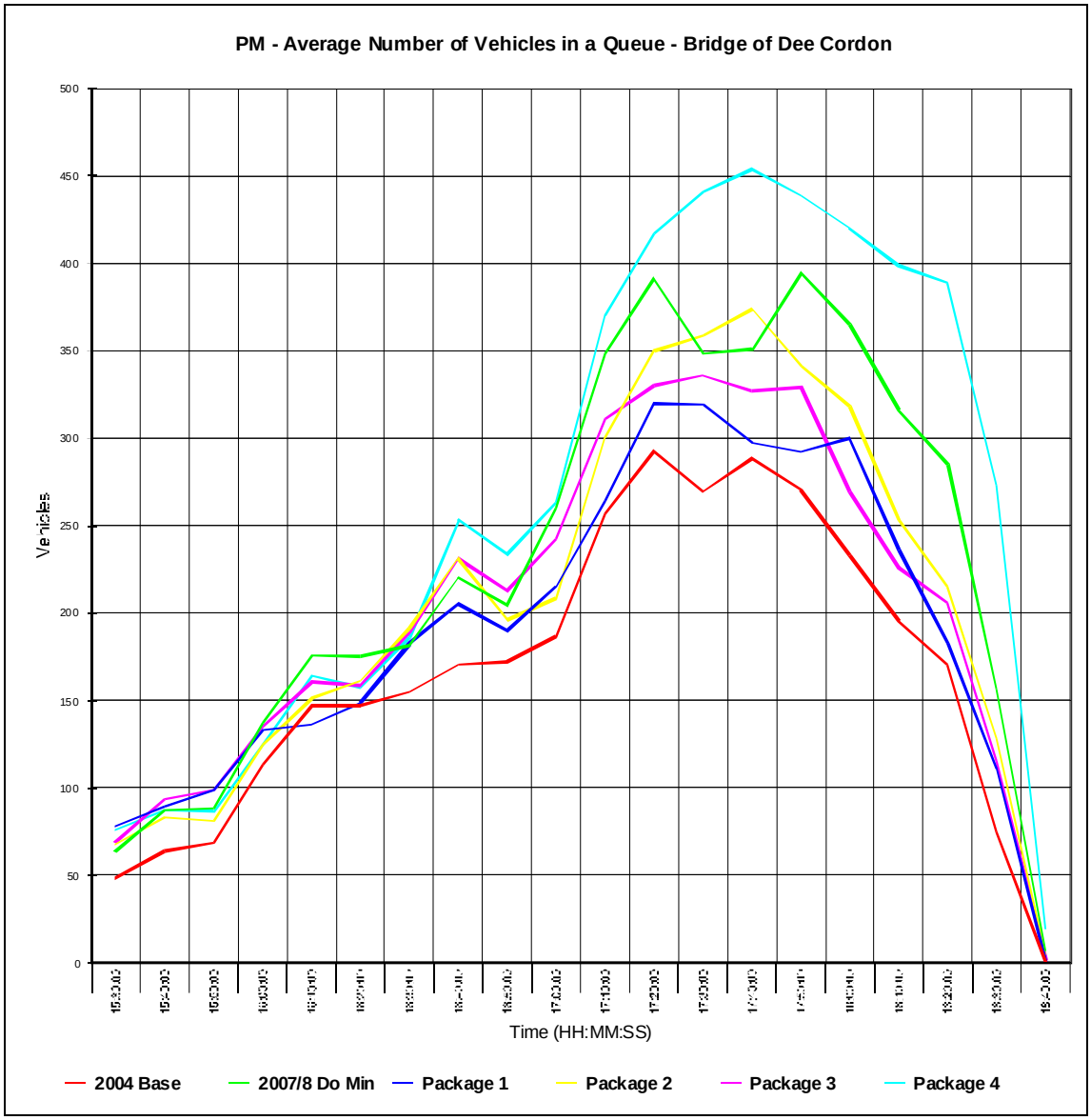

Figure 5.12 : Vehicles in Queue –Bridge of Dee Cordon

Figure 5.12 shows that in the PM peak Package 1 is the most favourable for queued vehicles in the network during the peak.

Figure 5.13 show the PM results for the King George VI Bridge cordon.

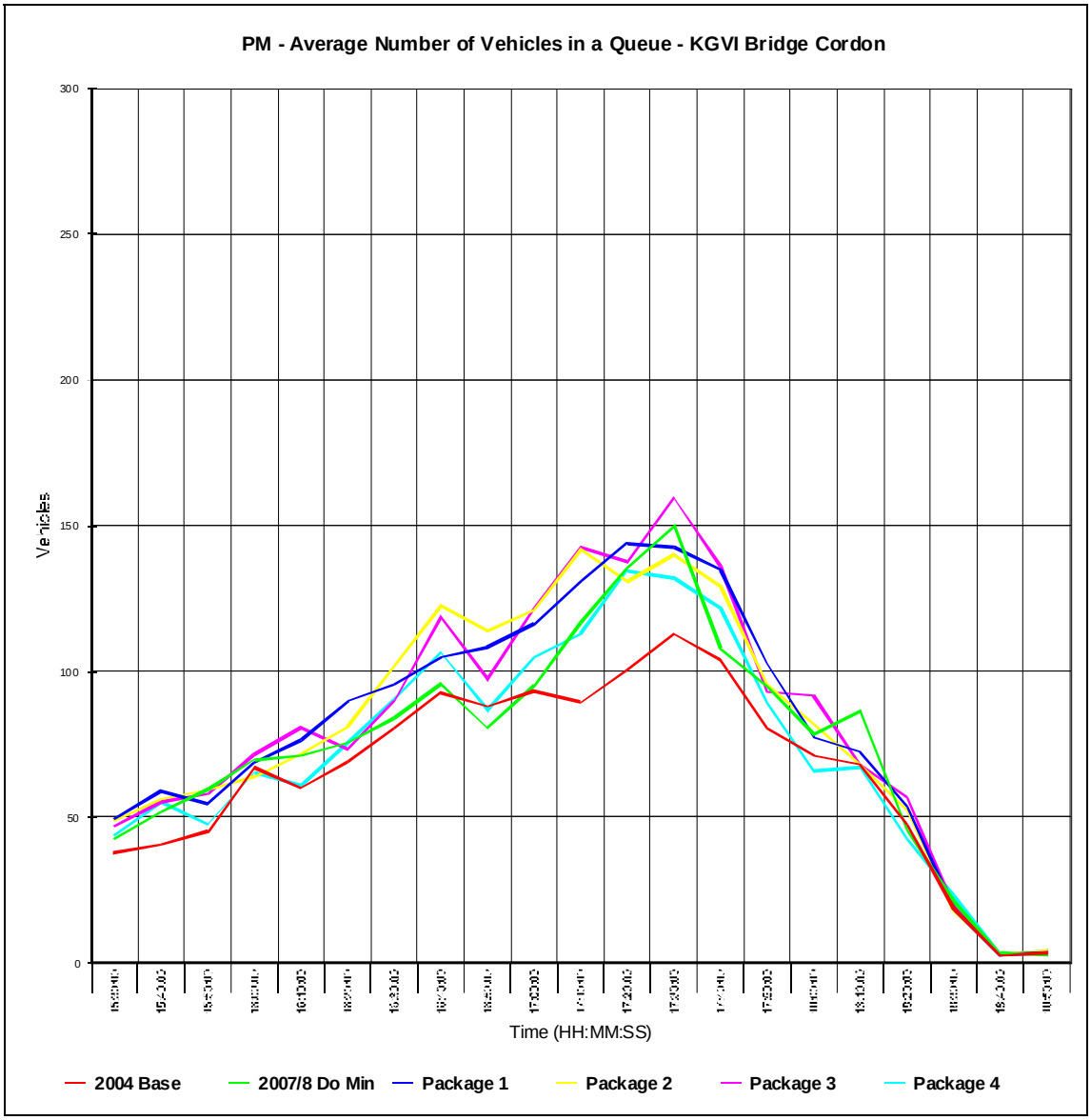

Figure 5.13 : Vehicles in Queue –King George VI Bridge Cordon

Figure 5.13 illustrates that during the PM peak there is very little difference between the 2008 scenarios when comparing the King George VI cordon for levels of queued vehicles.

Figure 5.14 shows the PM results for the QEII Bridge cordon.

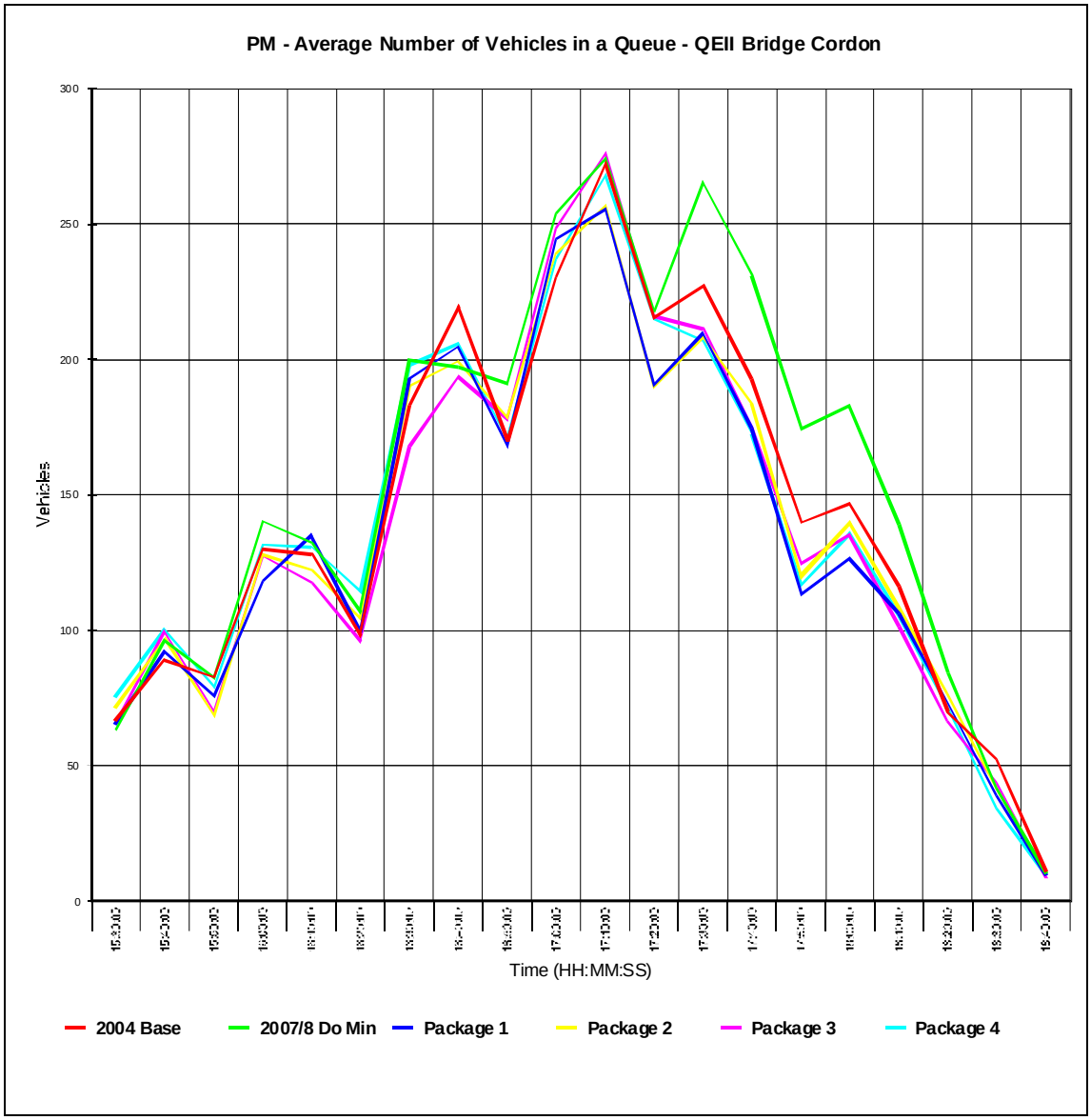

Figure 5.14 : Vehicles in Queue –QEII Bridge Cordon

Figure 5.14 illustrates that over the QEII cordon there is no real difference between the levels of queued vehicles within the cordon area between the 2008 scenarios.

Figure 5.15 shows the PM results for the Wellington Road cordon.

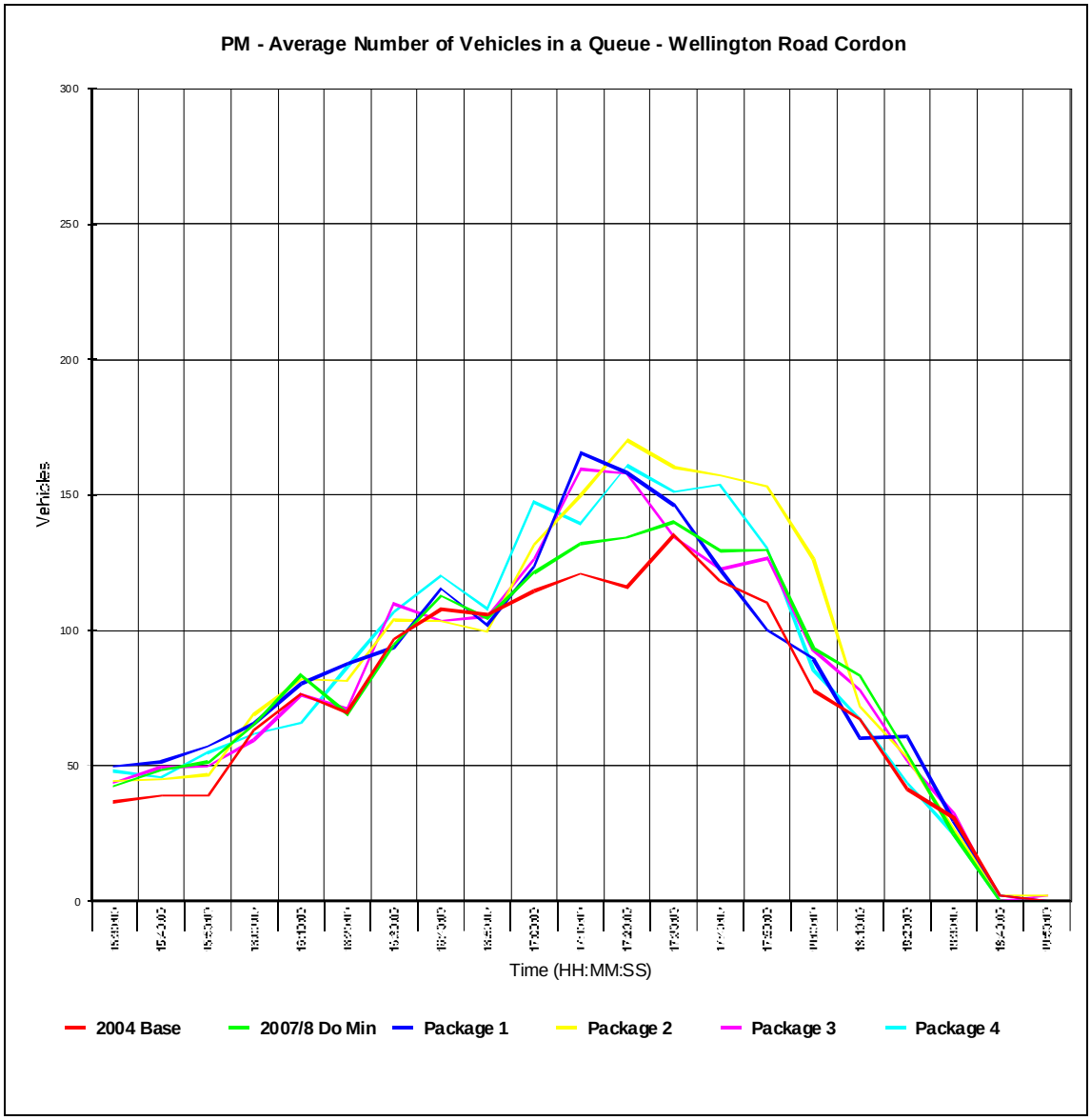

Figure 5.15 : Vehicles in Queue –Wellington Road Cordon

Figure 5.15 illustrates that the number of vehicles queued within the Wellington Road cordon is relatively unchanged though the number of vehicles queued in all test packages is slightly higher than the 2008 Do-Minimum.

Figure 5.16 shows the PM results for the North of Bridges cordon.

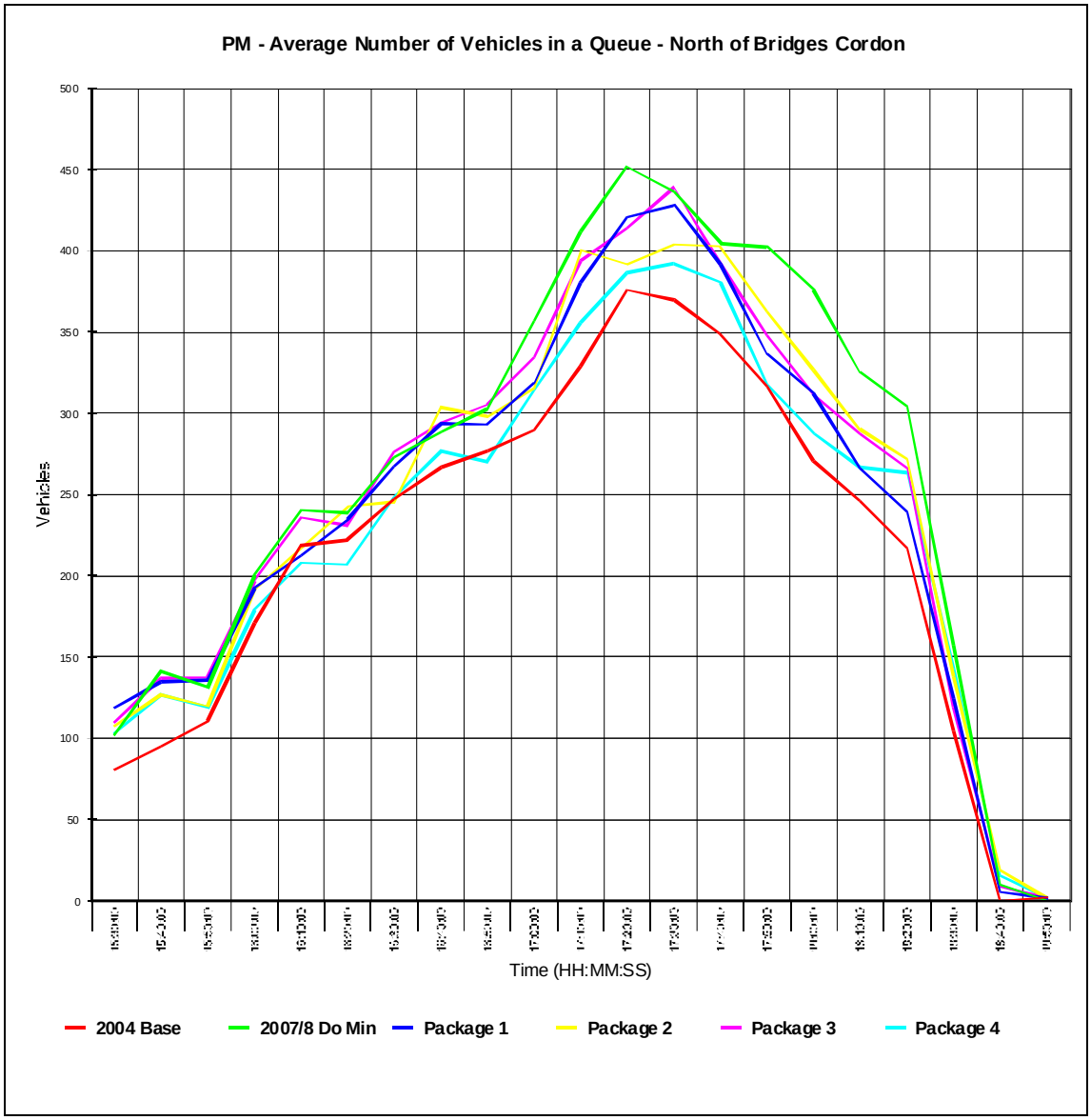

Figure 5.16 : Vehicles in Queue –North of Bridges Cordon

Figure 5.16 illustrates that for the North of Bridges cordon in the PM peak there is very little difference between the Packages assessed for 2008, though all offer slight benefits when compared to the 2008 Do-Minimum.

Figure 5.17 shows the PM results for the South of Bridges cordon.

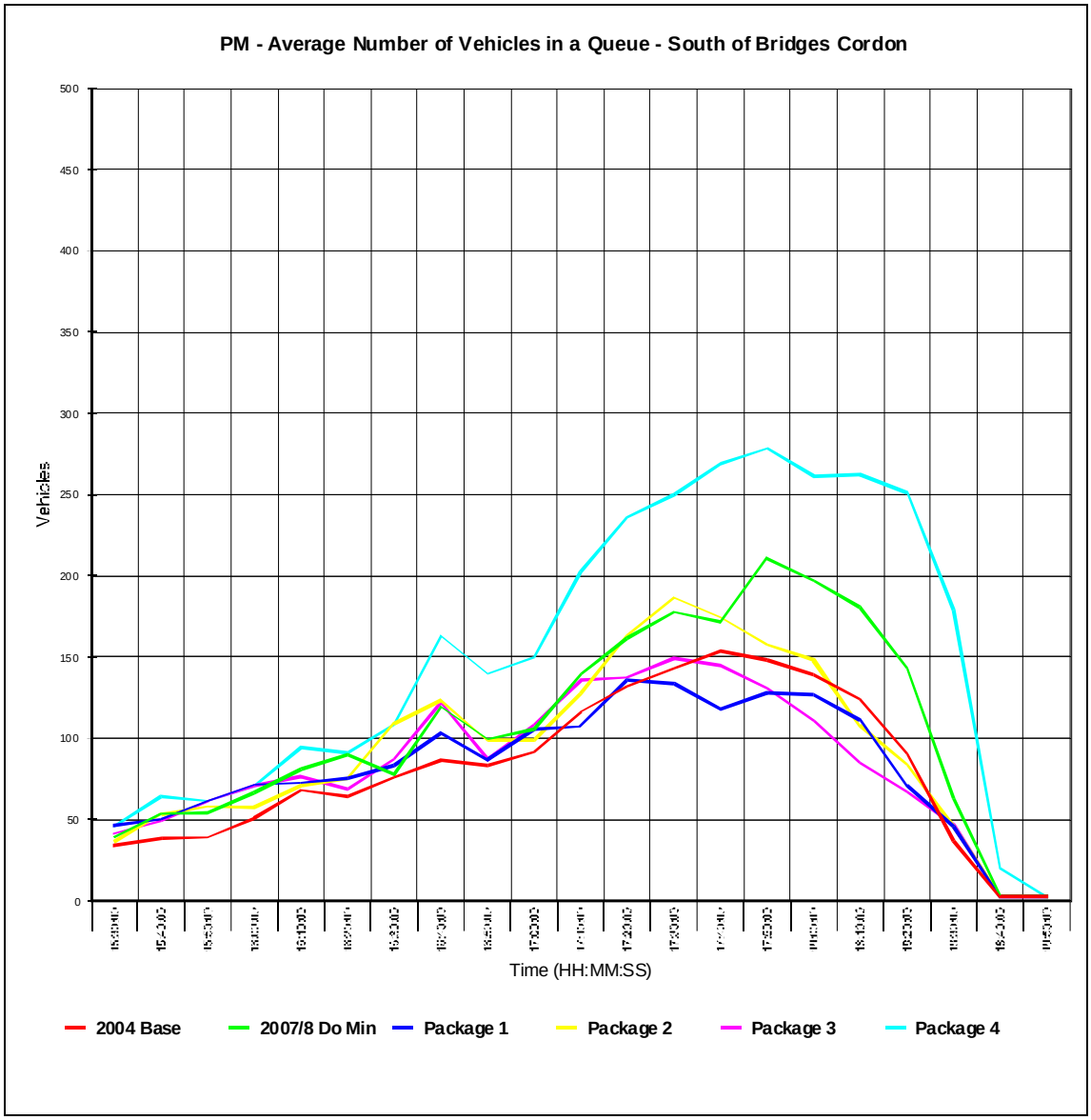

Figure 5.17 : Vehicles in Queue –South of Bridges Cordon

Figure 5.17 illustrates that with the exception of Package 4, all scenarios assessed for 2008 show benefits over the Do-Minimum within the South of Bridges cordon area.

Table 5.3 shows the maximum number of vehicles queued off the network at key locations in the PM period.

Table 5.3 : PM Period – Max Queue off Network

Scenario / Location	Broomhill Ave	Garthdee Rd Retail Park	Leggart Terrace	Great Northern Rd	Greenbank Rd	Souterhead Rd	Hareness Rd	Greenwell Rd	Provost Watt Drive
2004 Base	100	97	0	0	0	10	0	102	0
2008 Do Min	331	181	11	0	0	31	108	0	0
Package 1-1	115	38	786	20	703	18	114	11	0
Package 1-2	164	53	608	26	735	22	105	0	80
Package 1-3	181	30	836	18	609	14	118	0	5
Package 1-4	130	72	407	3	703	10	123	0	0
Package 1-5	131	86	280	74	0	16	98	12	183
Package 1-6	161	113	366	46	0	20	94	0	0
Package 1-7	194	104	310	0	0	10	116	30	0
Package 1-8	151	104	355	0	0	18	0	11	0
Package 1-9	141	257	0	0	0	20	12	14	0
Package 2-1	166	160	57	0	0	14	7	0	0
Package 2-2	167	186	58	0	0	10	22	24	0
Package 3-1	214	223	0	0	0	16	0	11	0
Package 4-1	183	155	34	0	0	14	8	5	0

Table 5.3 shows that all modelled scenarios during the PM peak have a number of vehicles queued off the modelled road network. It is clear that packages 1-1 to 1-8 are least favourable.

6 SUMMARY AND CONCLUSIONS

6.1 Summary of Short Term Testing

The short term Do-Minimum model was based on the 2004 Base model infrastructure, with the addition of dualling from Charleston to Souterhead on the A956 which is under construction at time of writing.

The short term Do-Minimum model represents an assessment year of 2008 and growth was derived from the Aberdeen Sub Area Model (ASAM3b) model using an interpolation procedure between 2005 and 2012. Details of growth are reported in the ASAM3b iteration technical report (Appendix A).

The growth from the 2004 base model applied using ASAM3b forecasts to form the 2008 future year models is summarised as follows for the AM and PM peak periods:

- AM Peak 2004 Base 31475 vehicles growth of 3.7% (1175 vehicles) to 2008 giving 32650 vehicles in 2008
- PM peak 2004 base 40496 vehicles with growth of 3.2% (1292 vehicles)to 2008 giving 41788 vehicles in 2008

Four work packages were agreed by Aberdeen City Council and Nestrans and assessed using the 2008 Do-Minimum model as the reference case. The summary findings for the work packages are provided in the following sections.

6.1.1 Package 1

Package 1 formed the main package and investigated a range of measures, over nine sensitivity tests, designed to improve use of existing road capacity, such as signalisation of roundabouts, increased signalisation at junctions, segregated left turn lanes and remarking of roundabout lanes.

The key measures identified as potential short term solutions from the Package 1 testing were:

- Segregated left turn lanes from Great Southern Road to Stonehaven Road, Great Southern Road to King George VI Bridge and King George VI Bridge to West Tullos Road
- Segregated left turn lane from Wellington Road Southbound to Hareness Road
- Extended 3 lanes on Wellington Road northbound approach to Hareness Roundabout
- Abbotswell Crescent left in/ left out to Wellington Road and West Tullos Road
- Minor adjustments to signals at Souterhead Roundabout and Balnagask Rd/ Somerfield junction

The impact of these changes was found to be limited over the AM peak with journey times and mean delay remaining relatively consistent with the 2008 Do-Minimum. In the PM peak the measures suggested within Package 1 could reduce mean travel times across the study area network and reduce key journey times.

6.1.2 Package 2

Package 2 carried forward measures considered successful from the Package 1 testing and investigated measures to provide easier egress for HGVs from Great Southern Road (southbound) through managing the circulating flow from Bridge of Dee into a single lane. Package 2 testing considered:

- Bridge of Dee single lane at exit onto southern roundabout
- Great Southern Rd to Stonehaven Rd dedicated left turn lane

The modelled results and observations from Package 2 showed significant additional queuing on Holburn Street which actually increased delay on Great Southern Road. This was due to rerouting away from

Riverside Drive and Holburn Street as a result of delays on Bridge of Dee at Stonehaven Road from the reduction to a single lane. Package 2 measures were rejected and omitted from further consideration within subsequent packages.

6.1.3 Package 3

Due to the lack of clear benefit from Package 2, Package 3 carried forward Package 1 as its reference to assess the performance of an HGV/Bus lane on Great Southern Road between Bridge of Dee and King George VI Bridge. Package 3 added:

- HGV/ Bus lane on Great Southern Rd between Bridge of Dee and KGVI Bridge

The Package 3 test results showed little overall change to the network performance and efficiency for both general traffic and HGV traffic alike when comparing overall mean delay and key journey routes. As such, the provision of a bus/HGV lane has been omitted from future test scenarios though it may be worth further consideration as part of any package of HGV/Bus improvements.

6.1.4 Package 4

With neither Package 2 or 3 offering significant benefits over Package 1, Package 4 again adopted Package 1 as its reference condition to assess the performance of a new large roundabout on the northern side of King George VI Bridge to aid the movement of commercial traffic.

The initial model findings and observations did show benefits from Package 4 through improved journey times for some routes during the AM peak. However, the release of traffic from Riverside Drive in the PM caused downstream congestion problems both at King George VI Bridge/West Tullos Road and Bridge of Dee/Stonehaven Road.

It is unlikely that this option could be built in the short term due to the likely acquisition of cemetery land and the potential requirement for land from Duthie Park. Taking this into account, and considering the initial model findings, the larger roundabout on the northern side of King George VI Bridge has been rejected at this stage and omitted from future testing.

6.1.5 Additional Short Term Measures not Modelled

Some of the options raised at the stakeholder workshops, while not suitable for traffic modelling, were certainly worthy of consideration within the short term time frame. These measures could assist in meeting the key objectives and provide solutions to access to Aberdeen from the South. Measures raised by stakeholders which were not suitable for modelling or incorporation into this appraisal are listed below, they have been scored against key planning objectives and details can be found in Appendix B:

- Public transport subsidy at peak times
- Prevent rat running through Torry and other residential areas
- Improve public transport access to East and West Tullos Industrial estates
- Travel management organisation (TMO) for the Altens, Tullos and Cove areas to implement green travel plan initiatives
- Westbound Trinity Quay traffic signals. Maintain Trinity Quay southbound phase even when Guild Street has green
- Wellington Road Southbound, consider signal adjustment to allow for speed and acceleration of HGVs

Some of these additional suggestions are reflective of other elements within the Regional and Local Transport Strategies and the delivery of these strategies can provide additional benefit.

6.2 Findings

In summary, components of the short term assessment which traffic modelling has shown may provide some benefits to the Aberdeen south study area are:

1. Segregated left turn lane Great Southern Road to King George VI Bridge
2. Segregated left turn lane King George VI Bridge to West Tullos Road
3. Segregated left turn lane Wellington Road to Hareness Road
4. Segregated left turn lane Great Southern Road to Stonehaven Road
5. Extended 3 lanes on Wellington Road northbound approach to Hareness Roundabout
6. Adjusted traffic signals Souterhead Roundabout
7. Adjusted traffic signals Balnagask Road/ Somerfield junction
8. Adjusted traffic signals Wellington Road/Greenbank Road

The re-configuration of access around Abbotswell Crescent/Wellington Road/West Tullos Road has not been adopted for future testing as the required routing of bus services would conflict with any future potential to install traffic signal control at the Hareness Road/Wellington Road junction.

Figure 6.1 shows the locations of these measures and these components will form the Do-Minimum base for the medium term, 2012 with Aberdeen Western Peripheral Route, options. The additional short term measures which could not be modelled should also be considered.

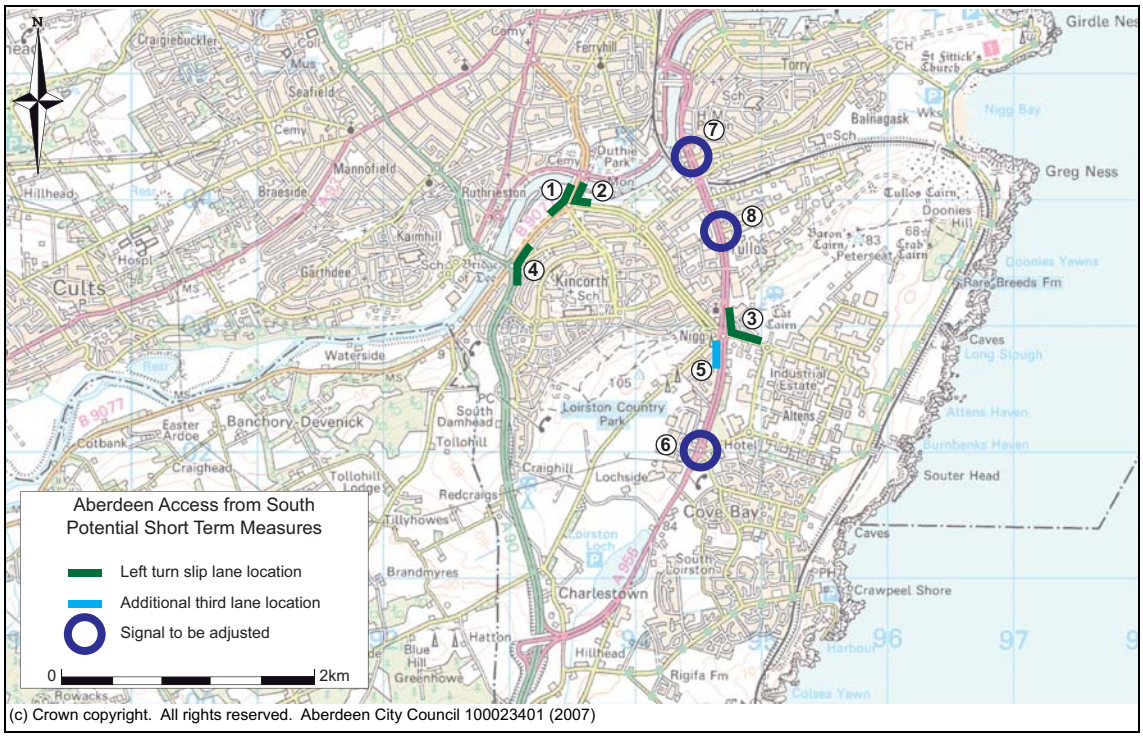

Figure 6.1 : Potential Short Term Measures