Aberdeen Access from the South Appendix E

Aberdeen City Council, Aberdeenshire Council, Nestrans

Long Term (2027) S-Paramics Testing

LONG TERM (2027) S-PARAMICS TESTING

Description:

Aberdeen Access from the South Appendix E

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1 INTRODUCTION

1.1 Purpose of Report

This technical report details the long term (2027) option testing considered for the Aberdeen Access from the South Study.

The long term testing completes the final part of a structured testing regime to consider measures to improve access to Aberdeen from the South in the:

- Short term testing – 2008
- Medium term testing – 2012 with Aberdeen Western Peripheral Route
- Long term testing – 2027 with Aberdeen Western Peripheral Route

1.2 Structure of Report

Following this brief introduction, Chapter 2 details the development of the Do-Nothing and Do-Minimum scenarios. Chapters 3 to 6 detail the long term packages and their results, and Chapter 7 summarises the recommended measures from the long term assessment.

1.3 Medium Term Measures

The medium term option testing is reported in Appendix D. Following the medium term testing, the measures considered appropriate for taking forward to the long term testing forming initially the 2027 Do-Minimum were:

- New pedestrian footbridge over River Dee at Bridge of Dee to improve safety and comfort for pedestrians and cyclists at this location. New pedestrian/cycle bridge allows removal of footways on Bridge of Dee negating the existing width restriction
- Replace Wellington Road/Hareness Roundabout with signalised junction incorporating pedestrian and cyclist facilities
- Existing Abbotswell Crescent to West Tullos Road stopped up with access created further west from Abbotswell Crescent to West Tullos Road
- Replace Souterhead Roundabout with signalised junction incorporating pedestrian and cyclist facilities
- Park and Ride located at Schoolhill subject to future detailed investigation
- New bus lane on Wellington Road between Charleston and Hareness Road
- HOV lane on the A90 northbound from Charleston to a point 100 metres south of Bridge of Dee

2 DEVELOPMENT OF LONG TERM OPTIONS

2.1 2027 Demand

The long term Do-Minimum model represents an assessment year of 2027 and growth was derived from the Aberdeen Sub Area Model (ASAM3b) model. Details of growth are reported in the ASAM3b iteration technical report (Appendix A).

The growth as applied to the 2004 base model, using ASAM3b forecasts to form the 2027 future year models (with Aberdeen Western Peripheral Route), can be summarised as follows for the AM and PM peak periods:

- AM Peak 2004 Base 31475 vehicles growth of 11.5% (3612 vehicles) to 2027 giving 35087 vehicles in 2027 in the AM peak period
- PM peak 2004 base 40496 vehicles with growth of 10.5% (4272 vehicles) to 2027 giving 44768 vehicles in 2027 in the PM peak period

2.2 Long Term Do-Nothing Model

2.2.1 2027 Do-Nothing Model Development

The long term (2027) Do-Nothing model is based on the medium term Do-Minimum network (2012 plus short term improvements). The long term scenarios incorporate the 2027 forecast travel demand, and the infrastructure measures included are consistent with the 2012 Do-Minimum model and include:

- Segregated left turn lane Great Southern Road to King George VI Bridge
- Segregated left turn lane King George VI Bridge to West Tullos Road
- Segregated left turn lane Wellington Road to Hareness Road
- Segregated left turn lane Great Southern Road to Stonehaven Road
- Extended 3 lanes on Wellington Road northbound approach to Hareness Roundabout
- Adjusted traffic signals Souterhead Roundabout
- Adjusted traffic signals Balnagask Road/ Somerfield junction

2.2.2 2027 Do-Nothing Model Observations

In the AM peak queueing is observed on South Anderson Drive southbound and northbound on Wellington Road from Souterhead roundabout. These queues are in excess of those in the 2004 base model.

In the PM peak queueing is observed on South Anderson Drive southbound from the Bridge of Dee. Significant queueing is also observed on many of the roads with junctions onto Wellington Road: Hareness Road, Souterhead Road and Greenbank Road. Other areas where congestion was observed are Garthdee, Broomhill Road and Craigshaw Drive with significant numbers of vehicles unable to access the modeled network and queued back into zones.

2.3 Long Term Do-Minimum Model

2.3.1 2027 Do-Minimum Model Development

The long term Do-Minimum model adopts the measures identified in the medium term testing, as described in Chapter 1.

2.3.2 2027 Do-Minimum Model Observations

In the AM peak queueing is still observed on South Anderson Drive southbound and northbound on Wellington Road in excess of that observed in the 2004 base.

In the PM peak queueing is observed on South Anderson Drive southbound, Broomhill Road and Garthdee, with most congestion concentrated on the Bridge of Dee area with a significant number of vehicles unable to access the modeled network and in effect queuing back into the zones.

2.4 Schedule of Long Term 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 long term options which met the appropriate criteria were grouped into work packages.

The packages of long term (2027) option testing for application in the S-Paramics model were discussed between Aberdeen City Council, Nestrans and SIAS Limited 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 this combined with subsequent email communication, outlined four key long term packages for consideration.

A summary of the long term packages is given in Table 2.1.

Table 2.1 : Long Term Packages Considered

Reference	Package	Description	Rationale
Base	Base 04	JMP Validated Base 04	Provides a comparitive base to existing conditions
Do-Nothing	Do Nothing 2027	2027 forecast demand with potential short term measures	Provides an assessment baseline for worst case
Do-Min	Do Minimum 2027	2027 forecast demand with potential medium term measures	Provides an assessment baseline for comparison
1	P 1	Widen Bridge of Dee with either Roundabouts or Traffic Signals at terminal junctions	To access the benefits of providing significantly more capacity on the Bridge of Dee and the impact on the surrounding road network
2	P2	New two-way bridge upstream of Bridge of Dee	Investigate the impact of retaining Bridge of Dee in it's current form (width restriction revoked) but providing additional capacity upstream via Garthdee
3	P3	New two-way bridge upstream of Bridge of Dee to form gyratory (BOD one-way southbound, new bridge one-way northbound)	Investigate the impact of retaining Bridge of Dee in it's current form (width restriction revoked) but providing additional capacity upstream via Garthdee under a one-way gyratory arrangement
4	P4	Hign Occupancy Vehicle Lane on Great Southern Road between Bridge of Dee and King George VI Bridge in both directions	Assess the potential benefits to the road network through the provision of HOV lanes over this section

- Package 1 – Widen Bridge of Dee (BoD)
  - (a) with roundabouts
  - (b) with traffic signals
- Package 2 – New two-way bridge upstream of Bridge of Dee

- Package 3 – New bridge upstream of Bridge of Dee to form gyratory (BoD one way southbound, new bridge one-way northbound)
- Package 4 – HOV lane on Great Southern Road from BoD to King George VI Bridge and vice versa

A further measure included in all the long term packages is Leggart Terrace diverted onto the A90 Stonehaven Road. As part of this measure vehicles can access Leggart Terrace from the southern Bridge of Dee junction but egress from Leggart Terrace is no longer allowed. Roundabouts were added on Leggart Terrace and on the A90 to access the new link between the two. Figure 2.1 shows conceptual Leggart Terrace diversion onto Stonehaven Road. In this instance the roundabouts are conceptual, the junctions would benefit from future detailed design and possible consideration of traffic signal control.

While initial discussion with Aberdeen City Council Officers has indicated that a route is possible for the diversion of Leggart Terrace, the full design of this revised linkage will require full consideration of gradient variation and property.

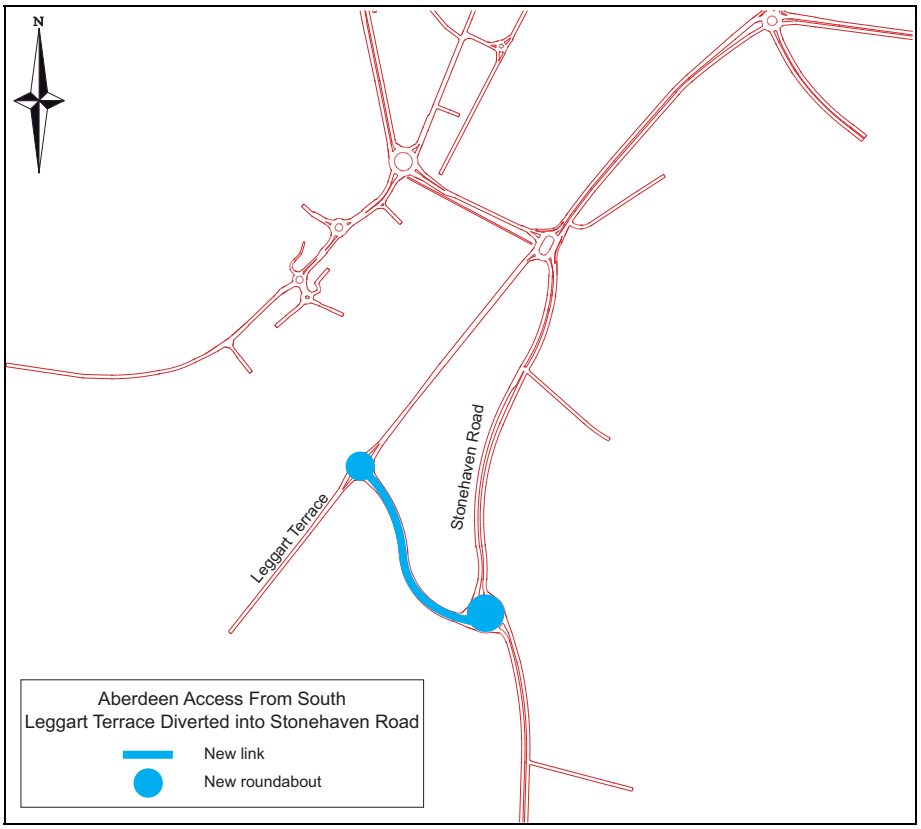


Figure 2.1 : Leggart Terrace Diverted onto Stonehaven Road

3 PACKAGE 1

3.1 Introduction

Package 1 focuses on the Bridge of Dee and its terminal junctions. Congestion is frequently observed during peak times due to the bridge being only a single lane in each direction.

3.2 Aim

The aim of Package 1 was to test a widened Bridge of Dee and identify whether this would reduce traffic congestion in the area.

3.3 Development of Package 1

In Package 1, the Bridge of Dee is widened to six lanes, allowing three lanes in each direction to accommodate traffic demand. Future detailed design should identify the length of the third lane flare required at the Bridge of Dee junctions. For the purpose of testing, six lanes have been assumed as the maximum.

Package 1 was split into two parts, as detailed below:

- Package 1-1 Widened Bridge of Dee (6 Lanes) and larger roundabout at A90/Holburn St
- Package 1-2 Widened Bridge of Dee (6 Lanes) and signal junctions at each end of bridge

In Package 1-1 the preliminary design of a larger roundabout at the A90/ Holburn St junction is based on forecast traffic flows.

Preliminary designs for signalised junctions in Package 1-2 were developed based on forecast traffic flows. The introduction of traffic signal control affords better facilities for cyclists and pedestrians. A full pedestrian crossing stage was incorporated into the northern junction, which allowed removal of the existing remote pedestrian crossing facilities. At the southern junction, ‘walk with traffic’ pedestrian facilities have been assumed, permitting a pedestrian route across all arms apart from the Bridge of Dee arm.

Forecast traffic flows for the Bridge of Dee area are shown Figure 3.1 shows the AM peak hour flows and Figure 3.2 shows the PM peak hour flows.

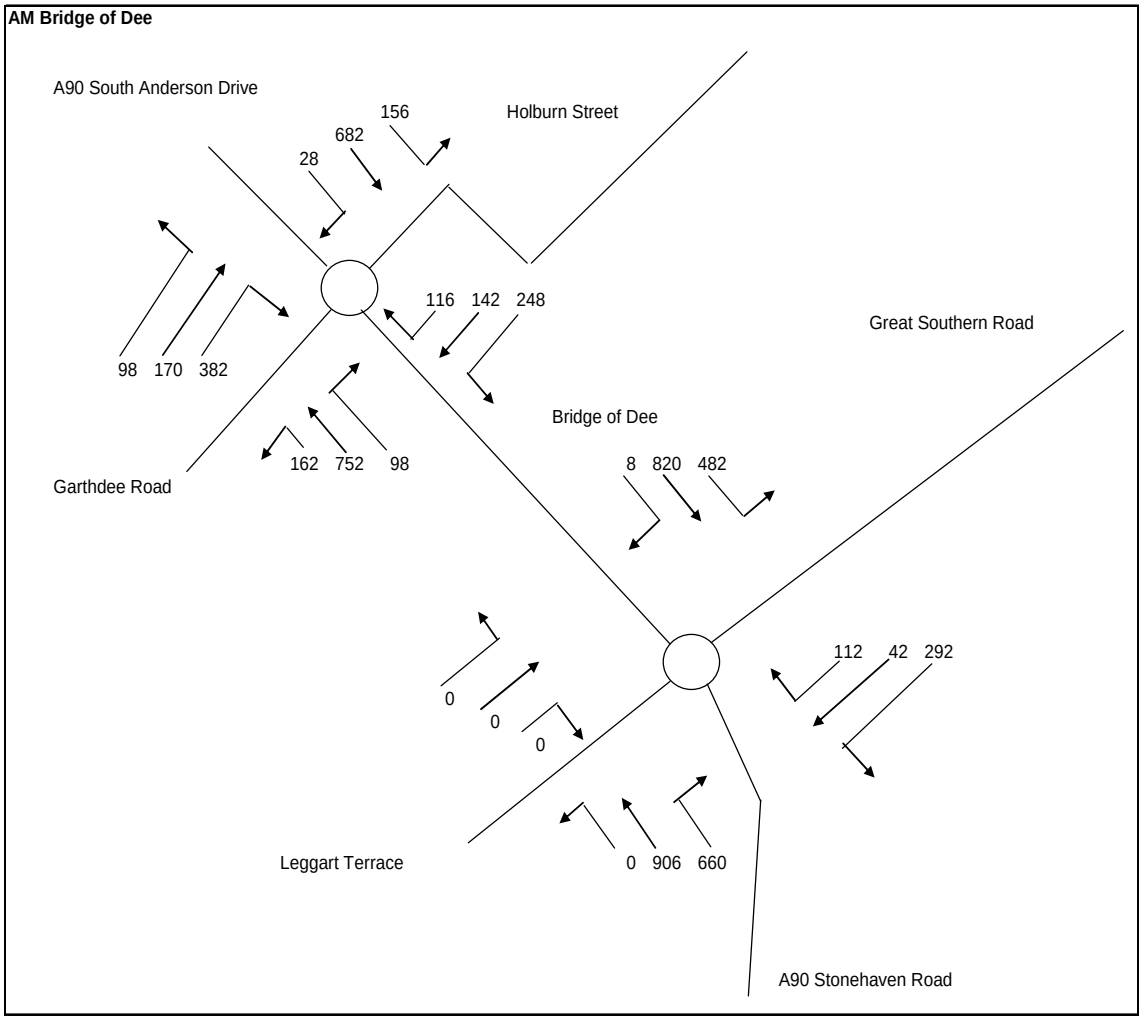


Figure 3.1 : Forecast 2027 Traffic Flows AM Peak Hour (08:00 – 09:00)

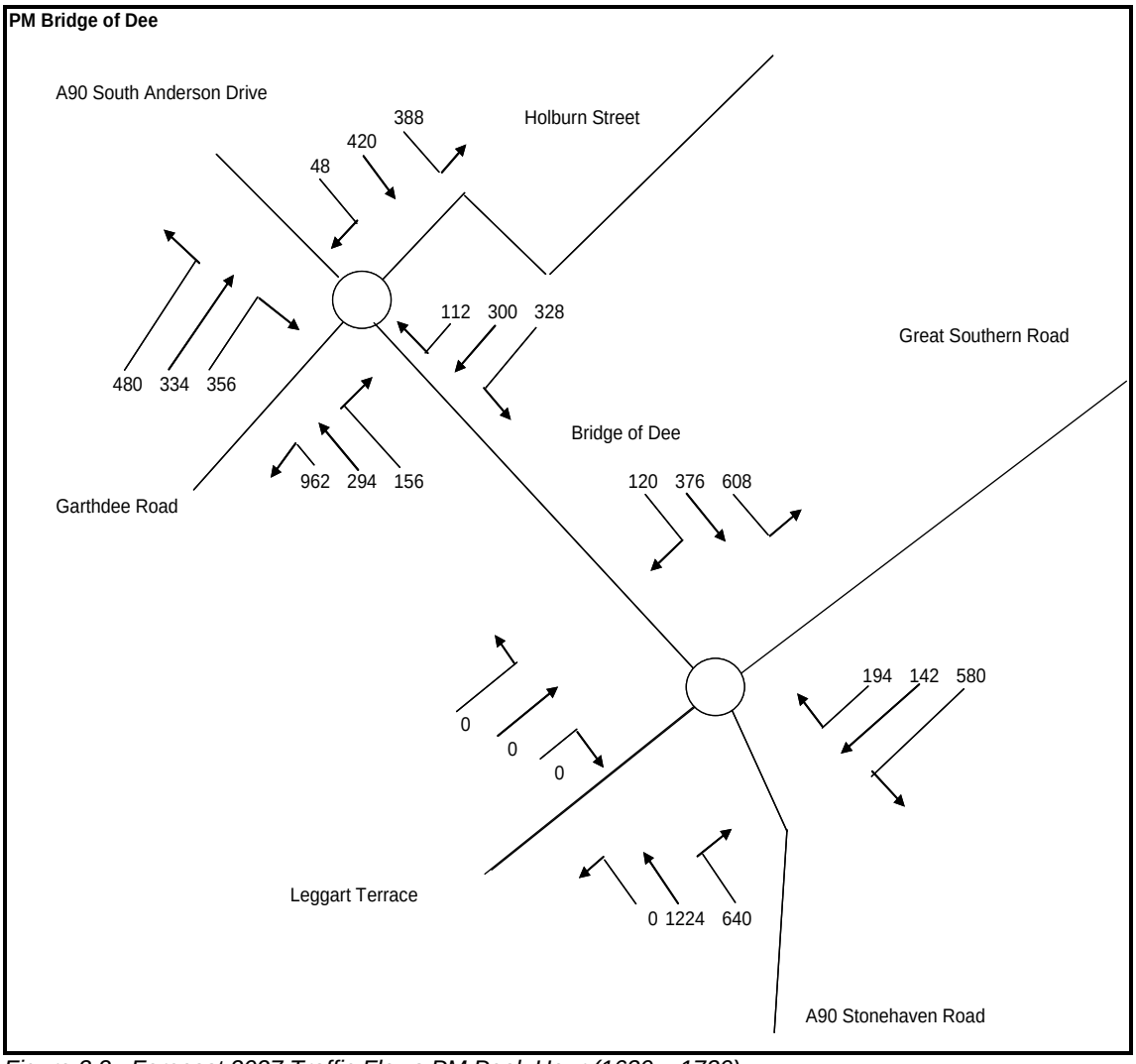


Figure 3.2 : Forecast 2027 Traffic Flows PM Peak Hour (1630 – 1730)

3.3.1 Package 1-1

Package 1-1 is the replacement of the existing northern roundabout of the Bridge of Dee with a larger roundabout (80metre ICD assumed). The Bridge of Dee is also widened to six lanes. Figure 3.3 illustrates the conceptual design.

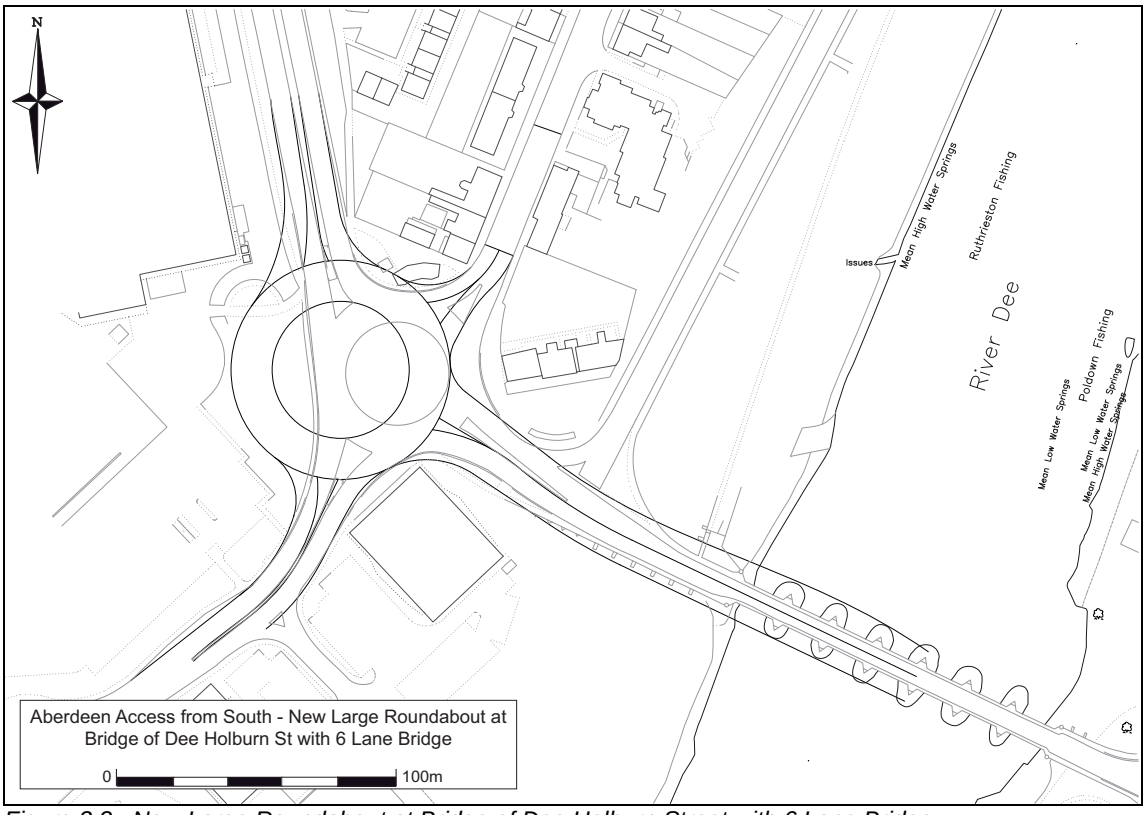


Figure 3.3 : New Large Roundabout at Bridge of Dee Holburn Street with 6 Lane Bridge

Figure 3.3 shows that fitting an 80 metre ICD roundabout is possible though some land acquisition may be required. It also demonstrates that a six lane bridge crossing can be accommodated.

3.3.2 Package 1-2

Package 1-2 involved replacing the roundabouts at each end of the Bridge of Dee with signal controlled junctions and widening the Bridge of Dee to six lanes. Figures 3.4 and 3.5 illustrate the signal layouts applied in the traffic model.

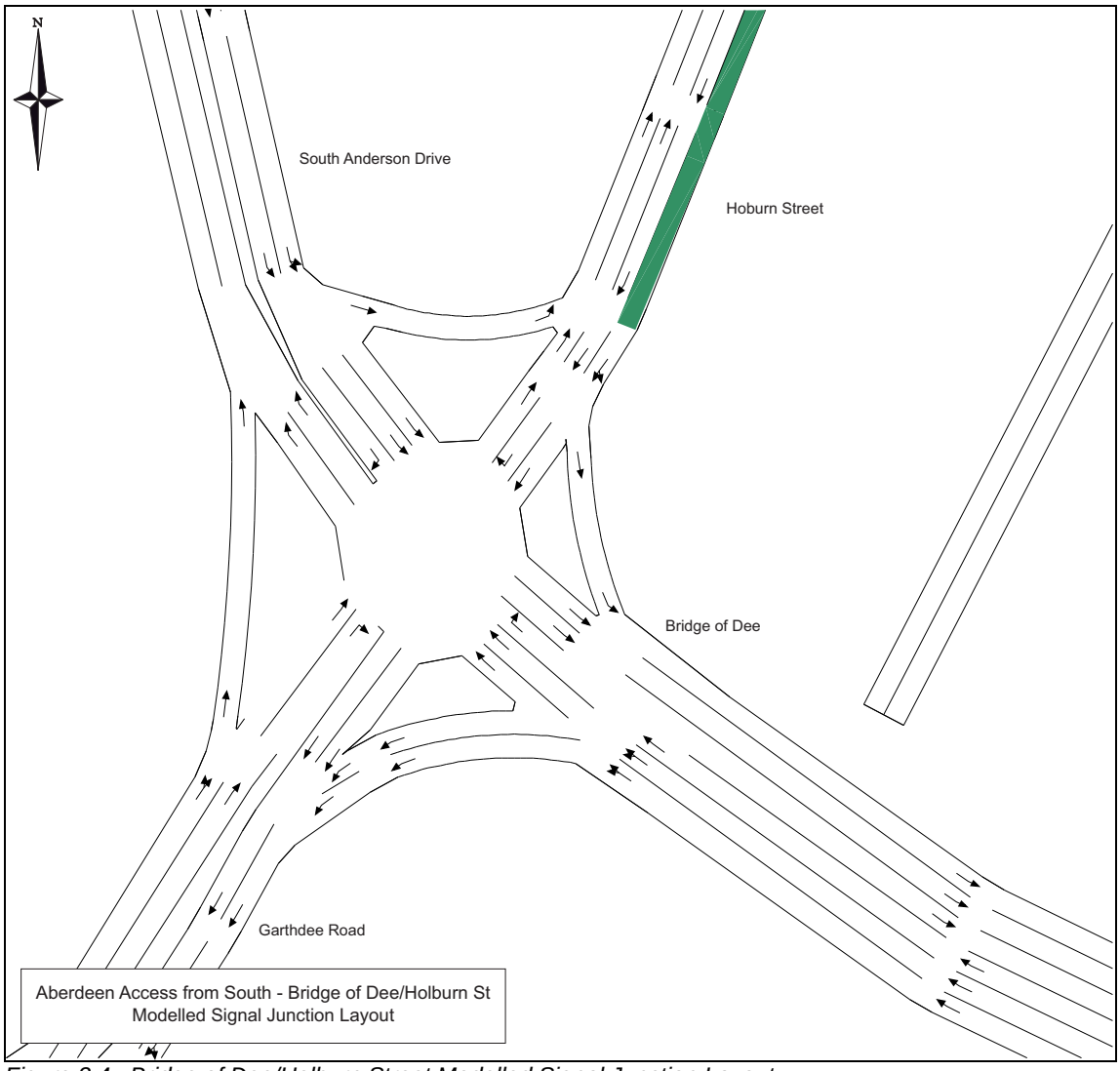


Figure 3.4 : Bridge of Dee/Holburn Street Modelled Signal Junction Layout

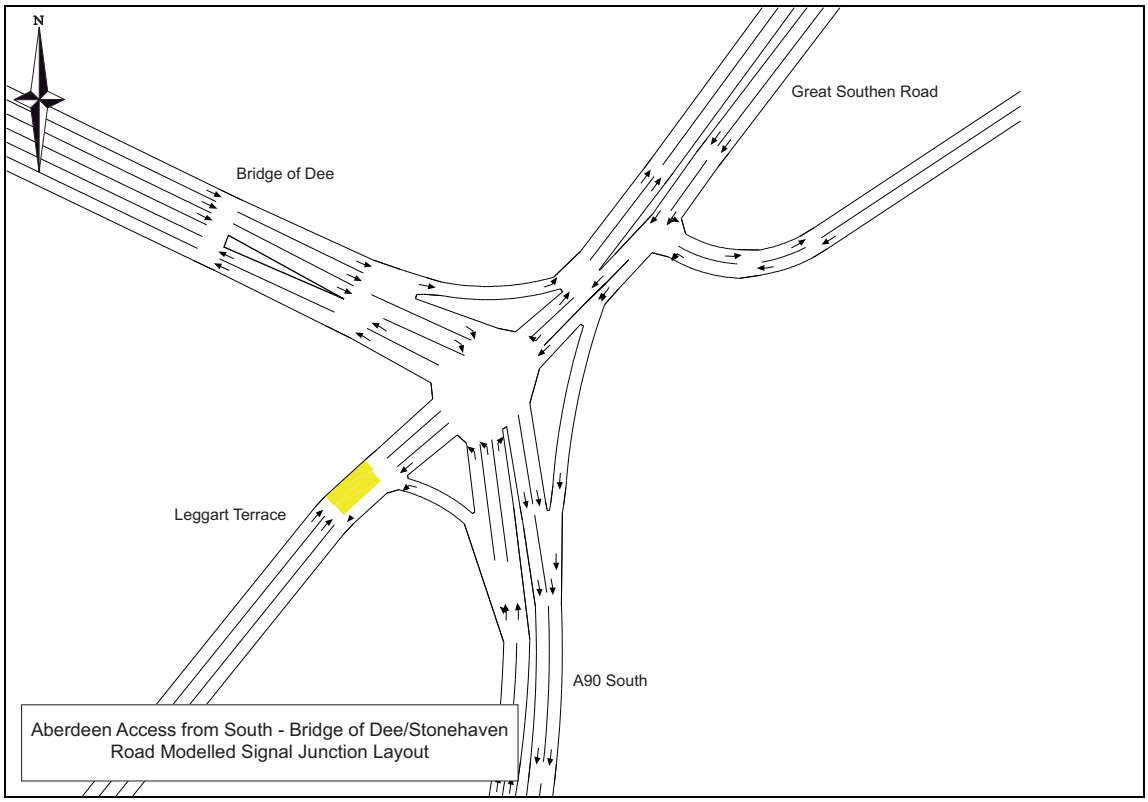


Figure 3.5 : Bridge of Dee/Stonehaven Road Modelled Signal Junction Layout

3.4 Model Observations

Package 1-1 did not operate satisfactorily. In the AM peak a queue develops on Stonehaven Road which extends back past the new access to Leggart Terrace. In the PM peak a queue develops on Stonehaven Road, extending onto the new link to Leggart Terrace and then onto Leggart Terrace. This area becomes gridlocked by approximately 17:30 and the queues extend over the Bridge of Dee and Great Southern Road, with the model eventually becoming gridlocked.

Package 1-2 operates well with no queueing observed in the Bridge of Dee area in the AM peak. In the PM peak the signal controlled junctions operate well and no significant congestion is observed around the Bridge of Dee.

3.5 Network Performance (Package 1)

3.5.1 Average Journey Times

The average journey times on key routes have been extracted from the models to show any benefits from the introduction of the improvement schemes. Journey times have been extracted for the following movements;

- A90 (south) to South Anderson Drive
- South Anderson Drive to A90 (south)
- A90 (south) to Great Southern Road
- Great Southern Road to A90 (south)

Table 3.1 shows the average journey times for all vehicles in the AM period.

Table 3.1 : AM Journey Time Comparison (mm:ss)

Route	Direction	2004 Base	2027 Do-Noth	2027 Do-Min	Package 1-1	Package 1-2
A90 (s) to S. Anderson Drive	NB	10:58	09:01	08:55	11:46	09:27
S. Anderson Drive to A90 (s)	SB	11:15	11:00	11:04	09:14	09:38
A90 (s) to Great Southern Rd	NB	09:14	09:23	09:22	12:18	09:47
Great Southern Rd to A90 (s)	SB	10:29	09:24	09:32	09:34	09:30

Table 3.1 shows that in the AM peak, Package 1-1 has an increased journey time in the northbound direction when compared to the 2027 Do-Min. Package 1-2 shows a slight increase in northbound journey times compared to the 2027 Do-Min, due to delay caused by the traffic signals. The southbound journey time from South Anderson Drive, is reduced from 11:04 in the 2027 Do Min to 09:38 in Package 1-2. Overall, there are marginal differences to the AM journey times though significant benefits would be realised in terms of cyclist and pedestrian provision both at the bridge junctions and across the bridge span.

Table 3.2 shows the average journey times for all vehicles in the PM period.

Table 3.2 : PM Journey Time Comparison (mm:ss)

Route	Direction	2004 Base	2027 Do Noth	2027 Do Min	Package 1-1	Package 1-2
A90 (s) to S. Anderson Drive	NB	09:05	53:05	08:54	11:51	09:35
S. Anderson Drive to A90 (s)	SB	11:55	36:54	17:36	09:12	10:55
A90 (s) to Great Southern Rd	NB	09:14	56:05	09:17	12:32	09:33
Great Southern Rd to A90 (s)	SB	10:29	06:22	10:39	10:09	11:10

Table 3.2 shows that in the PM peak Package 1-1 has an increased journey time in the northbound direction and a reduced journey time in the southbound direction compared to the 2027 Do-Min. Package 1-2 shows a small increase in northbound journey time from the 2027 Do-Min but shows a significant reduction in southbound journey time from South Anderson Drive. Package 1-2 also brings accessibility and safety benefits for pedestrians and cyclists and it has been adopted as the preferred Package 1 option for further comparisons and consideration.

3.5.2 Average Maximum Queue Lengths

The average maximum queue length at the two junctions of the Bridge of Dee has been analysed using the S-Paramics DAT (Data Analysis Tool) package and details are provided in Appendix A of this document. The queues have been compared against the 2027 Do-Nothing and the 2027 Do-Minimum for both the AM and PM Peaks. Package 1-2 only is shown graphically, as the preferred Package 1 option. The following summarises the queue length findings:

- AM Peak
    - South Anderson Drive southbound (Fig A.3) shows that with the introduction of traffic signals and a three lane bridge span at the Bridge of Dee, the queue length on South Anderson Drive is reduced from over 400m to less than 150m

- Holburn Street westbound (Fig A.4) queue length remains similar in Package 1-2 to the queue lengths in the 2027 Do-Nothing and Do-Minimum with a peak of around 300 metres
- Garthdee Road eastbound (Fig A.5) shows that in Package 1 the average maximum queue length on Garthdee Road has increased by approximately 50m compared with the Do-Minimum in the AM peak due to the queue balancing nature of the traffic signals
- Package 1 has dispersed the peak in queue lengths on Great Southern Road (Fig A.6) between 08:00 and 08:45 from 250-300m to 100-150m
- Stonehaven Road northbound (Fig A.7) shows that average maximum queue length in Package 1-2 has increased by approximately 100m at 07:50 to 200 metres compared with the Do-Minimum. This increase can be attributed to Leggart Terrace being diverted onto Stonehaven Road. it is however still significantly better that the 2004 base where the queue peaks at over 700m

- PM Peak
  - South Anderson Drive southbound (Fig A.8) shows a significant reduction in queue length on during the PM peak, from approximately 1050m (the extents of the model network) in the 2027 Do-Nothing and Do-Minimum to approximately 100m in Package 1-2
  - The average maximum queue on Holburn Street (Fig A.9) has increased in Package 1-2 by approximately 50-100m to around 200 metres due to the traffic signals balancing queueing on other arms
  - Garthdee Road (Fig A.10) shows the average maximum queue has increased in Package 1-2 by approximately 50-100m to around 150 metres due to the traffic signals balancing queueing on other arms
  - Great Southern Road westbound (Fig A.11) shows no significant change in queueing in Package 1-2 when compared to the Do-Minimum however both are significantly better than the 2004 base with an average around 100 metres in length compared to 400-500 metres
  - Stonehaven Road northbound (Fig A.12) shows no significant change in queueing during the PM peak with between 150-200 metres of queue

3.5.3 Unreleased Vehicles

The number of vehicles in a queue off the model network was extracted for the PM peak hour, as an indicator of congestion. The number of unreleased vehicles is an average, calculated from five S-Paramics model runs. Appendix A provides detailed graphs showing the following; the total number of unreleased vehicles in the network, the number of unreleased vehicles in the Garthdee area, and the number of unreleased vehicles in the Anderson Drive area during the PM peak hour. Note the graphs use different scales. The results showed that:

- the total number of unreleased vehicles in Package 1-2 is less than the 2004 Base and significantly less than the 2027 Do-Nothing
- all scenarios have peak of approximately 40 to 60 unreleased vehicles at 17:00, in the Garthdee area
- in the 2027 Do-Nothing and Do-Minimum scenarios the number of unreleased vehicles is still increasing at the end of the peak hour (around 150 vehicles), in the Anderson Drive area. In Package 1-2 the number has reduced to approximately 10 by 1730 offering a significant benefit

3.5.4 Park and Ride

Graphs have been produced which compare the bus journey time from the Park and Ride site (Schoolhill), against the car from the A90 at Schoolhill to Market Street via the A956 (Wellington Road). The AM inbound and PM outbound journey times are compared for the 2027 Do-Minimum and Package 1-2.

Figure 3.6 and Figure 3.7 show the AM inbound journey times.

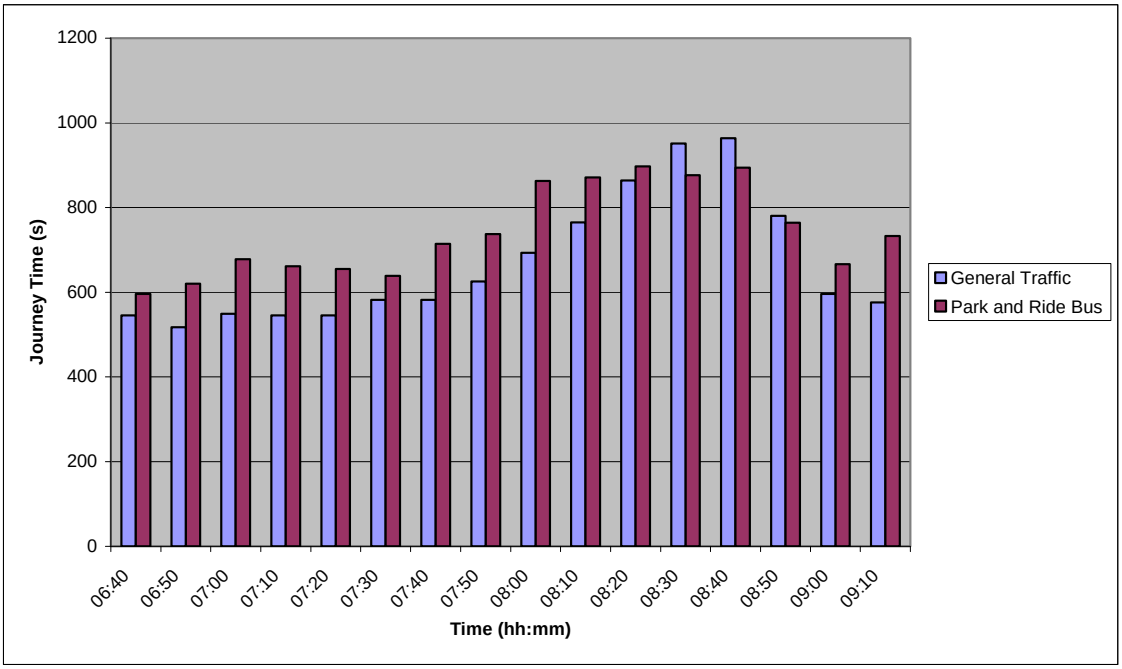


Figure 3.6 : 2027 Do-Minimum – AM Inbound Journey Times

Figure 3.6 shows that the AM inbound journey time in the 2027 Do-Minimum scenario, general traffic is quicker than the Park and Ride bus until 08:30 when the bus becomes quicker. The bus remains the quicker option until 08:50.

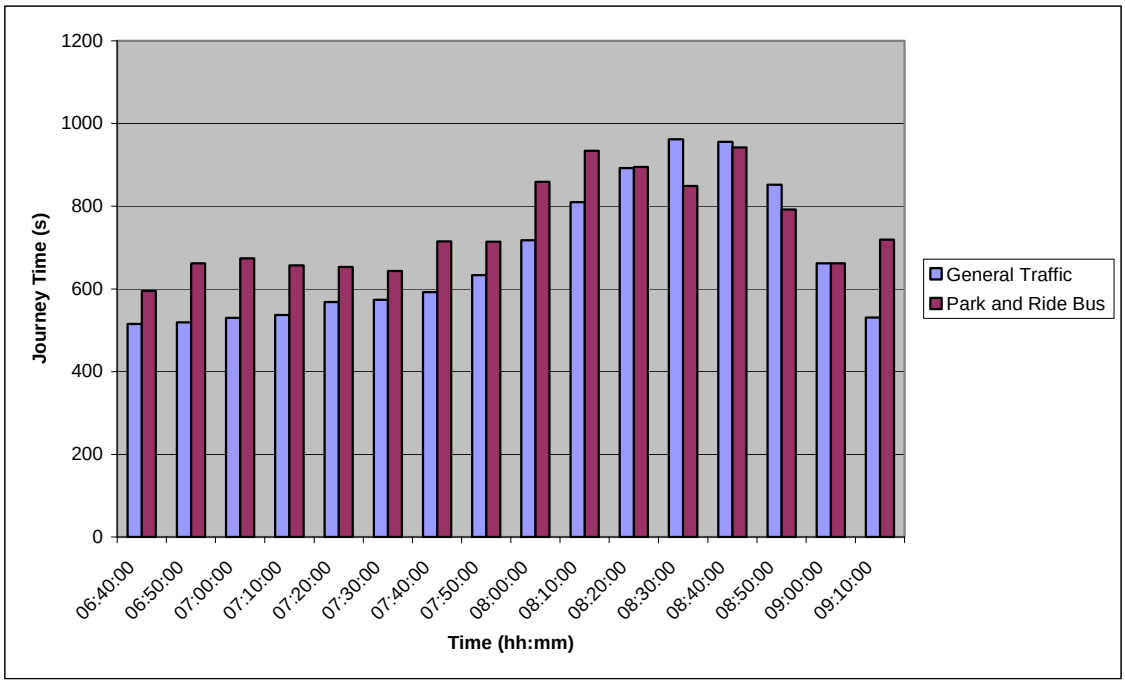


Figure 3.7 : Package 1-2 – AM Inbound Journey Times

Figure 3.7 shows that the AM inbound journey time for Package 1-2 is quicker for general traffic until 08:20 when the journey times are equal. The Park and Ride bus is then faster until 09:00 where the journey times become equal again.

Figure 3.8 and Figure 3.9 show the PM outbound journey times.

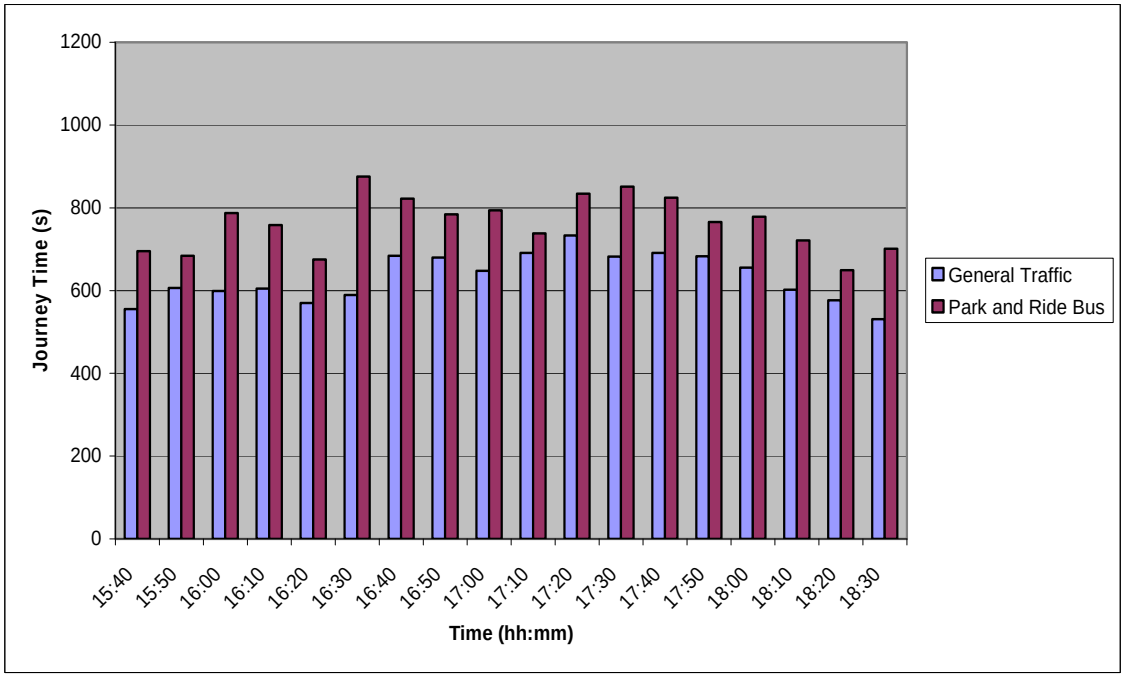


Figure 3.8 : 2027 Do Minimum – PM Outbound Journey Times

Figure 3.8 shows that the PM outbound journey times for general traffic are quicker than the Park and Ride bus throughout the period, in the 2027 Do-Minimum scenario.

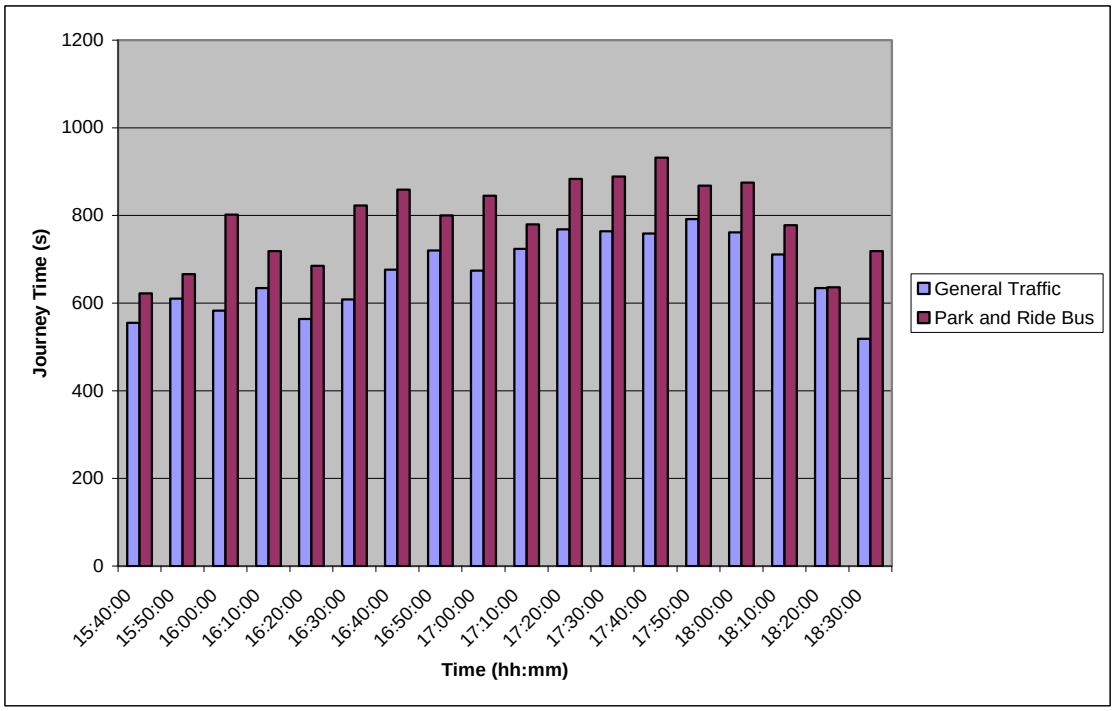


Figure 3.9 : Package 1-2 – PM Outbound Journey Times

Figure 3.9 shows that in Package 1-2 the PM outbound journey times for general traffic are quicker than the Park and Ride bus throughout the period. No bus priority is provided southbound on Wellington Road these results are logical.

3.6 Findings from Package 1

Package 1-1, a widened Bridge of Dee with a larger roundabout at the A90/ Holburn St junction did not operate satisfactorily. The larger roundabout and widened Bridge delivered traffic with greater ease to the southern roundabout of the Bridge of Dee, which, with no improvements, failed cope with the demand resulting in significant delays in the PM peak on the A90.

Package 1-2, a widened Bridge of Dee with signal controlled junctions at the ends has shown benefits such as overall improvements to average journey times. Package 1-2 was also observed to reduce queue lengths on South Anderson Drive in both the AM and PM peaks, a key area of congestion in the long term.

Significant benefits could be realised for both pedestrians and cyclists through the widening of Bridge of Dee with traffic signal control, incorporating pedestrian/cyclist facilities, at either end of the bridge. Traffic signal control and the extra lanes on the bridge may provide future potential to introduce bus priority measures.

4 PACKAGE 2

4.1 Introduction

The Bridge of Dee is currently a key point of congestion, due to the current single lane in each direction. Forecast traffic demands indicate that additional infrastructure would be required to accommodate traffic forecasts in an efficient manner. A new bridge further upstream has been identified through stakeholder consultation as an alternative to widening the existing bridge.

It is envisaged that the new bridge would enhance and support the operation of the existing Bridge of Dee with both bridges operating with two-way traffic. No widening of Bridge of Dee would be undertaken in this package.

4.2 Aim

The aim of Package 2 is to test the suitability of a new bridge upstream of the existing Bridge of Dee to relieve existing pressure from the Bridge of Dee and its terminal junctions.

4.3 Development of Package 2

Preliminary designs for a new bridge alignment were developed by SIAS, with access to the new bridge from the roundabout on Leggart Terrace and an additional roundabout modelled on Garthdee Road to allow connection to the north of the river. The Bridge of Dee remains two way and the new bridge is also two way. Figure 4.1 shows the layout of Package 2.

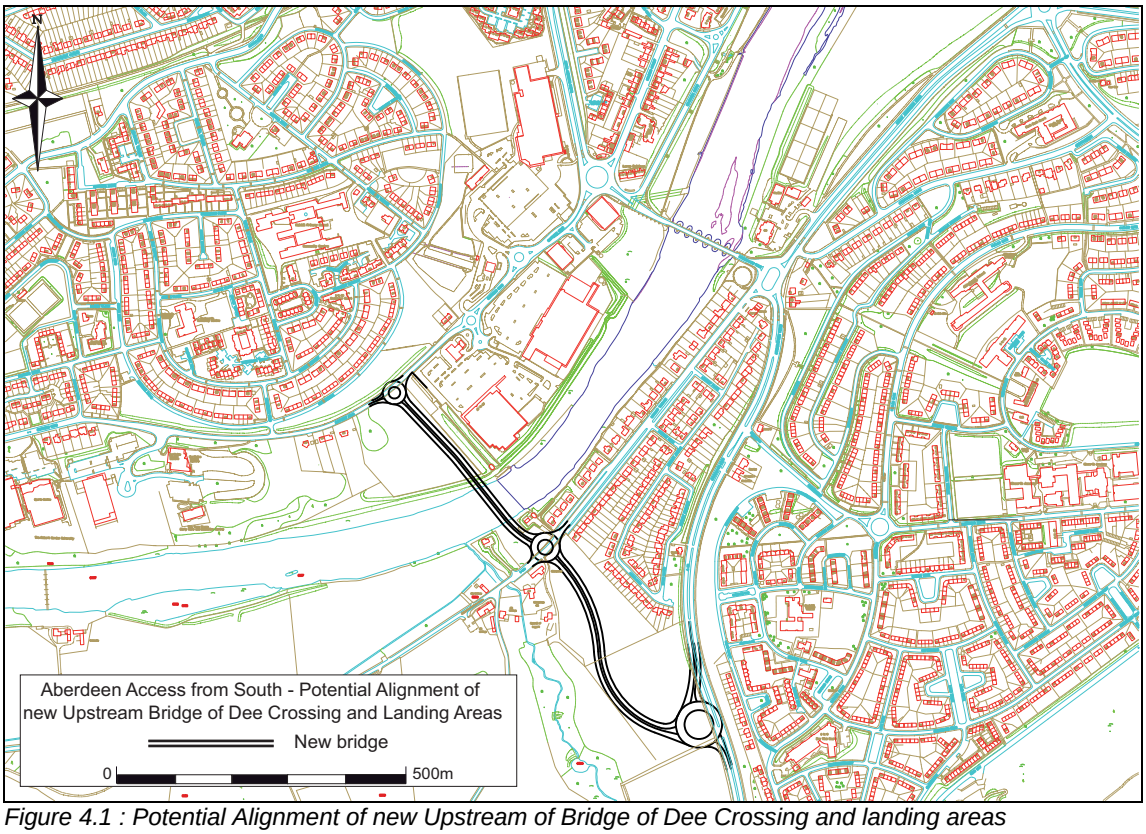


Figure 4.1 : Potential Alignment of new Upstream of Bridge of Dee Crossing and landing areas

4.4 Model Observations

In Package 2 no significant congestion is observed in the AM peak. In the PM peak a queue is observed by 17:00 on South Anderson Drive, extending back from the northern roundabout of the Bridge of Dee,

and caused by the cutting movement of traffic from Garthdee Road. This queue builds until 18:00 when there are observed to be approximately 400 vehicles queued off the network on Broomhill Avenue. This queueing off the model network is not represented in journey time or queue length statistics.

4.5 Network Performance (Package 2)

4.5.1 Average Journey Times

The average journey times between certain zones have been extracted from the models to show any benefits from the introduction of the improvement schemes. Journey times have been extracted for the following movements;

- A90 (south) to South Anderson Drive
- South Anderson Drive to A90 (south)
- A90 (south) to Great Southern Road
- Great Southern Road to A90 (south)

Table 4.1 shows the average journey times for all vehicles in the AM period.

Table 4.1 : AM Journey Time Comparison (mm:ss)

Route	Direction	2004 Base	2027 Do Noth	2027 Do-Min	Package 2
A90 (s) to S. Anderson Drive	NB	10:58	09:01	08:55	09:18
S. Anderson Drive to A90 (s)	SB	11:15	11:00	11:04	09:57
A90 (s) to Great Southern Rd	NB	09:14	09:23	09:22	10:07
Great Southern Rd to A90 (s)	SB	10:29	09:24	09:32	09:29

Table 4.1 shows that in the AM peak, northbound journey times increase with the introduction of the new bridge, while southbound journey times decrease when compared to the 2027 Do-Minimum.

Table 4.2 shows the average journey times for all vehicles in the PM period.

Table 4.2 : PM Journey Time Comparison (mm:ss)

Route	Direction	2004 Base	2027 Do Noth	2027 Do Min	Package 2
A90 (s) to S. Anderson Drive	NB	09:05	53:05	08:54	09:01
S. Anderson Drive to A90 (s)	SB	11:55	36:54	17:36	16:52
A90 (s) to Great Southern Rd	NB	09:14	56:05	09:17	09:48
Great Southern Rd to A90 (s)	SB	10:29	06:22	10:39	10:47

Table 4.2 shows that in the PM peak, with the exception of the southbound journey from South Anderson Drive, all journey times in Package 2 are increased compared to the 2027 Do-Minimum

4.5.2 Average Maximum Queue Lengths

The average maximum queue length on arms from the two junctions of the Bridge of Dee has been analysed using the S-Paramics DAT package and detailed graphs are provided in Appendix B. The queues have been compared against the 2027 Do-Nothing and the 2027 Do-Minimum in both the AM and PM Peaks and the following provide a summary of results:

- AM Peak
  - the average maximum queue length on South Anderson Drive (Fig B.1) reduces from approximately 400m in the 2027 Do-Nothing and Do-Minimum to 200m at 07:45 in Package 2
  - the average maximum queue on Holburn Street (Fig B.2) is reduced from approximately 300m to less than 100m with the introduction of the new bridge
  - Package 2 causes no significant change to queue lengths on Garthdee Road (Fig B.3) in the AM peak
  - the introduction of the new bridge has removed the peak in queue lengths on Great Southern Road (Fig B.4) between 08:00 and 08:45
  - Stonehaven Road (Fig B.5) shows an increase in queue length to 200-300 metres in the AM peak, which is partly due to Leggart Terrace being diverted onto Stonehaven Road, the queue is still significantly less than the 2004 base peak of more than 700 metres
- PM Peak
  - Package 2 does not improve the congestion on South Anderson Drive (Fig B.6) in the PM peak, with queues in all three scenarios reaching the extents of the model. Observations of the model show that Package 2 is unable to cater for the forecast travel demand on South Anderson Drive with significant numbers of vehicles queued off the network on Broomhill Avenue
  - Package 2 causes no significant change to queue lengths on Holburn Street (Fig B.7) during the PM peak
  - there is no significant queueing on Garthdee Road (Fig B.8) in the PM peak
  - Package 2 has similar average maximum queue lengths to the 2027 Do-Nothing scenario on Great Southern Road (Fig B.9) in the PM peak of around 100 vehicles, this is significantly less than the 2004 base peak of 450 metres
  - Package 2 has an average maximum queue length on Stonehaven Road (Fig B.10) approximately 50-100m longer than the 2027 Do-Minimum scenario in the PM peak at around 300 metres

4.5.3 Unreleased Vehicles

The number of vehicles in a queue off the model network was extracted for the PM peak hour, as an indicator of congestion. The number of unreleased vehicles is an average, calculated from five S-Paramics model runs. Appendix B provides detailed graphs showing the following; the total number of unreleased vehicles in the network, the number of unreleased vehicles in the Garthdee area, and the total number of unreleased vehicles in the Anderson Drive area during the PM peak hour. Note the graphs use different scales. The results showed that:

- Over the peak, Package 2 has a slightly lower total number of unreleased vehicles than the 2004 Base, 2027 Do-Nothing and Do-Something scenarios
- Package 2 has no unreleased vehicles in the Garthdee area and the bulk of benefits are felt in this area as vehicles are given a direct alternative to access the A90 Southbound without having to cross the Bridge of Dee
- In Package 2 the number of unreleased vehicles in the Anderson Drive area is similar to that in the 2027 Do-Nothing with queueing to the extents of the network blocking back into zones. This indicates that the measures introduced in Package 2 will not provide benefits to southbound traffic on South Anderson Drive during the PM peak hour as they still require to merge into a single lane across the Bridge of Dee

4.6 Findings from Package 2

The results from Package 2 have shown that average journey times were mainly increased compared to the 2027 Do-Minimum. The new bridge did reduce the number of unreleased vehicles in the Garthdee area but the congestion problem on South Anderson Drive was considerably worse than in Package 1 in the PM peak and back to the levels of the Do-Nothing and Do-Minimum. As identified during the medium term assessments, developing signal controlled junctions for the Bridge of Dee terminal junctions is difficult due to the limited stacking capacity of the single lane in each direction over the bridge span.

5 PACKAGE 3

5.1 Introduction

Package 3 is based on Package 2 and uses the new bridge design in a different manner in an attempt to gain more road capacity and improve the operation of the Bridge of Dee area.

5.2 Aim

To investigate if the new bridge option (Package 2) would operate more successfully as a gyratory with the existing Bridge of Dee. Under this scenario, Bridge of Dee would operate one-way Southbound, with the new bridge operating one-way Northbound.

5.3 Development of Package 3

Package 3 uses Package 2 as a starting point. Initial sensitivity testing identified serious problems with the roundabouts at the northern end of both bridges due to the change and unbalanced flows. During the AM peak a significant movement across the face of the Holburn Street arm quickly caused the network to 'gridlock' with severe congestion on Holburn Street, Riverside Drive and beyond. The roundabouts to the north of the river were replaced with signal controlled junctions (north end of Bridge of Dee and new bridge). Initial designs for the two signalised junctions were based on desired traffic flows. Figure 5.1 shows the layout of Package 3.

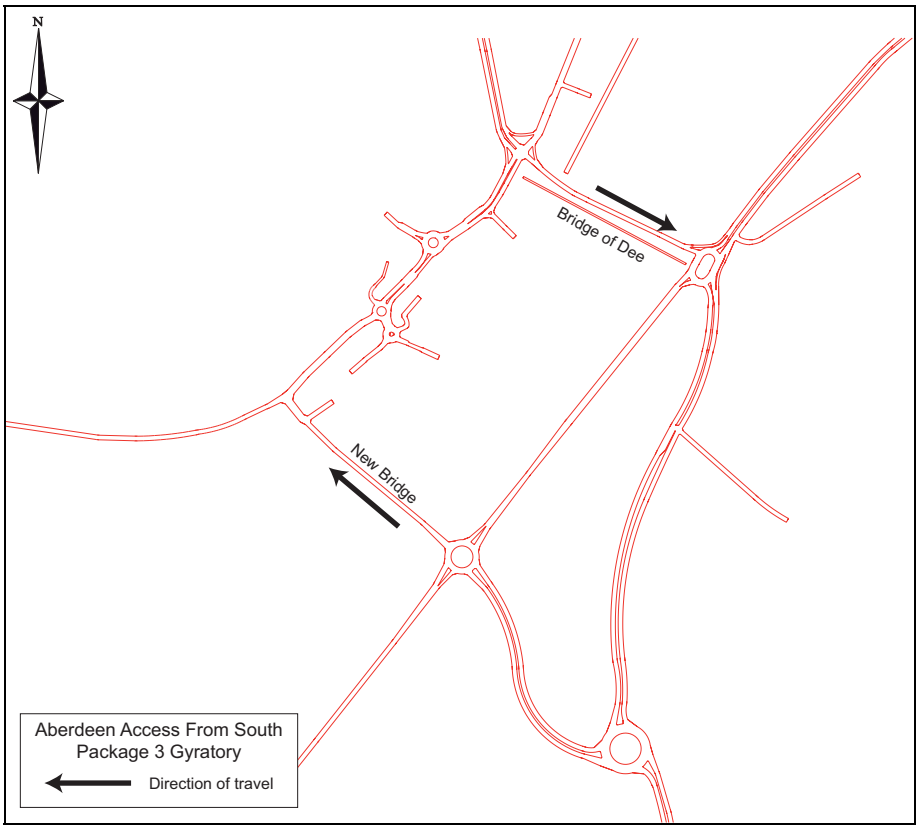


Figure 5.1 : Package 3 - Gyratory

Details of traffic signal timings are contained in Appendix C of this document.

5.4 Model Observations

Congestion is observed in Package 3 in the AM peak from 07:30 onwards. Queueing initially develops on Garthdee Road eastbound and on the Bridge of Dee southbound. After the queue on Garthdee Road

extends past the new bridge, a queue develops on the bridge northbound which extends onto Leggart Terrace resulting in queueing off the network.

In the PM peak traffic cannot exit Asda and get on to Garthdee Road, due to the steady eastbound flow of traffic on Garthdee Road. At the peak modelled time, the ASDA zone has around 500 vehicles stuck in the zone waiting to load onto the network.

5.5 Network Performance (Package 3)

5.5.1 Average Journey Times

The average journey times on key routes have been extracted from the models to show any benefits from the introduction of the improvement schemes. Journey times have been extracted for the following movements;

- A90 (south) to South Anderson Drive
- South Anderson Drive to A90 (south)
- A90 (south) to Great Southern Road
- Great Southern Road to A90 (south)

Table 5.1 shows the average journey times for all vehicles in the AM period and that Package 3 increases the northbound journey times compared to the 2027 Do-Minimum.

Table 5.1 : AM Journey Time Comparison (mm:ss)

Route	Direction	2004 Base	2027 Do Noth	2027 Do-Min	Package 3
A90 (s) to S. Anderson Drive	NB	10:58	09:01	08:55	13:46
S. Anderson Drive to A90 (s)	SB	11:15	11:00	11:04	10:53
A90 (s) to Great Southern Rd	NB	09:14	09:23	09:22	10:00
Great Southern Rd to A90 (s)	SB	10:29	09:24	09:32	09:20

Table 5.2 shows the average journey times for all vehicles in the PM period and in the PM peak, Package 3 increases journey times on all but one of the routes compared.

Table 5.2 : PM Journey Time Comparison (mm:ss)

Route	Direction	2004 Base	2027 Do Noth	2027 Do Min	Package 3
A90 (s) to S. Anderson Drive	NB	09:05	53:05	08:54	11:22
S. Anderson Drive to A90 (s)	SB	11:55	36:54	17:36	10:43
A90 (s) to Great Southern Rd	NB	09:14	56:05	09:17	10:01
Great Southern Rd to A90 (s)	SB	10:29	06:22	10:39	10:59

5.5.2 Average Maximum Queue Lengths

The average maximum queue length on arms from the two junctions of the Bridge of Dee has been analysed using the S-Paramics DAT package and detailed graphs are provided in Appendix C. The queues have been compared against the 2027 Do-Nothing and the 2027 Do-Minimum in both the AM and PM Peaks and the following provide a summary of results:

- AM Peak
  - The average queue length on South Anderson Drive (Fig C.3) reduces from over 400m in the 2027 Do-Nothing and Do-Minimum to approximately 200m in Package 3, at 07:40
  - There is a more prolonged period of queueing on Holburn Street (Fig C.4) during Package 3 when compared against the Do-Minimum, with the average queue length remaining over 250m until 09:00
  - The gyratory option increases average queue lengths on Garthdee Road (Fig C.5) in the AM peak to over 350m compared with 100m in the base
  - Queue lengths on Great Southern Road (Fig C.6) do not exceed 50m in Package 3 and are significantly better than the Do-Minimum and the 2004 base at over 150m and 300m respectively
  - Increased queueing on Stonehaven Road (Fig C.7) at 200 metres. This is partly due to Leggart Terrace being diverted onto Stonehaven Road though still considerably less than the 2004 base at over 700 metres
- PM Peak
  - The average maximum queue length on South Anderson Drive (Fig C.8) is reduced from approximately 1050m (the model extents) in the 2027 Do-Nothing and Do-Minimum scenarios to approximately 200m in Package 3
  - There is an increase in queue lengths on Holburn Street (Fig C.9) of approximately 100m to 250m in Package 3 compared to the 2027 Do-Nothing and Do-Min scenarios
  - Package 3 causes an increase in queue length on Garthdee Road (Fig C.10) in the PM peak, from approximately 50m in the 2027 Do-Nothing and Do-Min to 200-250m in Package 3
  - Package 3 has similar queue lengths on Great Southern Road (Fig C.11) to the 2027 Do-Nothing scenario at around 100m. Significantly less than the 2004 base
  - Maximum queue lengths on Stonehaven Road (Fig C.12) are approximately 50-100m longer than the 2027 Do-Minimum scenario at 350m. This due to Leggart Terrace being diverted onto Stonehaven Road

5.5.3 Unreleased Vehicles

The number of vehicles in a queue off the model network was extracted for the PM peak hour, as an indicator of congestion. The number of unreleased vehicles is an average, calculated from five S-Paramics model runs. Appendix C provides detailed graphs showing the following; the total number of unreleased vehicles in the network, the number of unreleased vehicles in the Garthdee area, and the number of unreleased vehicles in the Anderson Drive area during the PM peak hour. Note the graphs use different scales. The results showed that:

- the total number of unreleased vehicles in Package 3 is greater than the 2027 Do-Minimum
- the number of unreleased vehicles in the Garthdee area reaches a peak of over 100 vehicles between 17:00 and 17:15 compared to less than 60 for the 2027 Do-Nothing. This is due to the high proportion of traffic following the gyratory in an eastbound direction, resulting in queues from the developments in the Garthdee area
- that Package 3 has less unreleased vehicles in the Anderson Drive area than the 2004 Base and offers significant benefits over the Do-Minimum

5.6 Findings from Package 3

Analysis of Package 3 has identified that the gyratory design would increase queue lengths on Holburn Street and Garthdee Road. Package 3 was observed to have the highest number of unreleased vehicles with existing developments in the Garthdee area struggling to clear traffic. The design of Package 3 intensifies the volumes of traffic concentrated on Garthdee Road and mixes the trip purposes between local traffic, retail traffic and strategic traffic.

6 PACKAGE 4

6.1 Introduction

High occupancy vehicle lanes were introduced in the medium term assessment, and proved an effective complimentary option worthy of future consideration. An additional HOV lane proposed on Great Southern Road between Bridge of Dee and King George VI Bridge, in both directions has been considered.

6.2 Aim

Package 4 aims to increase the benefits to high occupancy vehicles by introducing an additional HOV lane between Great Southern Road and Stonehaven Road.

6.3 Development of Package 4

In order to reduce the number of sensitivity tests, Package 4 has adopted the best performing Package from 1, 2 and 3. Based on the results and analysis undertaken regarding key journey times, queue lengths and vehicles queued off the network, Package 1-2 is the best performing package and will be used to form the basis for the Package 4 test.

Package 4 involved the addition of a third lane from Great Southern Road to Stonehaven Road and vice versa, for use by public transport and high occupancy vehicles. The HOV lane on the A90 northbound between Charleston and 100m south of the Bridge of Dee, a recommended medium term measure, was also included in this package.

It has been assumed that 40% of vehicles are high occupancy and the remaining 60% are single occupancy vehicles.

6.4 Model Observations

Observation of the model shows no significant differences to the Package 1-2 scenario on which it was based. In the PM peak the proximity of the end of the HOV lane on Stonehaven Road to the southern Bridge of Dee junction is important. If it is too close, traffic turning from Stonehaven Road to Great Southern Road will block back past the HOV lane and cause significant congestion on Stonehaven Road.

6.5 Network Performance (Package 4)

6.5.1 Average Journey Times

The average journey times on key routes have been extracted from the models to show any benefits from the introduction of the improvement schemes. Journey times have been extracted for the following movements;

- A90 (south) to South Anderson Drive
- South Anderson Drive to A90 (south)
- A90 (south) to Great Southern Road
- Great Southern Road to A90 (south)

Table 6.1 shows the average journey times for all vehicles in the AM period. It shows a very little change in journey time for Package 4 compared to the 2027 Do-Minimum and Package 1-2.

Table 6.1 : AM Journey Time Comparison (mm:ss)

Route	Direction	2004 Base	2027 Do Noth	2027 Do-Min	Package 1-2	Package 4
A90 (s) to S. Anderson Drive	NB	10:58	09:01	08:55	09:27	09:30
S. Anderson Drive to A90 (s)	SB	11:15	11:00	11:04	09:38	09:56
A90 (s) to Great Southern Rd	NB	09:14	09:23	09:22	09:47	09:49
Great Southern Rd to A90 (s)	SB	10:29	09:24	09:32	09:30	09:58

Table 6.2 shows the average journey time for all vehicles in the PM period.

Table 6.2 : PM Journey Time Comparison (mm:ss)

Route	Direction	2004 Base	2027 Do Noth	2027 Do Min	Package 1-2	Package 4
A90 (s) to S. Anderson Drive	NB	09:05	53:05	08:54	09:35	09:45
S. Anderson Drive to A90 (s)	SB	11:55	36:54	17:36	10:55	11:00
A90 (s) to Great Southern Rd	NB	09:14	56:05	09:17	09:33	09:37
Great Southern Rd to A90 (s)	SB	10:29	06:22	10:39	11:10	11:22

Table 6.2 shows that in the PM peak, Packages 1-2 and 4 show a reduction in journey time from South Anderson Drive while all other routes show an increase in journey time compared to the 2027 Do-Minimum. Journey times in Package 4 are observed to be 4 – 12 seconds longer than the same journey times in Package 1. The increase when compared to the Do-Minimum is due to the additional junction to connect to Leggart Terrace and the additional traffic coming from Leggart Terrace to access Bridge of Dee from Stonehaven Road.

6.5.2 Average Maximum Queue Lengths

The average maximum queue length on arms from the two junctions of the Bridge of Dee has been analysed using the S-Paramics DAT package and detailed graphs are provided in Appendix D. Queue length graphs for Package 4 showed very little difference between the queue behaviour observed in Package 1.

6.5.3 Unreleased Vehicles

The number of vehicles in a queue off the model network was extracted for the PM peak hour, as an indicator of congestion. The number of unreleased vehicles is an average, calculated from five S-Paramics model runs. Appendix D provides detailed graphs showing the following; the total number of unreleased vehicles in the network, the number of unreleased vehicles in the Garthdee area, and the Anderson Drive area, in the PM peak hour. Note the graphs use different scales. The results showed that:

- the total number of unreleased vehicles in Package 4 is less than the 2004 Base and significantly less than the 2027 Do-Nothing
- all scenarios have peak of approximately 40 to 60 unreleased vehicles at 17:00, in the Garthdee area

- in the 2027 Do-Nothing and Do-Minimum scenarios the number of unreleased vehicles is still increasing at the end of the peak hour (around 150 vehicles), in the Anderson Drive area. In Package 4 the number has reduced to approximately 10 by 17:30 offering a significant benefit

6.5.4 HOV Travel Times

Average travel times for HOVs were calculated, for the inbound movement in the AM peak and the outbound movement in the PM peak. The average HOV travel times were then compared with the average time for all vehicles. Average travel times for HOVs using the Park and Ride were also calculated.

Average travel times for the AM peak are shown in Table 6.3.

Table 6.3 : AM Peak HOV Travel Times

	General Traffic	Existing HOV	P&R HOV
2004 Base	08:09	08:09	-
2027 Do Min	07:08	07:08	-
Package 1	07:43	07:43	-
Package 4	07:36	07:16	11:22

Table 6.3 shows that in Package 4 the travel time in the AM peak for general traffic shows an increase from the 2027 Do Min. The travel time for existing HOVs is 20 seconds less than general traffic and the time for Park and Ride HOVs is approximately four minutes more.

Package 4 shows benefits for general traffic compared to Package 1, as some traffic has been removed from the network to account for the change to high occupancy vehicle trips.

In the PM peak no advantage was observed for the existing high occupancy vehicles. This is due to the southbound HOV lane between Great Southern Road and Stonehaven Road being in a location where congestion previous congestion has been resolved through the provision of traffic signal control at the Bridge of Dee/Stonehaven Road junction.

6.6 Findings from Package 4

The results from Package 4 have shown that the HOV lane has benefits for the network in the AM peak for inbound traffic. The introduction of HOV lanes did not adversely affect average maximum queue lengths which were found to be consistent with Package 1-2. No benefits were found in the PM peak from having a southbound HOV lane on Great Southern Road mainly due to the introduction of traffic signals at Bridge of Dee removing delays to westbound traffic.

7 SUMMARY AND CONCLUSIONS

7.1 Summary of Long Term Testing

In order to undertake the long term testing two reference models were developed:

- 2027 Do-Nothing = Medium Term Do-Min model + Short Term (2008) preferred improvements, using 2027 traffic demands
- 2027 Do-Minimum = Medium Term Do-Min model + Medium Term (2012) preferred improvements, using 2027 traffic demands

Four work packages were agreed by Aberdeen City Council and Nestrans and tested with the 2027 Do-Minimum model as a reference. The work packages were:

- Package 1 – Widen Bridge of Dee (BoD)

  (c) with roundabouts

  (d) with traffic signals
- Package 2 – New two-way bridge upstream of Bridge of Dee
- Package 3 – New bridge upstream of Bridge of Dee to form gyratory (BoD one way southbound, new bridge one-way northbound)
- Package 4 – High Occupancy Vehicle (HOV) lane on Great Southern Road from BOD to King George VI Bridge

In all packages Leggart Terrace is diverted onto Stonehaven Road and traffic can no longer access the southern roundabout of the Bridge of Dee from Leggart Terrace.

The growth as applied to the 2004 base model, using ASAM3b forecasts to form the 2027 future year models (with Aberdeen Western Peripheral Route), can be summarised as follows for the AM and PM peak periods:

- AM Peak 2004 Base 31475 vehicles growth of 11.5% (3612 vehicles) to 2027 giving 35087 vehicles in 2027 in the AM peak period
- PM peak 2004 base 40496 vehicles with growth of 10.5% (4272 vehicles) to 2027 giving 44768 vehicles in 2027 in the PM peak period

7.2 Summary of Results

7.2.1 Package 1

In Package 1 where the Bridge of Dee is widened to 6 lanes with roundabouts forming the junctions at either end, queueing was observed on Stonehaven Road in both the AM and PM peaks. This queueing extended down Stonehaven Road onto the new Leggart Terrace link and the root cause was the southern roundabout of the Bridge of Dee being unable to cope with the 2027 traffic demands.

In Package 1 with signal controlled junctions at each end of the Bridge of Dee, the bridge operated well and no significant congestion was observed due to the increased stacking capacity of the bridge. Traffic signals also afforded better provision for pedestrians and cyclists.

7.2.2 Package 2

The new bridge in Package 2 reduced congestion in the Garthdee area in the PM peak compared to Package 1 but showed significantly more congestion on South Anderson Drive. This was in part due to the release of vehicles now using the new bridge and travelling eastbound along Garthdee Road increasing the cutting movement on South Anderson Drive but also the limitations of the existing Bridge

of Dee. As identified during the medium term assessments, developing signal controlled junctions for the Bridge of Dee terminal junctions is difficult due to the limited stacking capacity of the single lane in each direction over the bridge span.

7.2.3 Package 3

Analysis of Package 3 identified that the gyratory design would increase queue lengths on Holburn Street and Garthdee Road. Package 3 was observed to have the highest number of unreleased vehicles with existing developments in the Garthdee area struggling to clear traffic and access Garthdee Road. The design of Package 3 intensifies the volumes of traffic concentrated on Garthdee Road and mixes the trip purposes between local traffic, retail traffic and strategic traffic. Significant congestion is observed on Garthdee Road in both the AM and PM peaks. In the PM peak the constant flow of traffic on Garthdee Road means traffic cannot exit the Asda zone and up to 500 vehicles can be queued in this area.

7.2.4 Package 4

The results from Package 4 have shown that the HOV lane has benefits for the network in the AM peak for inbound traffic. The introduction of HOV lanes did not adversely affect average maximum queue lengths which were found to be consistent with Package 1. No benefits were found in the PM peak from having a southbound HOV lane on Great Southern Road mainly due to the introduction of traffic signals at Bridge of Dee removing much of the delays to westbound traffic.

7.2.5 Additional Long Term Measures Not Modelled

Some of the options raised at the stakeholder workshops, while not suitable for traffic modelling, are certainly worthy of consideration in the longer term time frame. These measures could assist in meeting the key objectives identified for assess to Aberdeen from the South. Measures raised by stakeholders which may be considered appropriate for the long term to accompany any preferred package of measures from the traffic modelling work are:

- Local charging schemes (Parking, congestion etc)
- Heavy rail options
- Improved coastal route east of A956 for development access
- More trains at Portlethen
- New pedestrian/cycle footbridge options across the network
- Additional pedestrian/cycle bridge to connect at RGU over the River Dee
- Raise height under Wellington suspension Bridge (Riverside Drive at South College Street)
- enhancement of existing crossrail proposals to include additional stations to improve rail access to industrial and residential areas to the south of the city

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.

7.3 Findings

The long term measures which through traffic modelling have shown a positive impact when tested through traffic modelling are:

- Leggart Terrace diverted onto Stonehaven Road
- Widened Bridge of Dee (six lanes)
- Signal controlled junctions at each end of Bridge of Dee

- Third lane for HOV use Northbound on Great Southern Road between Bridge of Dee and King George VI Bridge

Significant consultation will be required before considering the Bridge of Dee widening as it is a grade 'A' listed structure. Equally, new road construction to divert Leggart Terrace onto Stonehaven Road further south will require careful consideration, though it will be vital to the success of any long term option.

The provision of a new bridge upstream certainly alleviated some of the congestion around Garthdee but, based on current traffic flow predictions, did not benefit South Anderson Drive as the Bridge of Dee will still have limited capacity. Further to the implementation of the Aberdeen Western Peripheral Route (AWPR) it is suggested that traffic volumes and changes be monitored closely to further enhance the understanding of the impact of either a widened Bridge of Dee or a new bridge upstream.

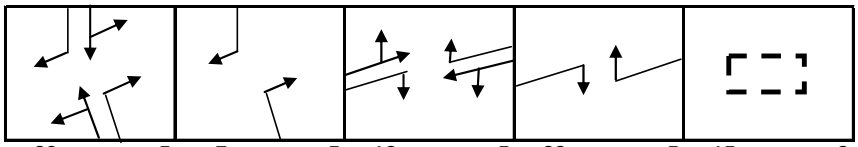
7.4 Further Consideration – Riverside Drive/King George VI Bridge

In all long term assessment scenarios, congestion is observed to develop from the southern roundabout of the King George VI Bridge in the PM peak. This causes queueing across the bridge and onto Riverside Drive. In the long term, improvements may have to be considered at this location and the large roundabout option considered during the short term option testing may require further consideration and consultation with particular regard to land acquisition issues.

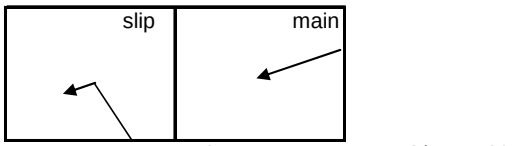
A PACKAGE 1 TABLES AND GRAPHS

Figure A.1 shows the traffic signal timings used in the Package 1-2 for the AM peak.

North BOD Junction



BOD to Garthdee Rd Slip



South BOD Junction

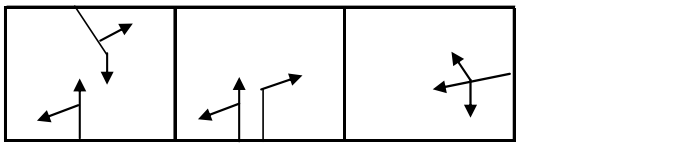
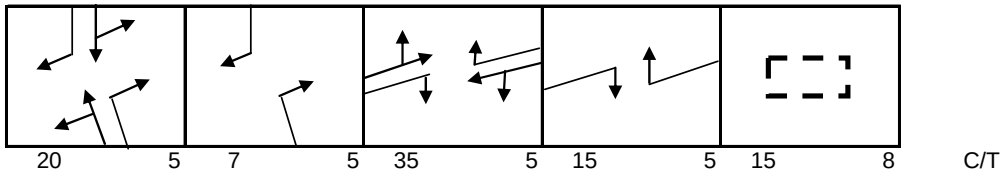


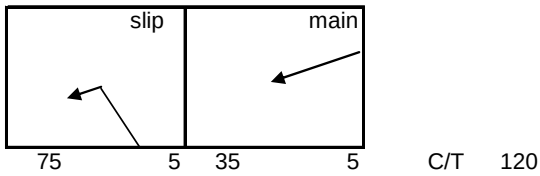
Figure A.1 : AM Signal Timings – Package 1-2

Figure A.2 shows the PM signal timings for Package 1-2.

North BOD Junction



BOD to Garthdee Rd Slip



South BOD Junction

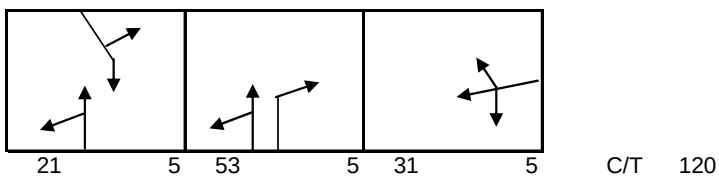


Figure A.2 : PM Signal Timings – Package 1-2

A.1 Package 1 Queue Length Graphs

Figure A.3 to Figure A.7 show the AM peak queue comparison graphs.

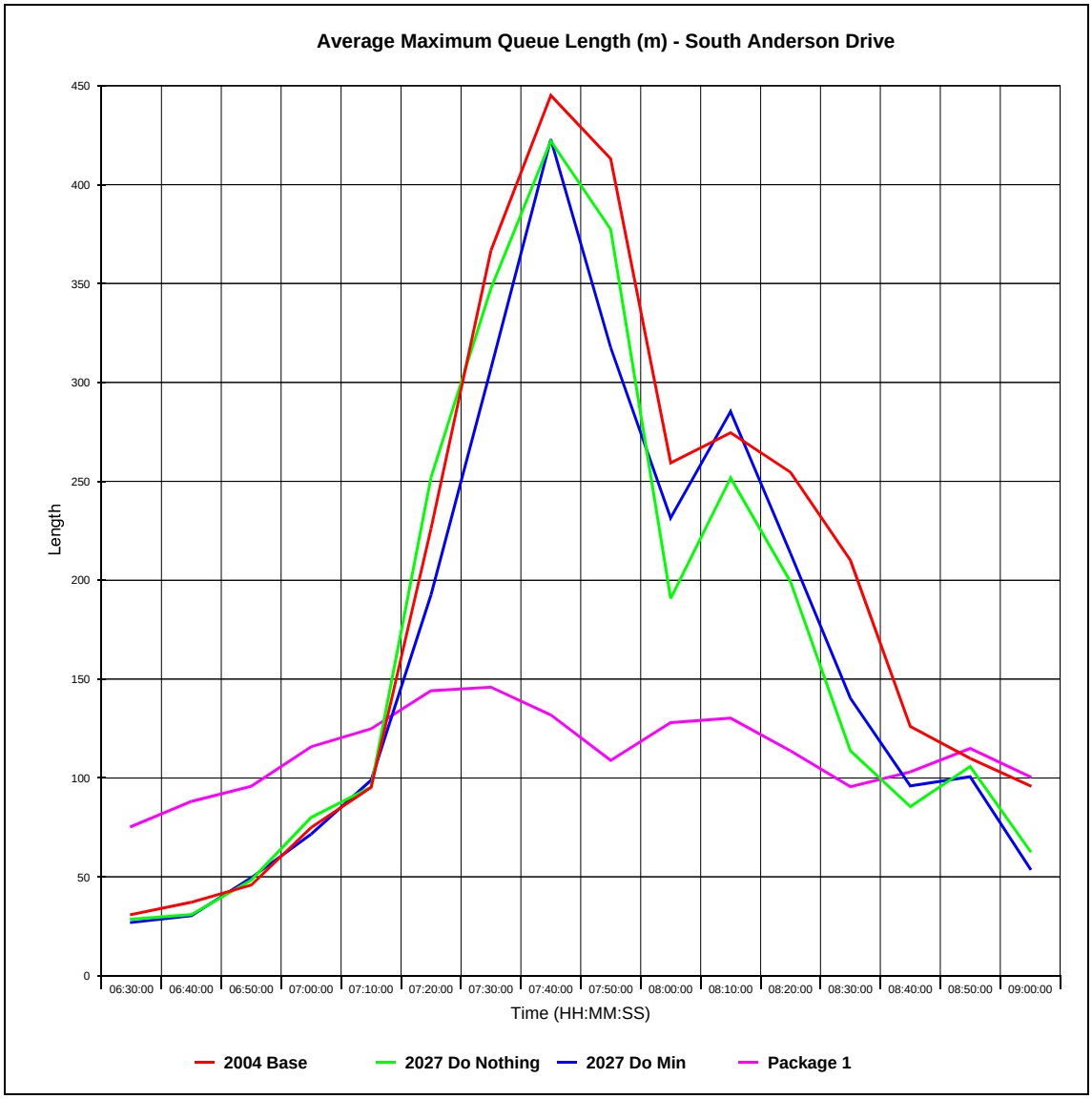


Figure A.3 : Queue Comparison (South Anderson Drive SB) – AM Peak

Figure A.3 shows that with the introduction of traffic signals and a three lane bridge span at the Bridge of Dee, the queue length on South Anderson Drive is reduced from over 400m to less than 150m.

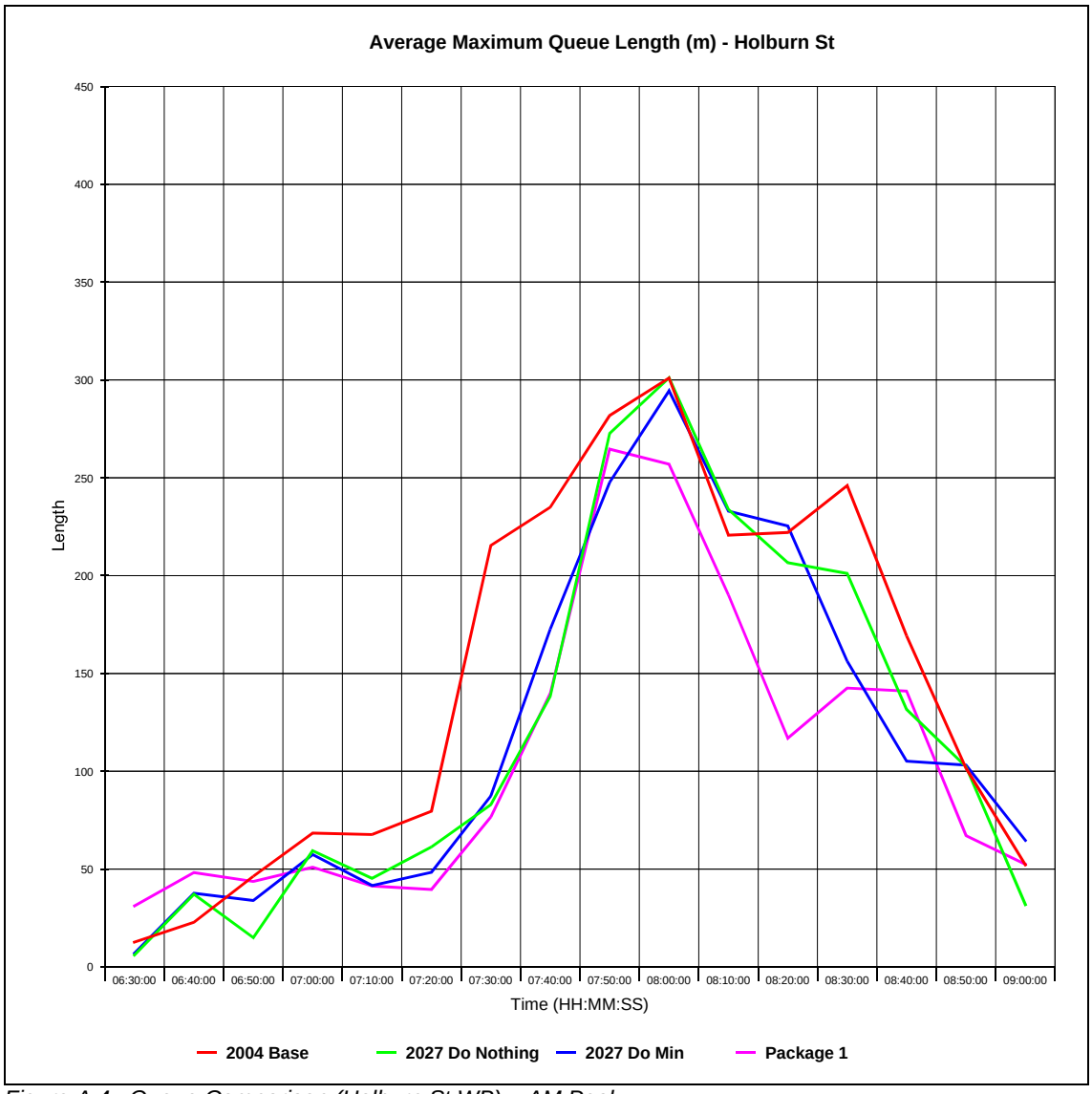


Figure A.4 : Queue Comparison (Holburn St WB) – AM Peak

Figure A.4 shows that the maximum queue length on Holburn Street remains similar in Package 1 to the queue lengths in the 2027 Do-Nothing and Do-Min.

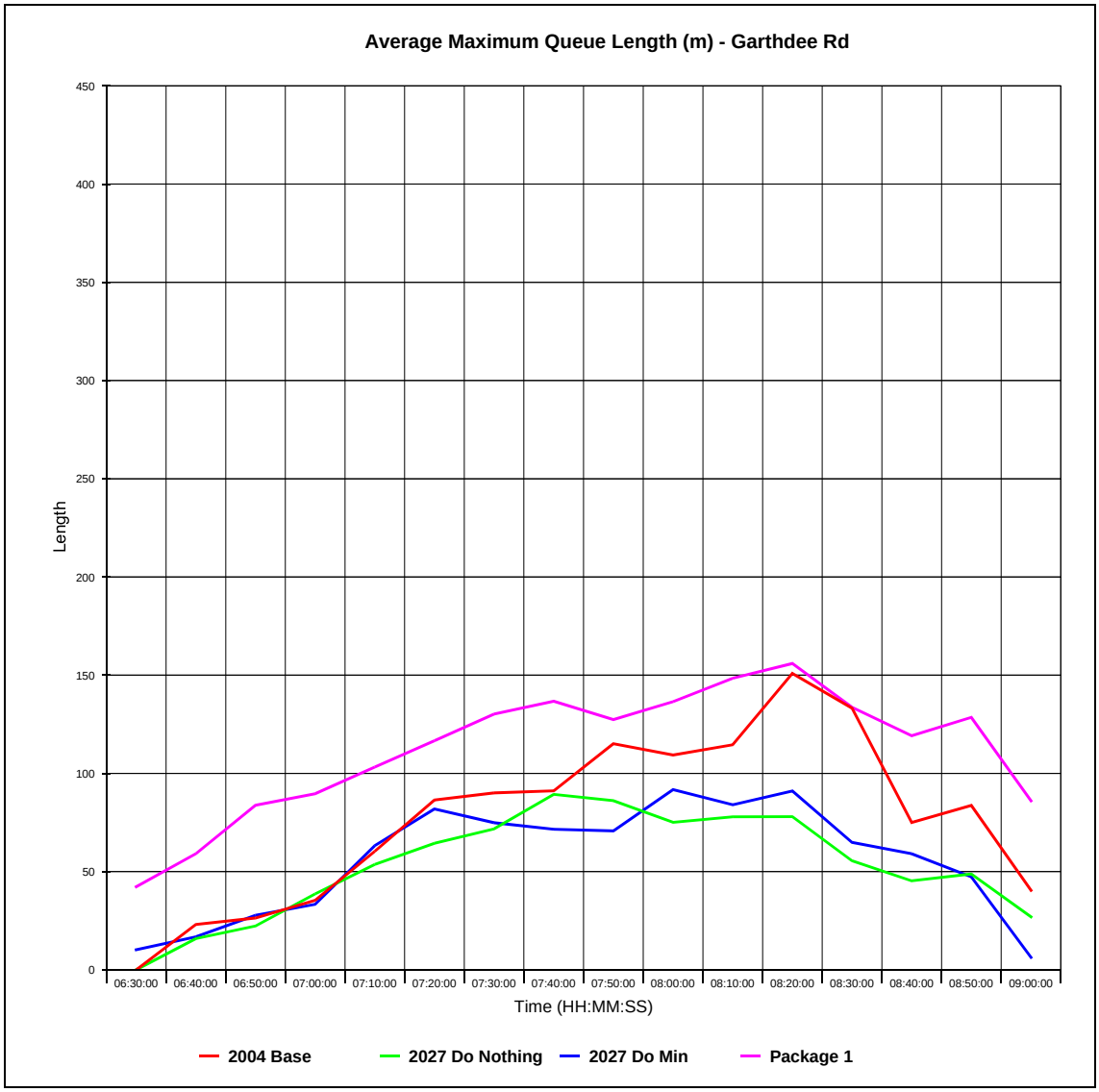


Figure A.5 : Queue Comparison (Garthdee Road EB) – AM Peak

Figure A.5 shows that in Package 1 the average maximum queue length on Garthdee Road has increased by approximately 50m in the AM peak due to the queue balancing nature of the traffic signals.

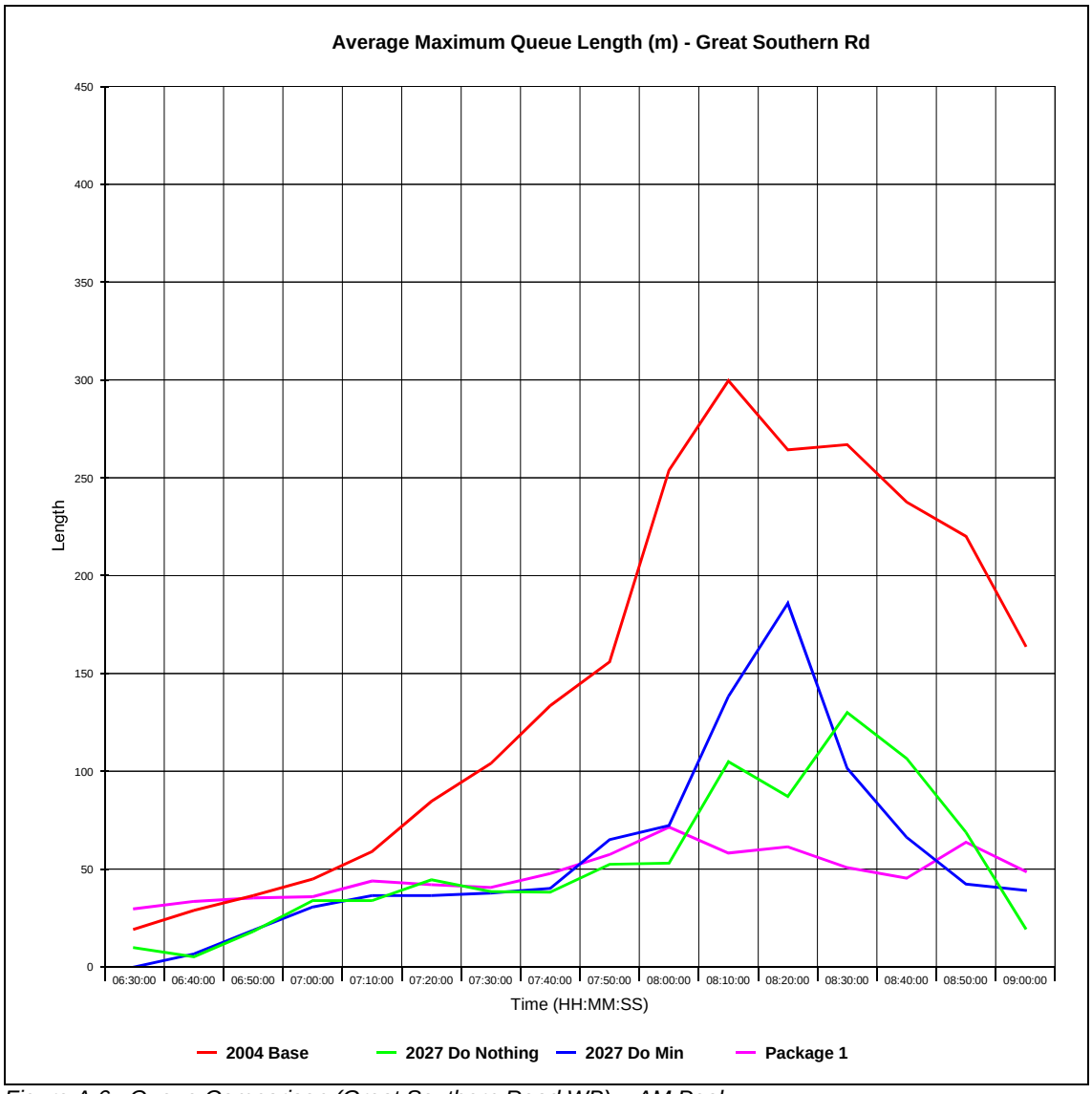


Figure A.6 : Queue Comparison (Great Southern Road WB) – AM Peak

Figure A.6 shows that Package 1 has removed the peak in queue lengths on Great Southern Road between 08:00 and 08:45.

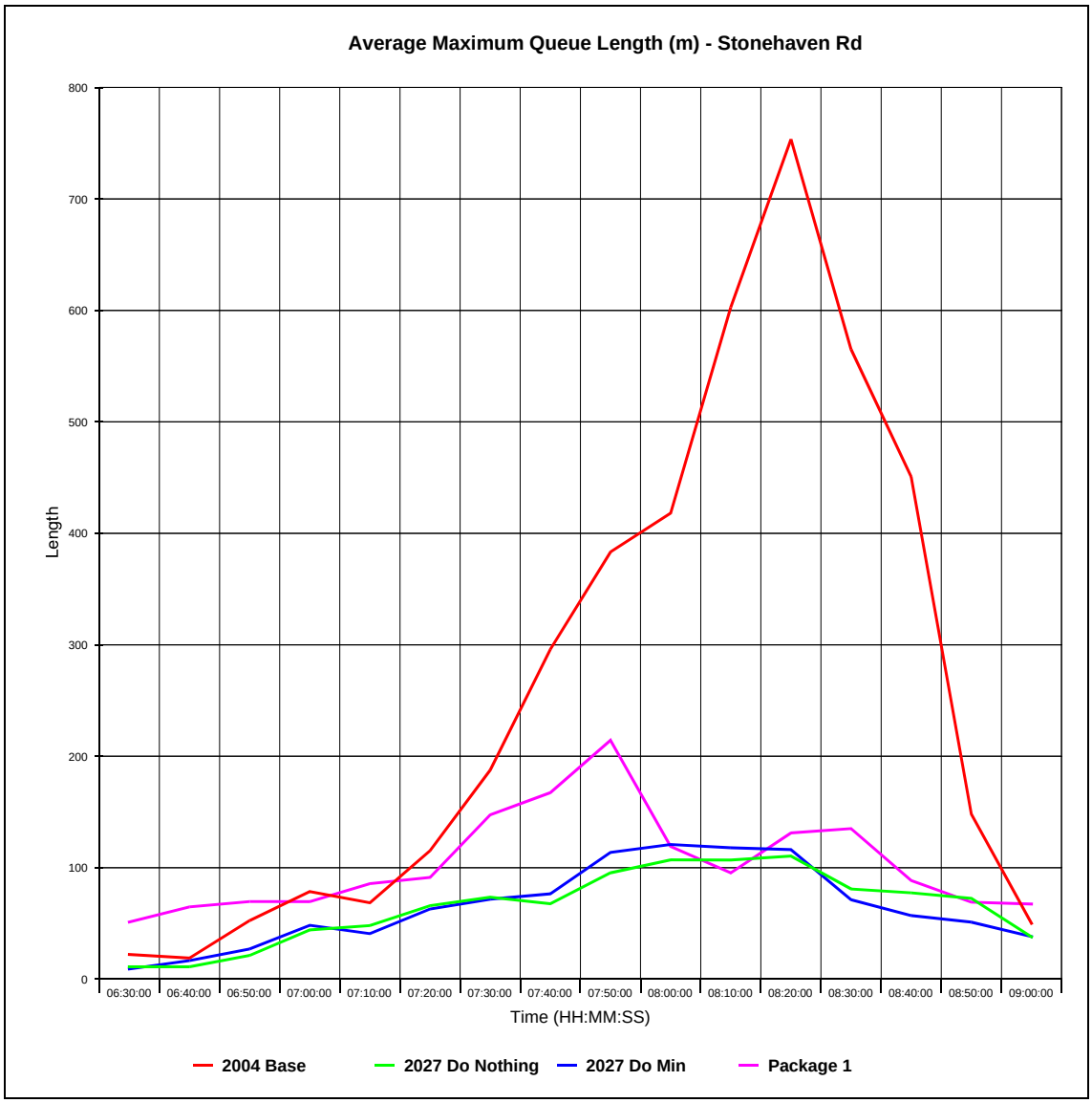


Figure A.7 : Queue Comparison (Stonehaven Road NB) – AM Peak

Figure A.7 shows that average maximum queue length on Stonehaven Road in Package 1 is increased by approximately 100m at 07:50. This increase can be attributed to Leggart Terrace being diverted onto Stonehaven Road, it is however still significantly better that the 2004 base. Note this graph uses a different scale to the rest of the AM graphs.

Figure A.8 to Figure A.12 show the PM peak graphs.

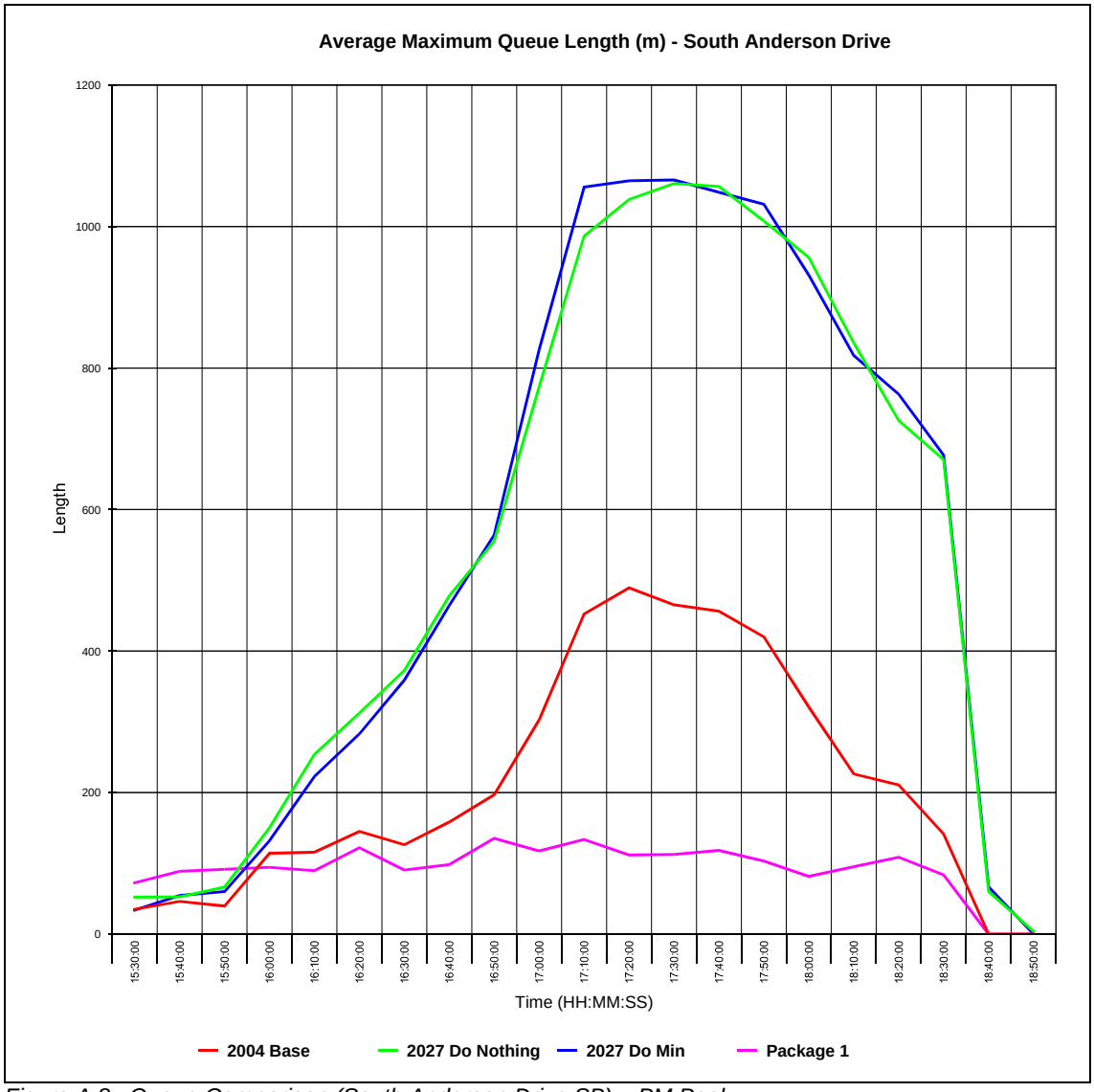


Figure A.8 : Queue Comparison (South Anderson Drive SB) – PM Peak

Figure A.8 shows a significant reduction in queue length on South Anderson Drive in the PM peak, from approximately 1050m (the extents of the model network) in the 2027 Do-Nothing and Do-Minimum to approximately 100m in Package 1. Note this graph is a different scale to the remaining PM graphs.

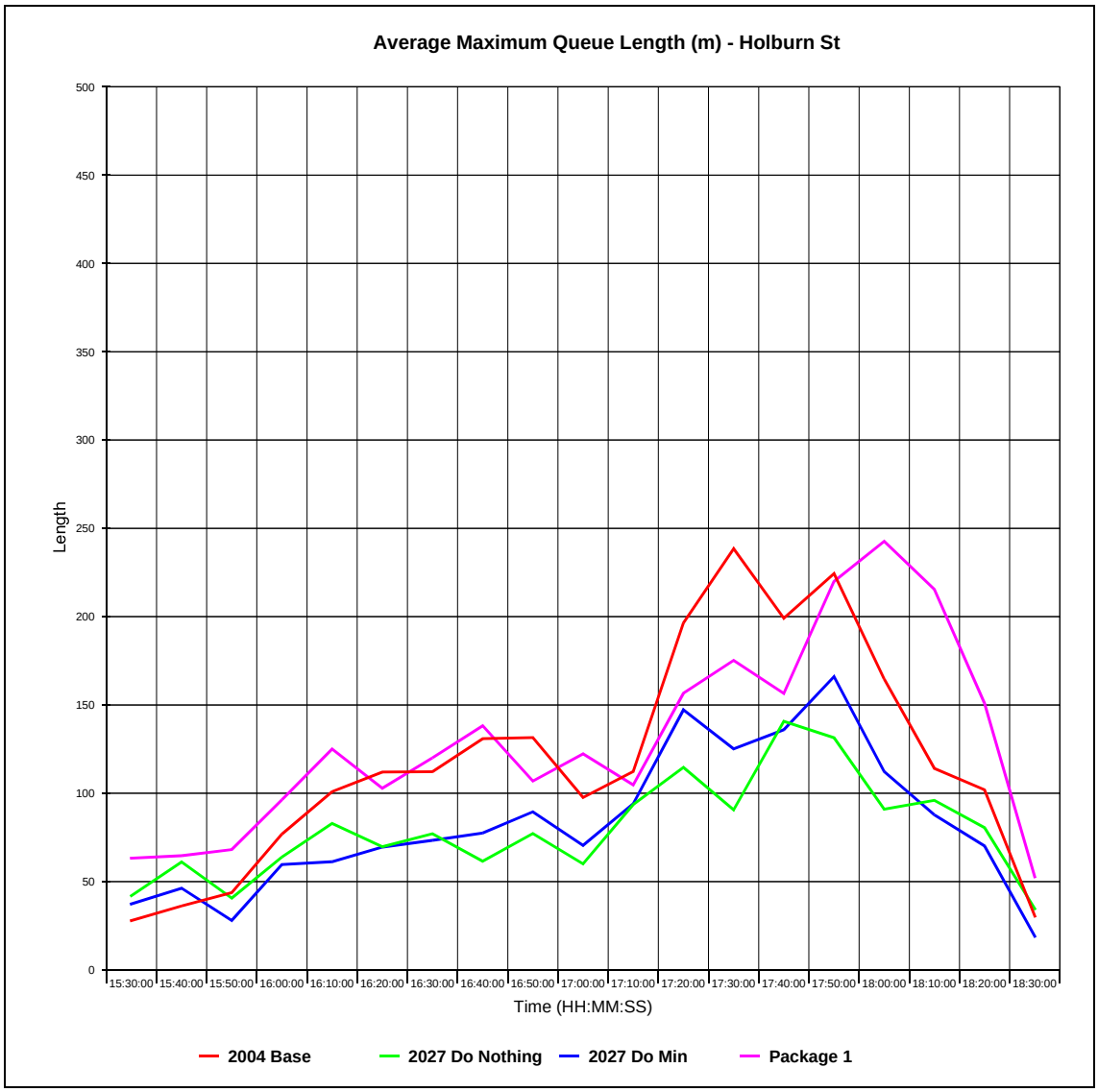


Figure A.9 : Queue Comparison (Holburn St WB) – PM Peak

Figure A.9 shows the average maximum queue on Holburn Street is increased in Package 1 by approximately 50-100m to around 200 metres due to the traffic signals balancing queueing on other arms.

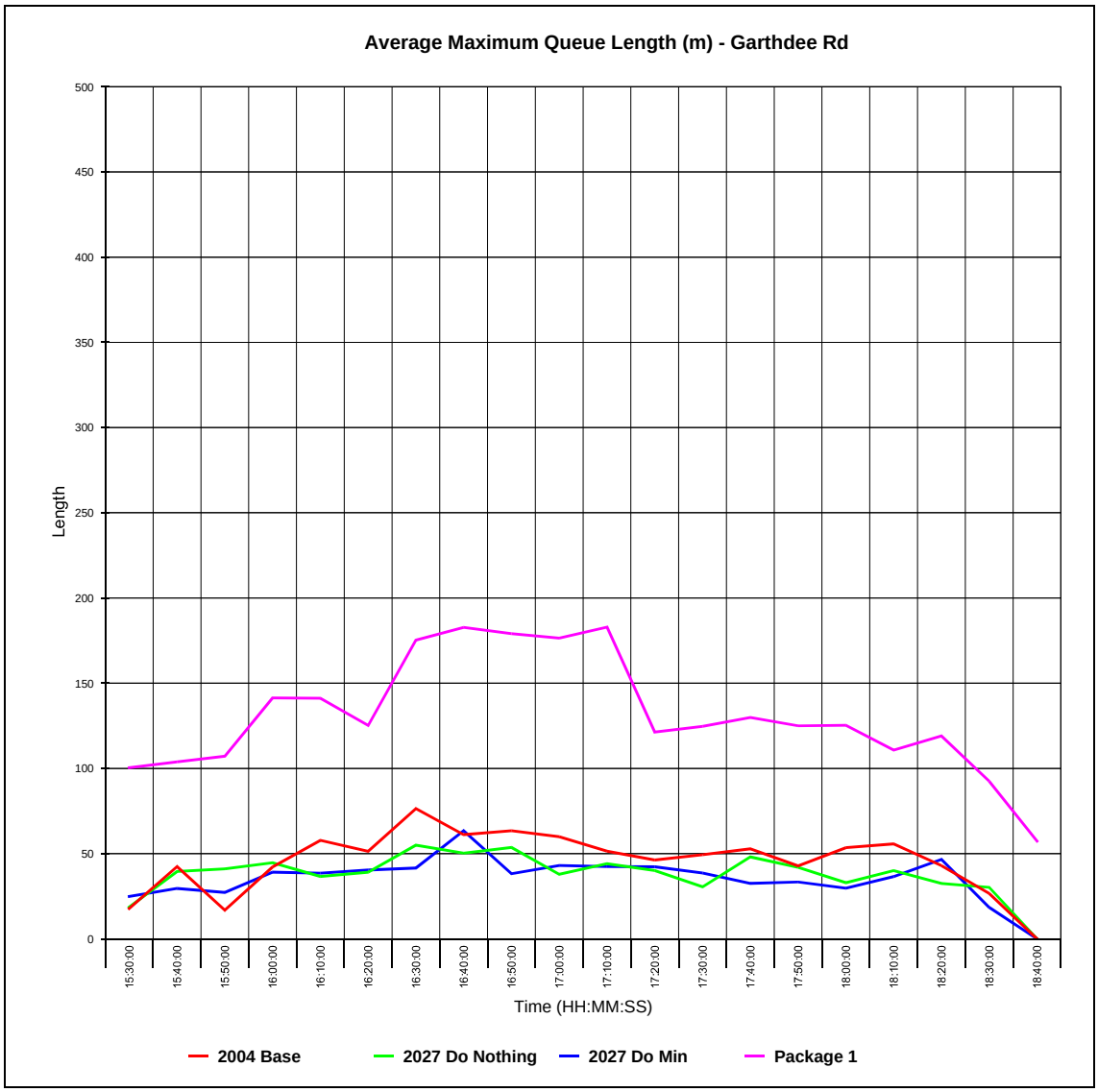


Figure A.10 : Queue Comparison (Garthdee Road EB) – PM Peak

Figure A.10 shows the average maximum queue on Garthdee Road is increased in Package 1 by approximately 50-100m due to the traffic signals balancing queueing on other arms.

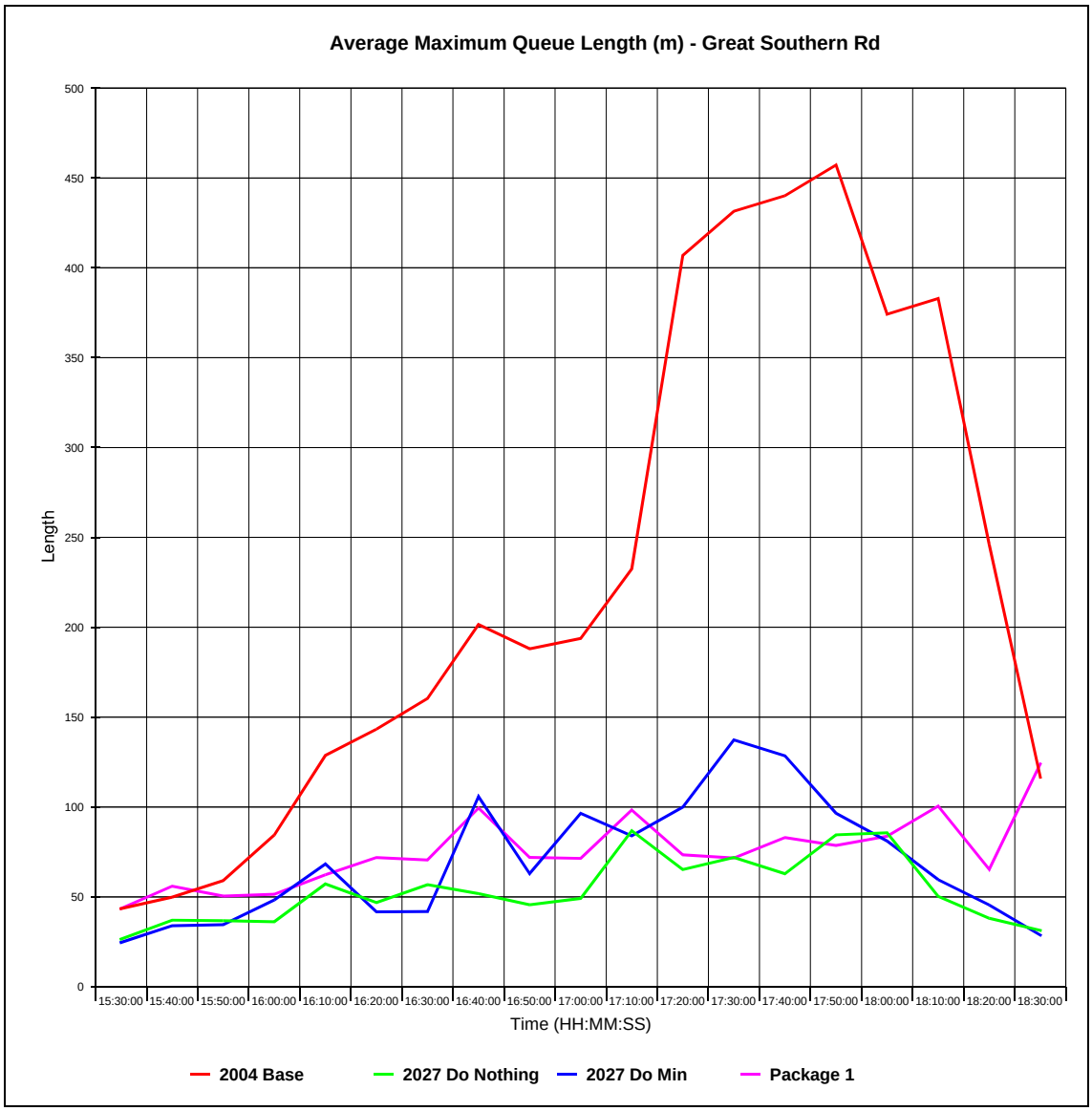


Figure A.11 : Queue Comparison (Great Southern Road EB) – PM Peak

Figure A.11 shows no significant change in queueing on Great Southern Road in the PM peak in Package 1 when compared to the Do-Minimum however both are significantly better than the 2004 base with an average around 100 metres in length.

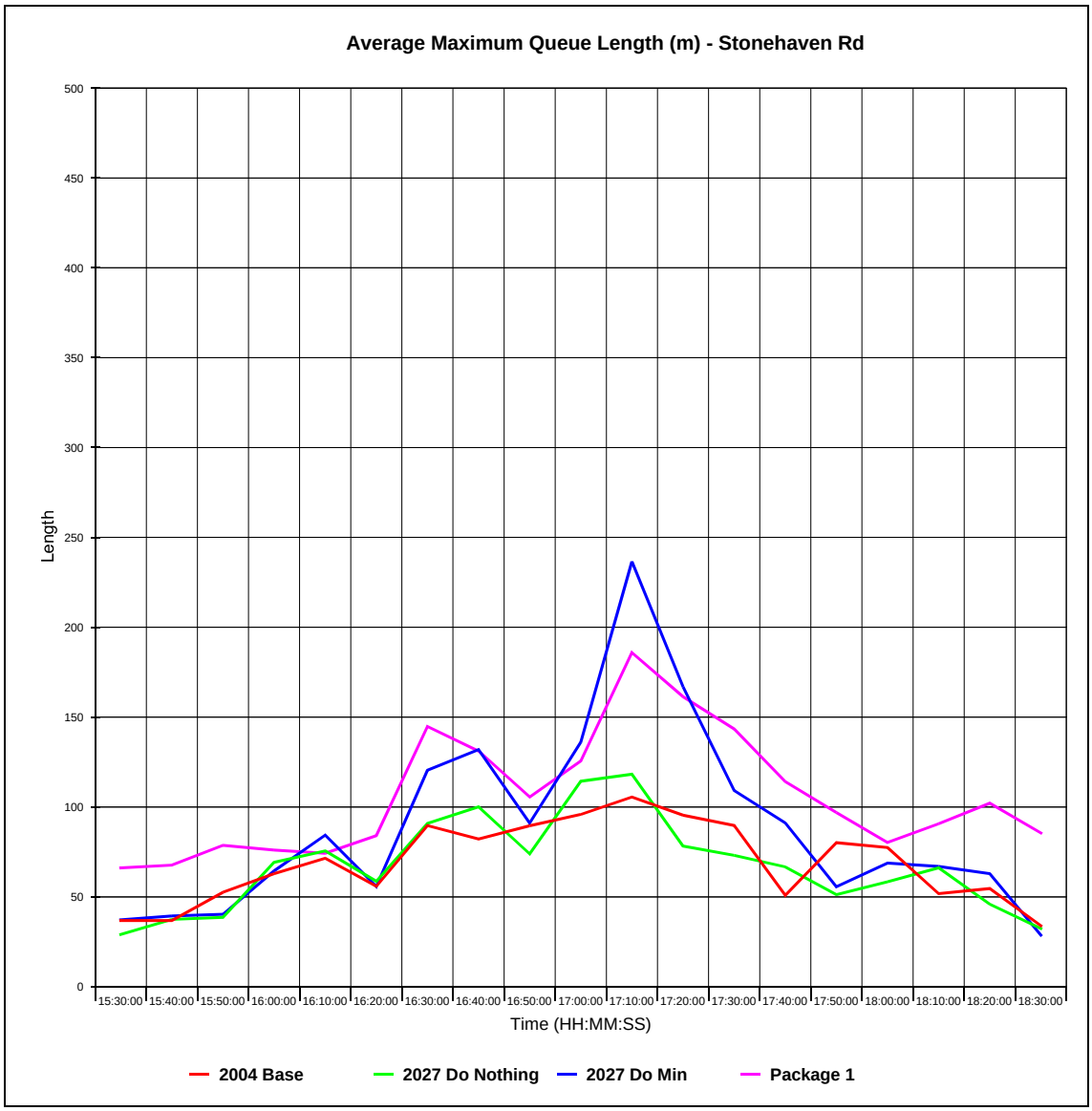


Figure A.12 : Queue Comparison (Stonehaven Road NB) – PM Peak

Figure A.12 shows no significant change in queueing on Stonehaven Road in the PM peak.

A.2 Package 1 Unreleased Vehicles Graphs

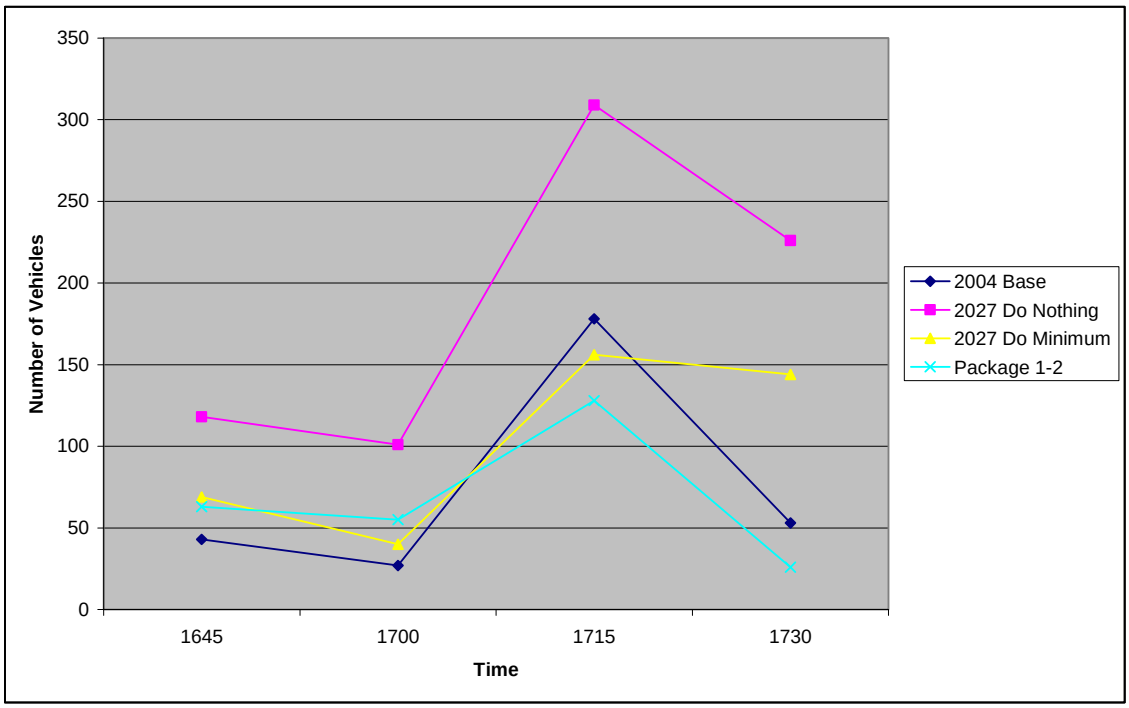


Figure A.13 : Total Number of Unreleased Vehicles – PM Peak Hour

Figure A.13 shows that the total number of unreleased vehicles in Package 1-2 is less than the 2004 Base and significantly less than the 2027 Do-Nothing. This indicates that the measures introduced have significantly improved the ability of the traffic network to cater for travel demand over the peak period.

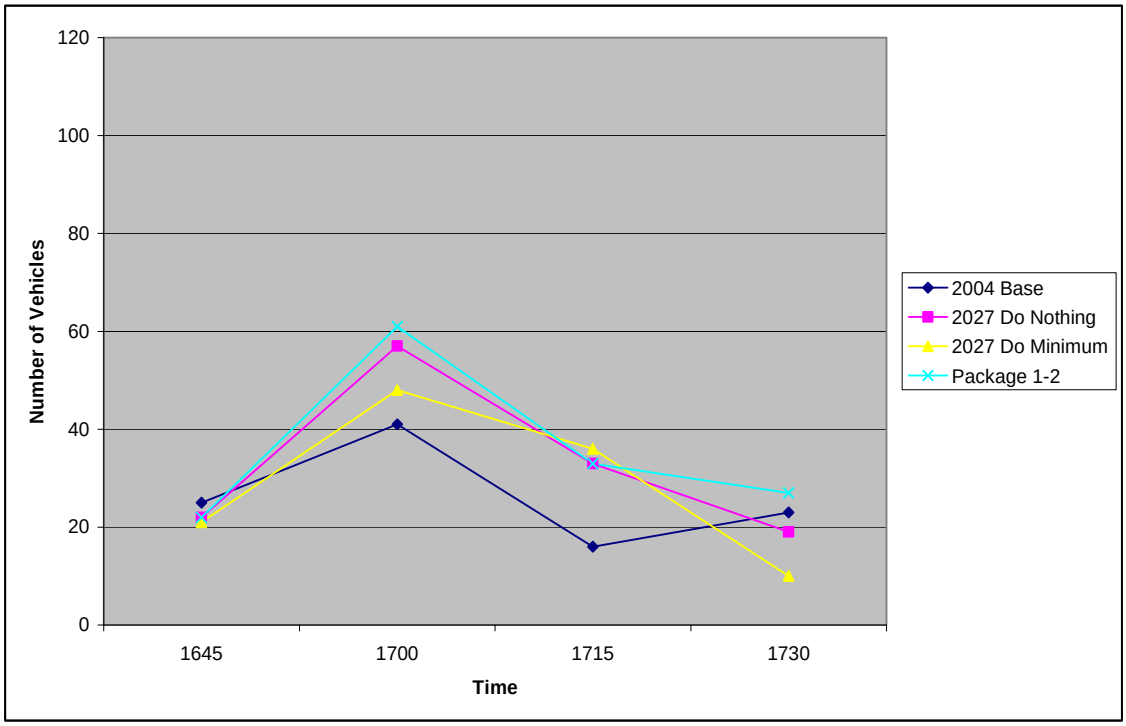


Figure A.14 : Number of Unreleased Vehicles in Garthdee Area – PM Peak Hour

Figure A.14 shows that all scenarios have peak of approximately 40 to 60 unreleased vehicles at 17:00, in the Garthdee area.

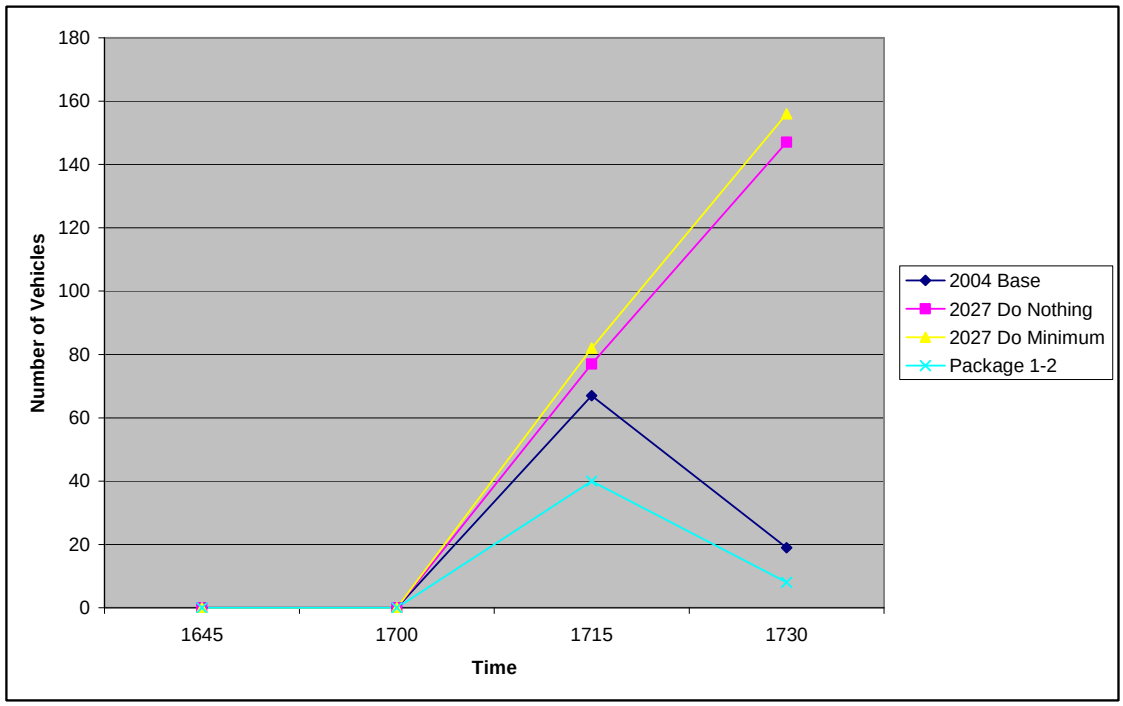


Figure A.15 : Number of Unreleased Vehicles in Anderson Drive Area – PM Peak Hour

Figure A.15 shows that in the 2027 Do-Nothing and Do-Minimum scenarios the number of unreleased vehicles is still increasing at the end of the peak hour, in the Anderson Drive area. In Package 1-2 the number has reduced to approximately 10 by 1730 offering a significant benefit.

B PACKAGE 2 GRAPHS

B.1 Package 2 Queue Length Graphs

Figure B.1 to Figure B.5 show the AM peak graphs.

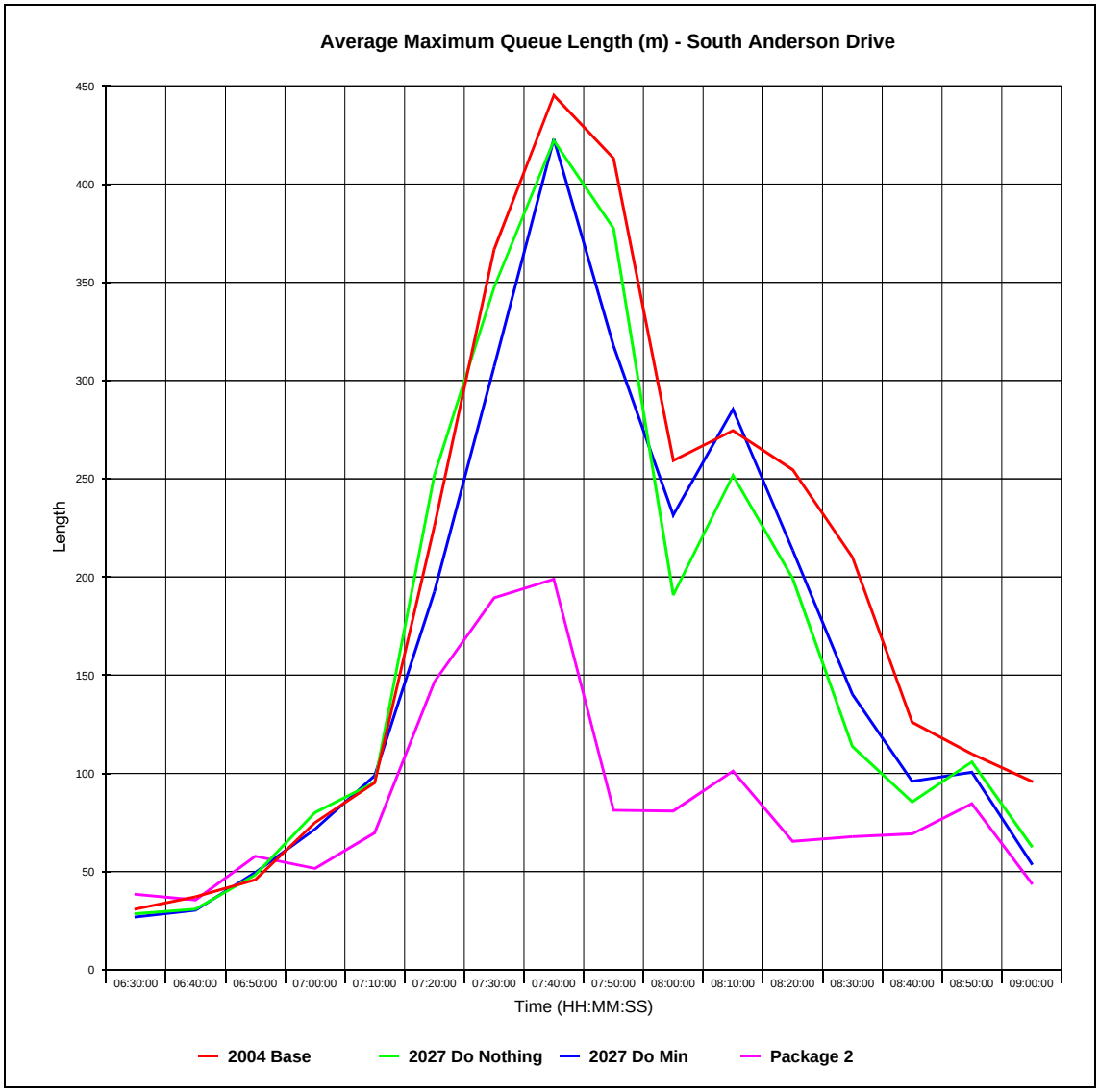


Figure B.1 : Queue Comparison (South Anderson Drive SB) – AM Peak

Figure B.1 shows the average maximum queue length on South Anderson Drive reduces from approximately 400m in the 2027 Do-Nothing and Do-Minimum to 200m at 07:45 in Package 2.

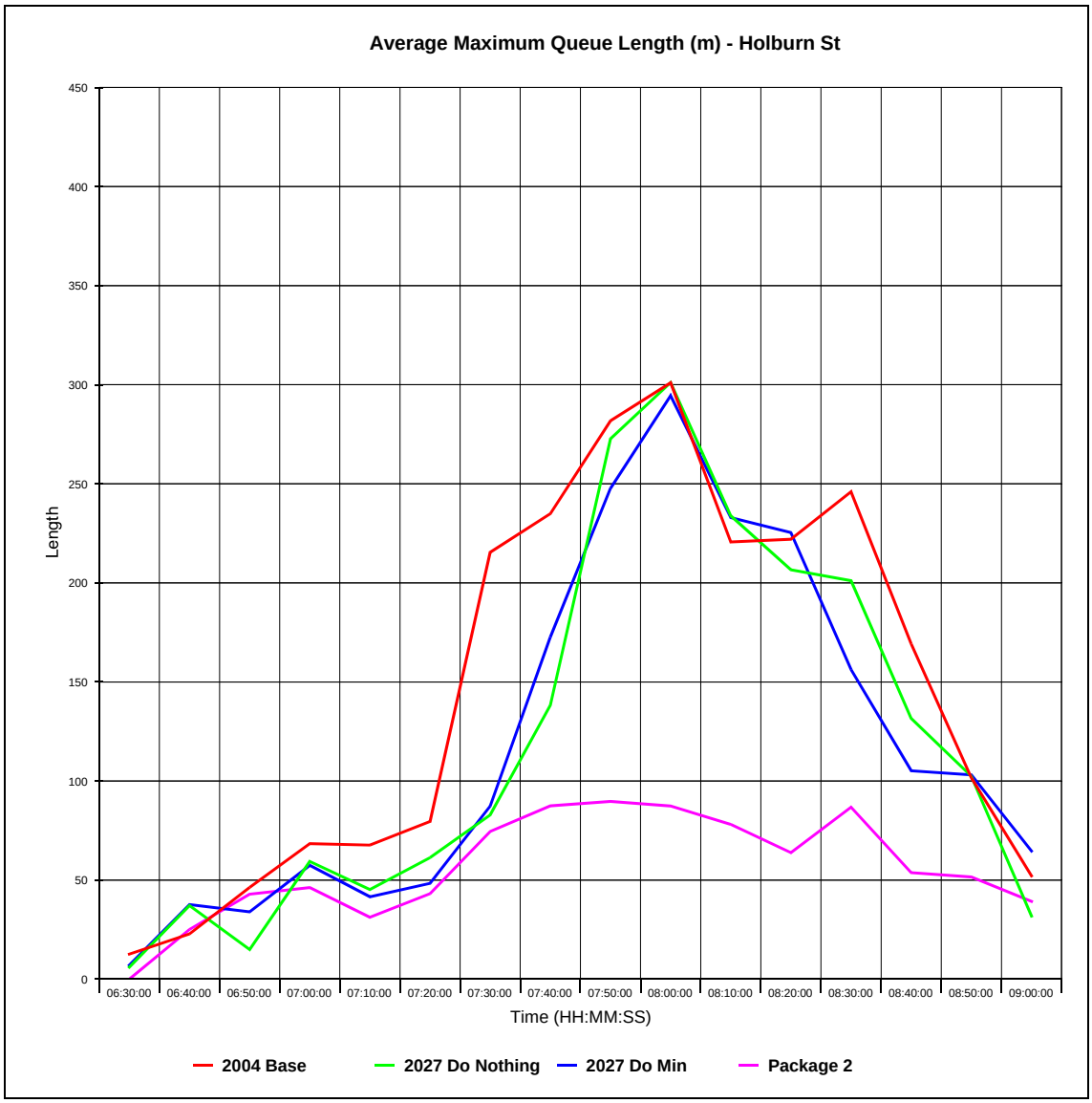


Figure B.2 : Queue Comparison (Holburn St WB) – AM Peak

Figure B.2 shows the average maximum queue on Holburn Street is reduced from approximately 300m to less than 100m with the introduction of the new bridge.

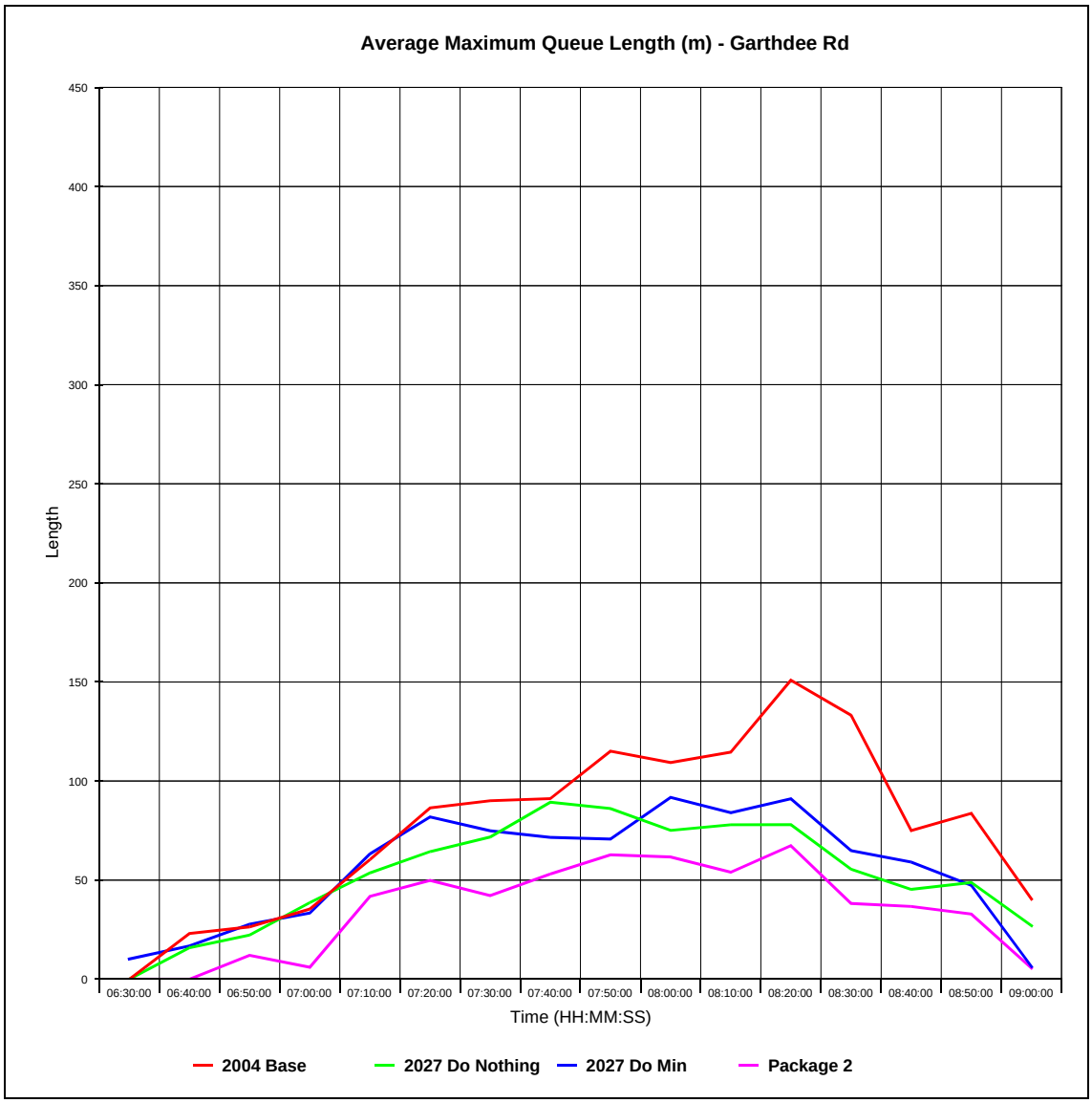


Figure B.3 : Queue Comparison (Garthdee Road EB) – AM Peak

Figure B.3 shows that Package 2 causes no significant change to queue lengths on Garthdee Road in the AM peak.

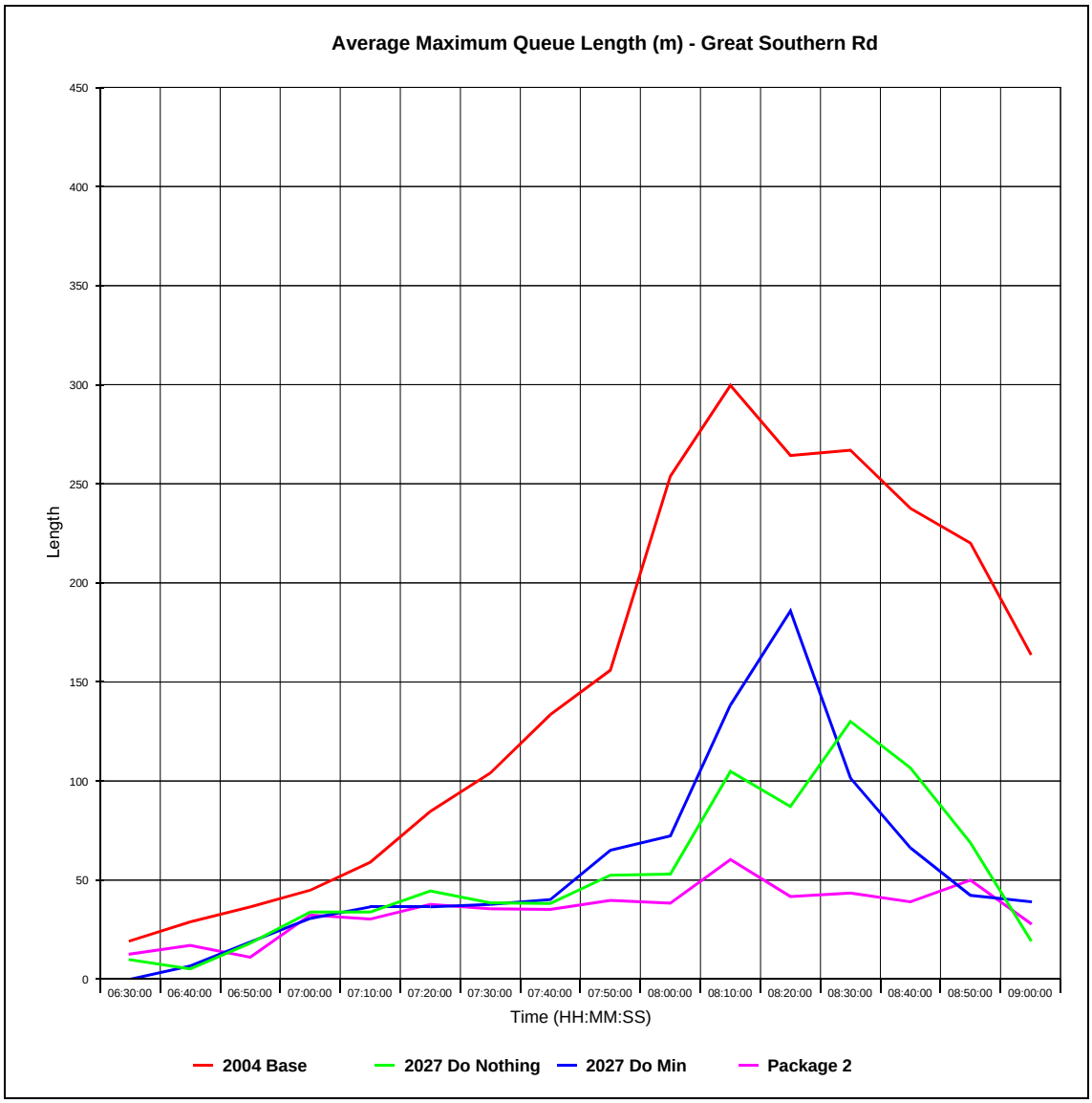


Figure B.4 : Queue Comparison (Great Southern Road EB) – AM Peak

Figure B.4 shows that the introduction of the new bridge has removed the peak in queue lengths on Great Southern Road between 08:00 and 08:45.

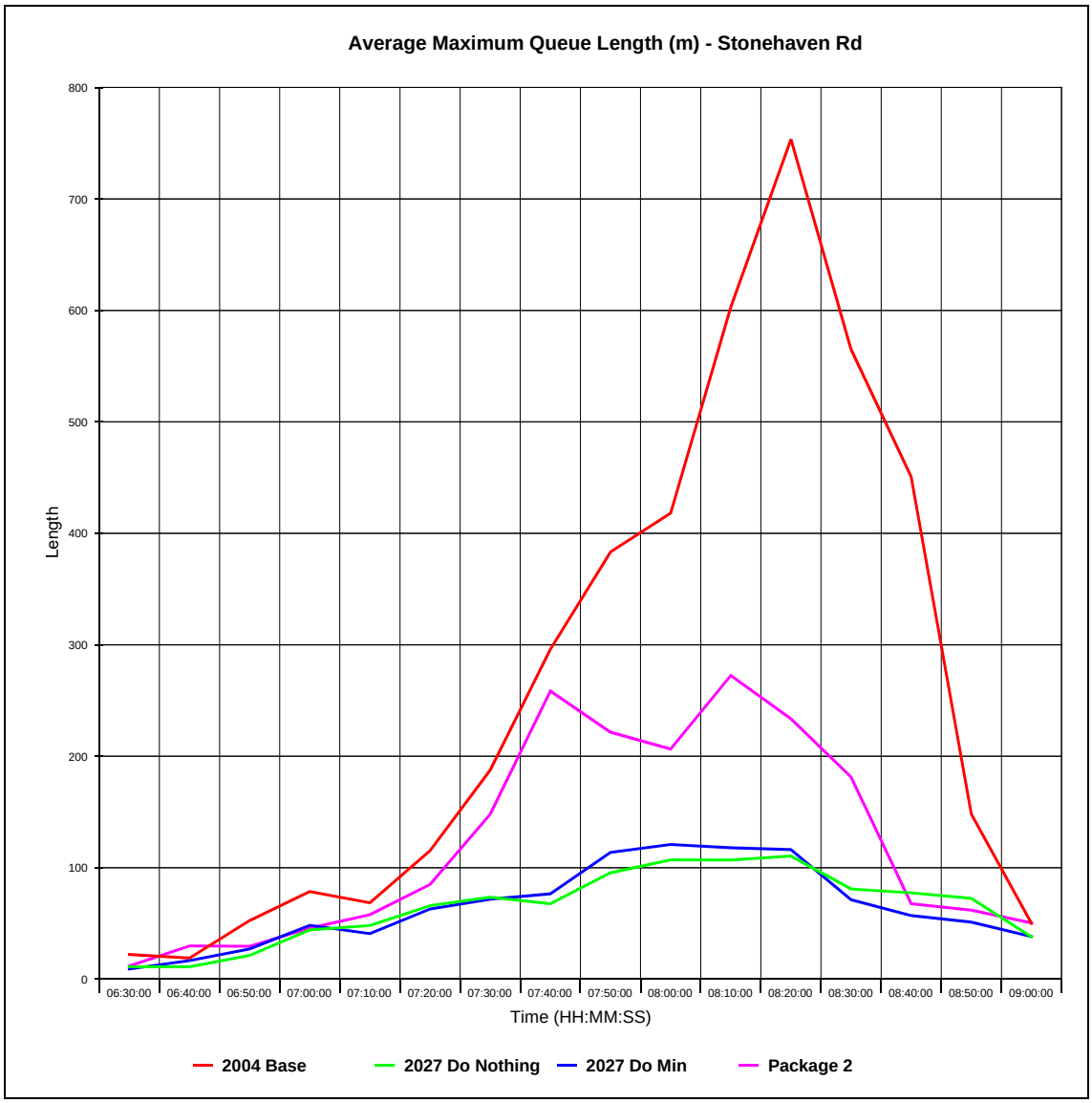


Figure B.5 : Queue Comparison (Stonehaven Road NB) – AM Peak

Figure B.5 shows an increase in queue length on Stonehaven Road in the AM peak, which is partly due to Leggart Terrace being diverted onto Stonehaven Road, the queue is still significantly less than the 2004 base. Note this graph uses a different scale to the rest of the AM graphs.

PM graphs for Package 2 are shown in Figure B.6 to Figure B.10.

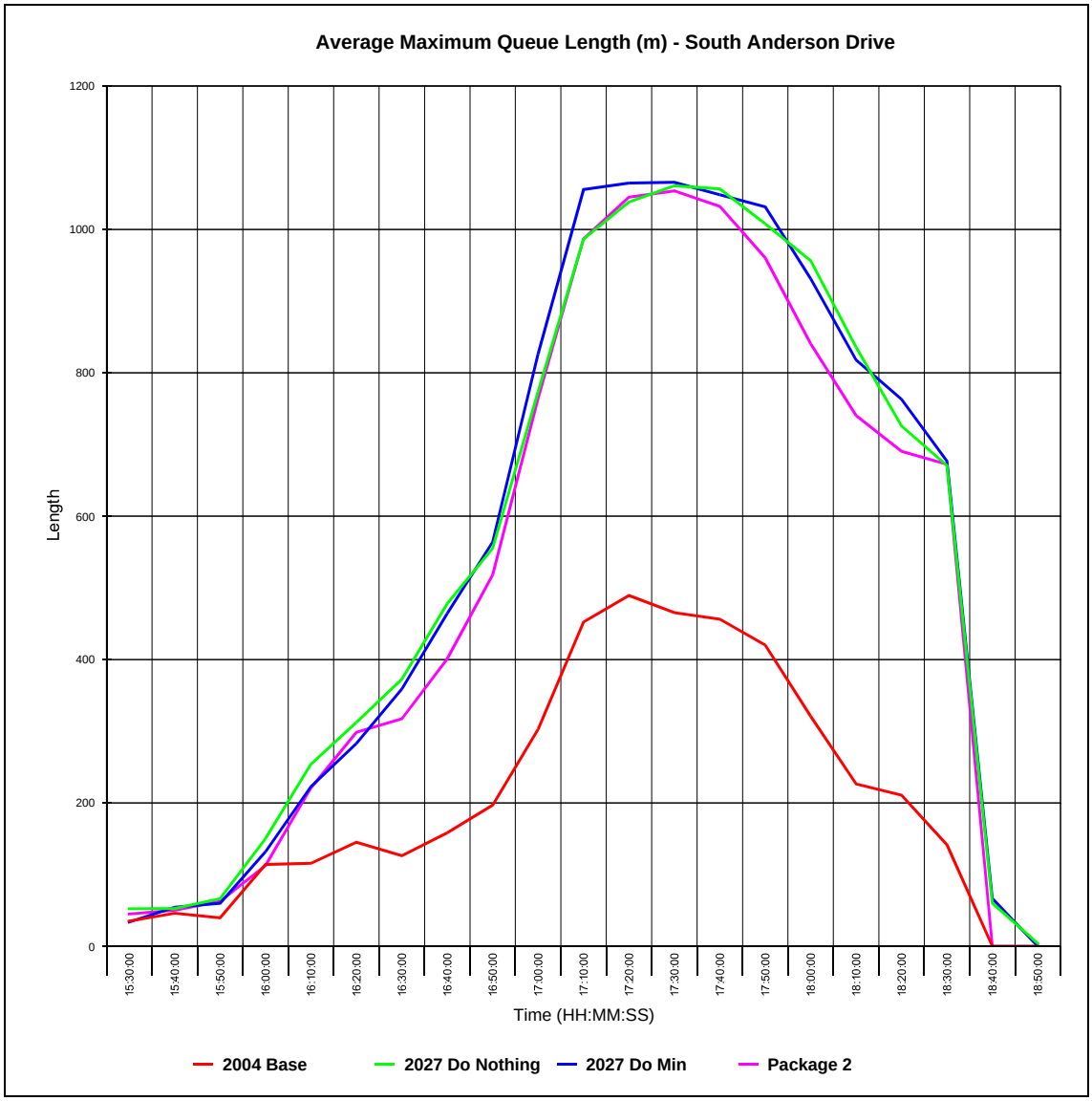


Figure B.6 : Queue Comparison (South Anderson Drive SB) – PM Peak

Figure B.6 shows that Package 2 does not improve the congestion on South Anderson Drive in the PM peak, with queues in all three scenarios reaching the extents of the model. Note this graph uses a different scale to the other PM graphs.

Observations of the model show that Package 2 is unable to cater for the forecast travel demand on South Anderson Drive with significant numbers of vehicles queued off the network on Broomhill Avenue.

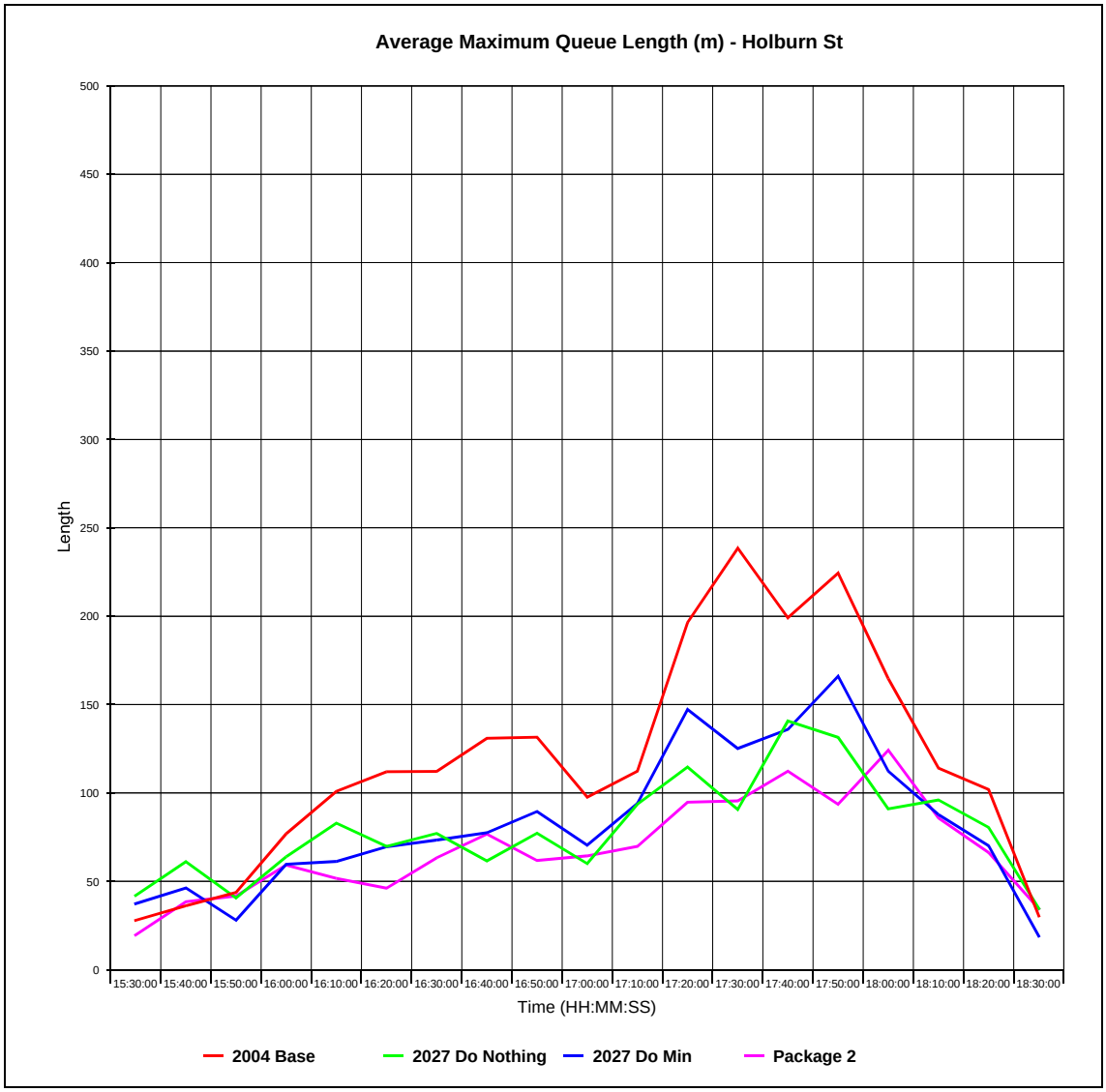


Figure B.7 : Queue Comparison (Holburn St WB) – PM Peak

Figure B.7 shows that Package 2 causes no significant change to queue lengths on Holburn St in the PM peak.

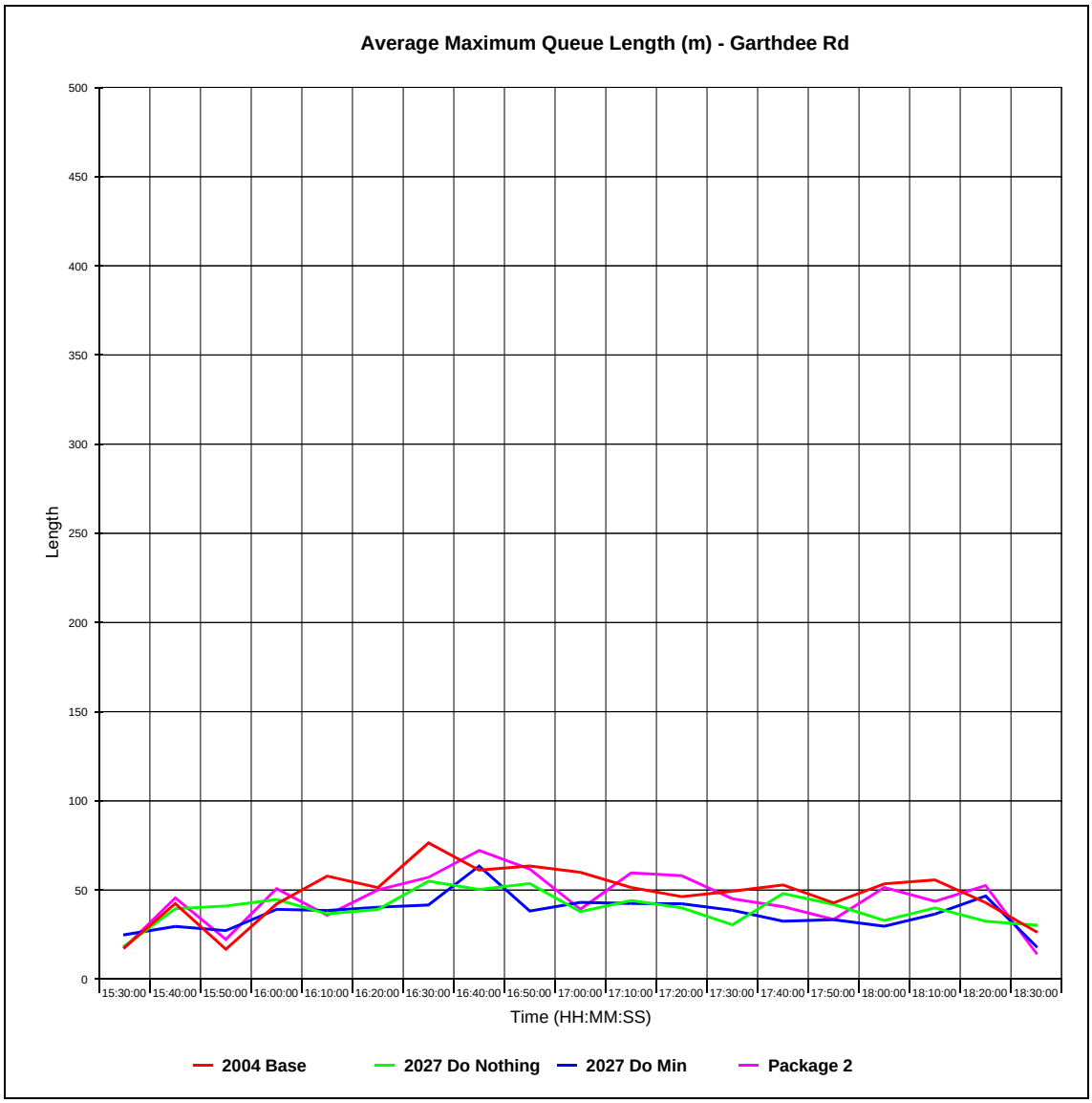


Figure B.8 : Queue Comparison (Garthdee Road EB) – PM Peak

Figure B.8 shows that there is no significant queueing on Garthdee Road in the PM peak.

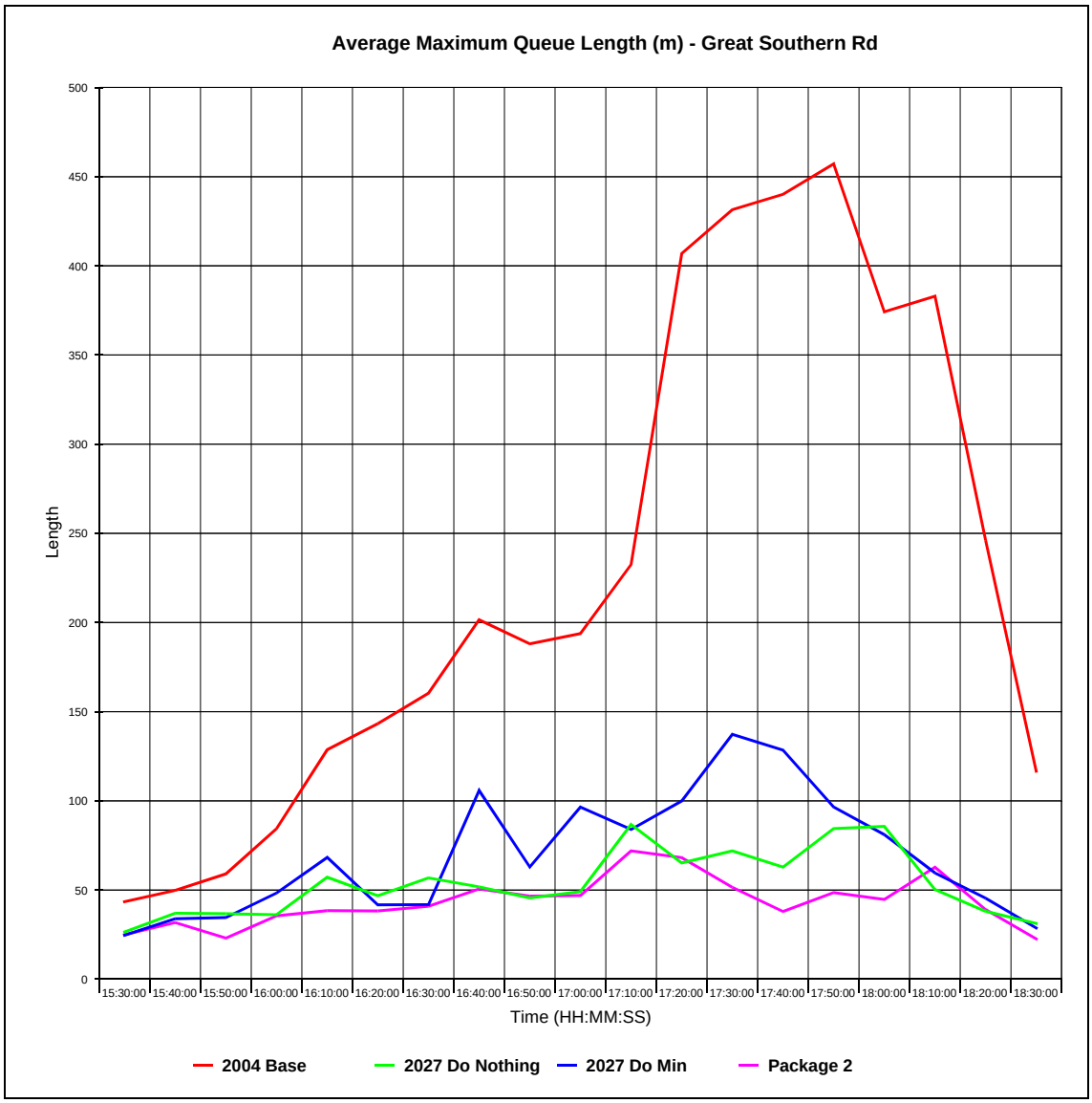


Figure B.9 : Queue Comparison (Great Southern Road EB) – PM Peak

Figure B.9 shows Package 2 has similar average maximum queue lengths to the 2027 Do-Nothing scenario on Great Southern Road in the PM peak of around 100 vehicles, this is significantly less than the 2004 base

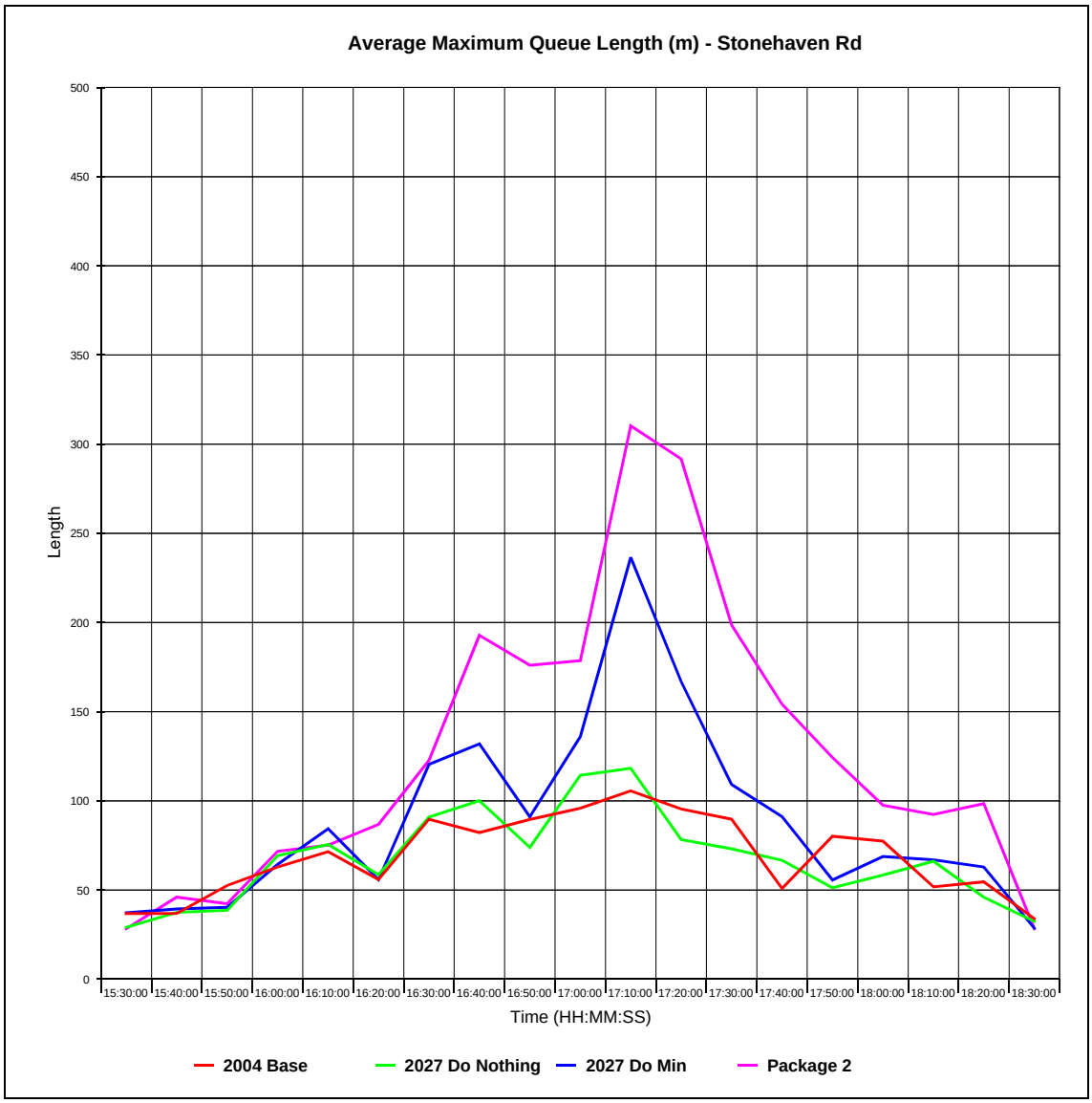


Figure B.10 : Queue Comparison (Stonehaven Road NB) – PM Peak

Figure B.10 shows Package 2 has an average maximum queue length on Stonehaven Road approximately 50-100m longer than the 2027 Do-Minimum scenario in the PM peak at around 300 metres.

B.2 Package 2 Unreleased Vehicle Graphs

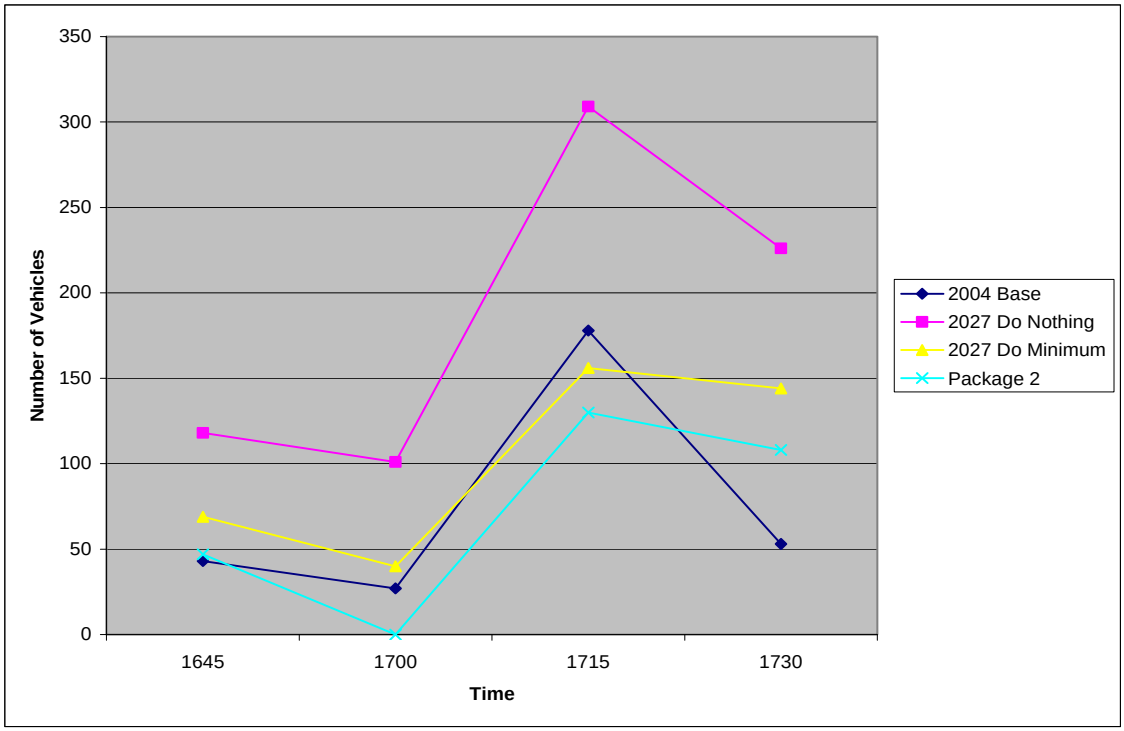


Figure B.11 : Total Number of Unreleased Vehicles – PM Peak Hour

Figure B.11 shows Package 2 has a lower total number of unreleased vehicles than the 2004 Base, and 2027 Do-Nothing and Do-Something scenarios.

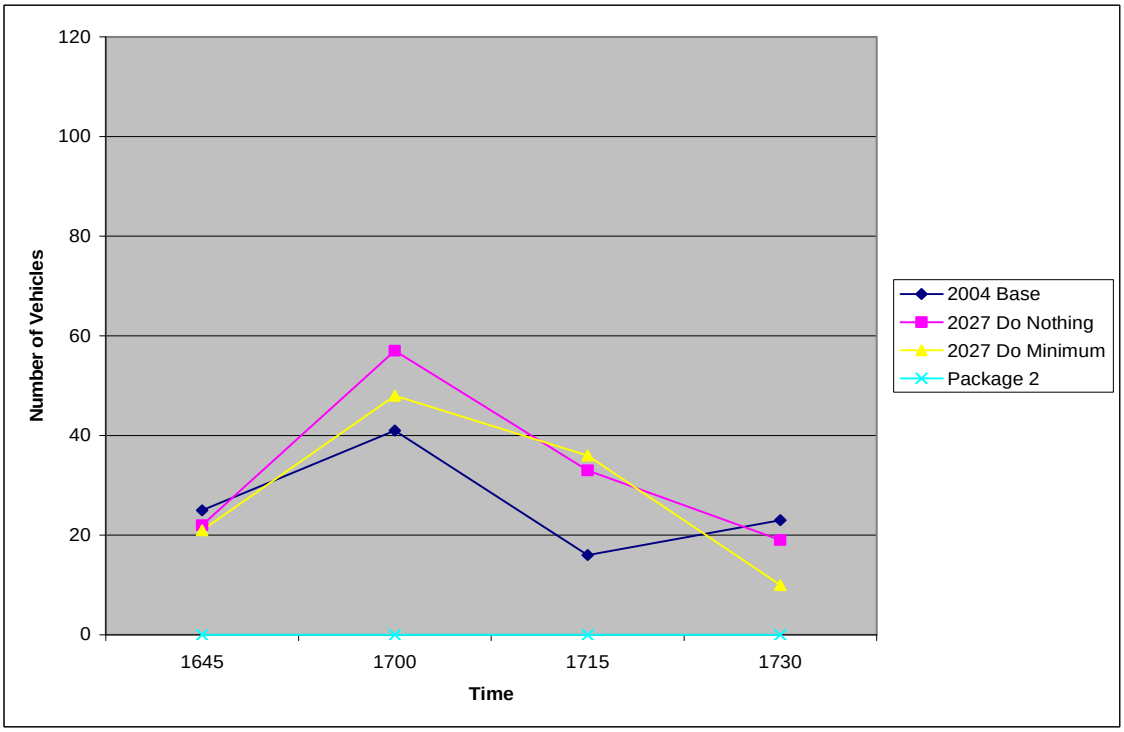


Figure B.12 : Number of Unreleased Vehicles in Garthdee Area – PM Peak Hour

Figure B.12 shows Package 2-1 has no unreleased vehicles in the Garthdee area and the bulk of benefits are felt in this area as they are given a direct alternative to access the A90 Southbound without having to cross the Bridge of Dee.

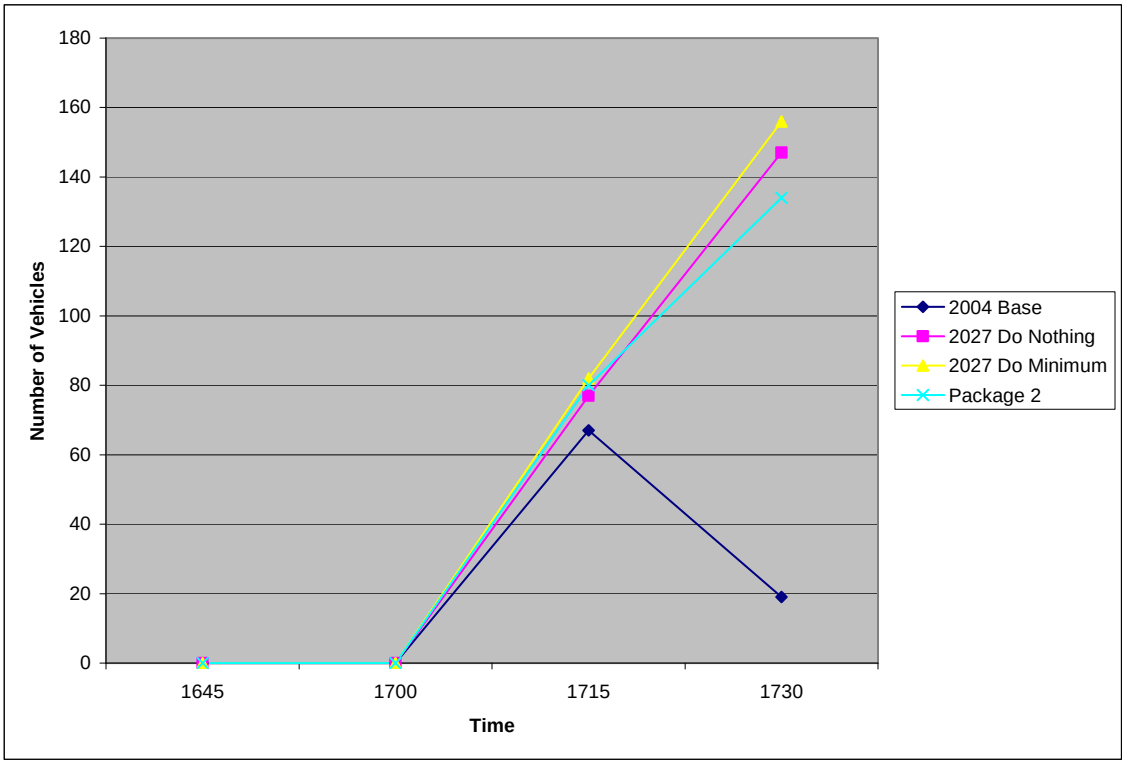


Figure B.13 : Number of Unreleased Vehicles in Anderson Drive Area – PM Peak Hour

Figure B.13 shows that in Package 2 the number of unreleased vehicles in the Anderson Drive area is similar to that in the 2027 Do-Nothing indicating that the measures introduced in Package 2 will not provide benefits to southbound traffic on South Anderson Drive during the peak hour.

C PACKAGE 3 GRAPHS

C.1 Signal Timings for Bridge of Dee Junctions

Figure C.1 shows the signal stages and timings used in the AM peak.

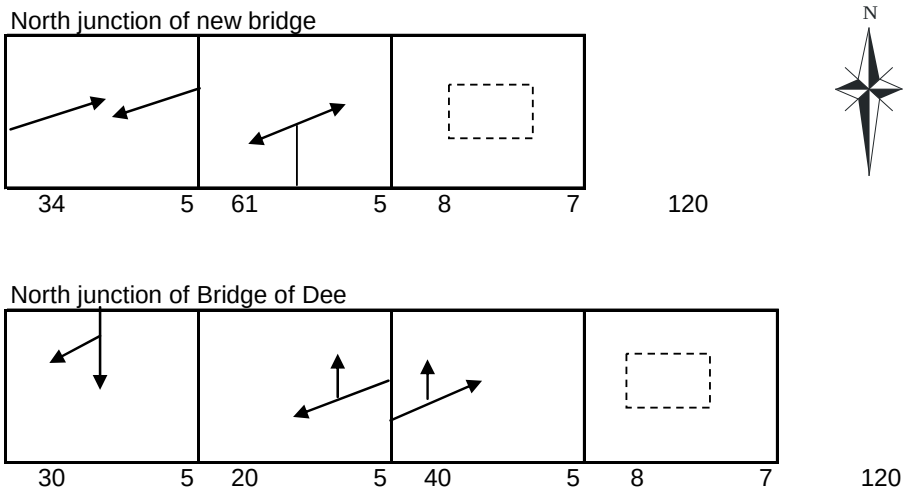


Figure C.1 : AM Signal Timings – Package 3

Figure C.2 shows the signal timings and stages used in the PM peak.

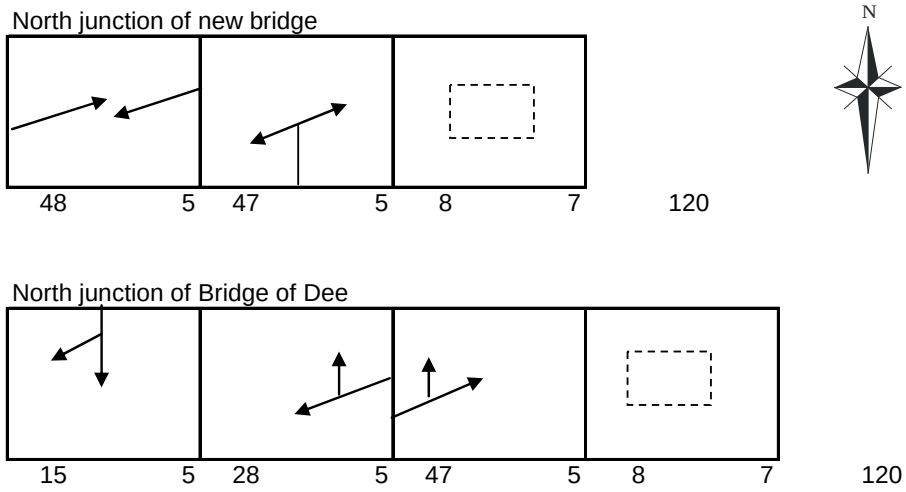


Figure C.2 : PM Signal Timings – Package 3

C.2 Package 3 Queue Length Graphs

Figure C.3 to Figure C.7 show the AM queue length graphs.

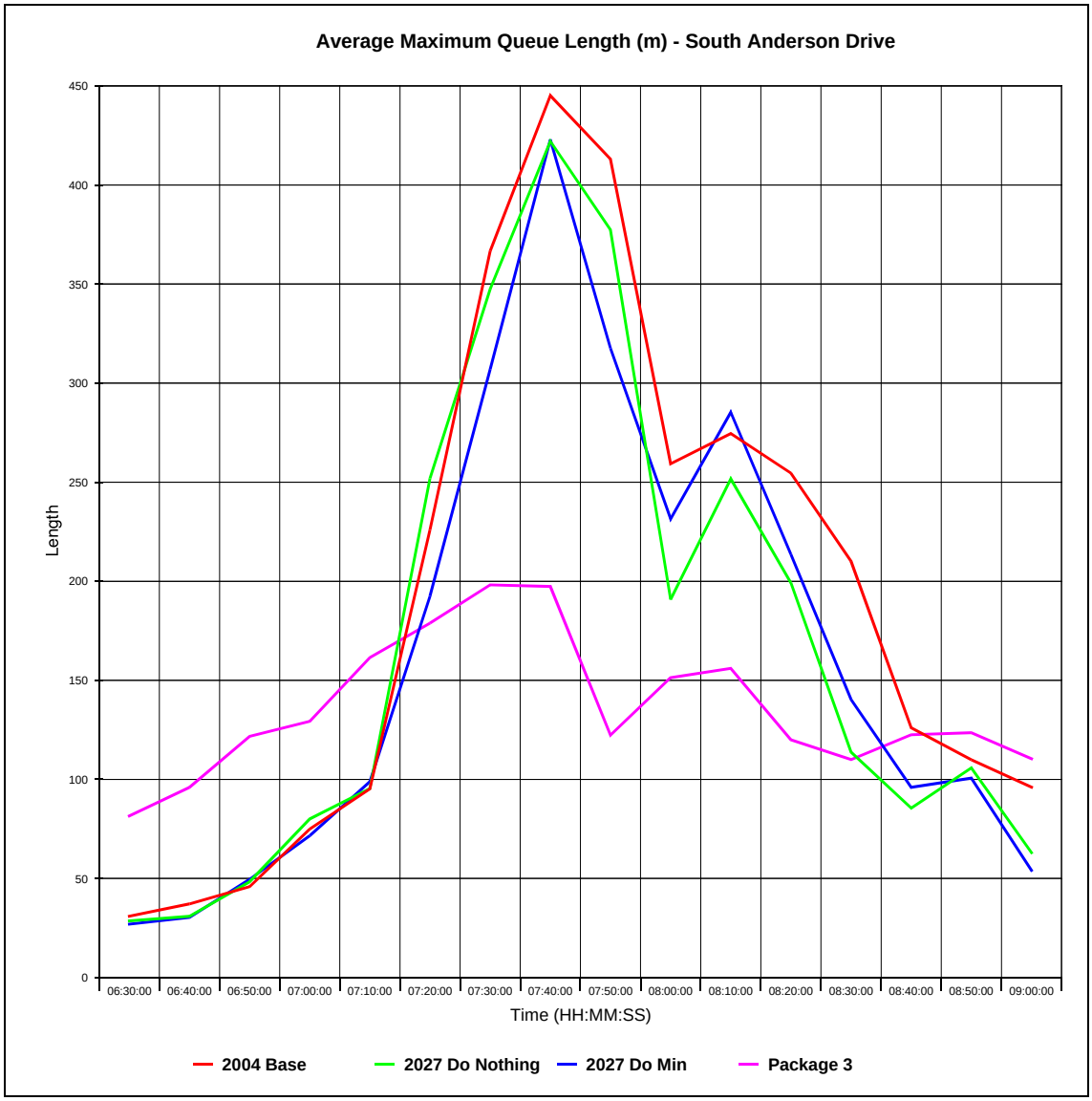


Figure C.3 : Queue Comparison (South Anderson Drive SB) – AM Peak

Figure C.3 shows that the average queue length on South Anderson Drive reduces from over 400m in the 2027 Do-Nothing and Do-Minimum to approximately 200m in Package 3, at 07:40.

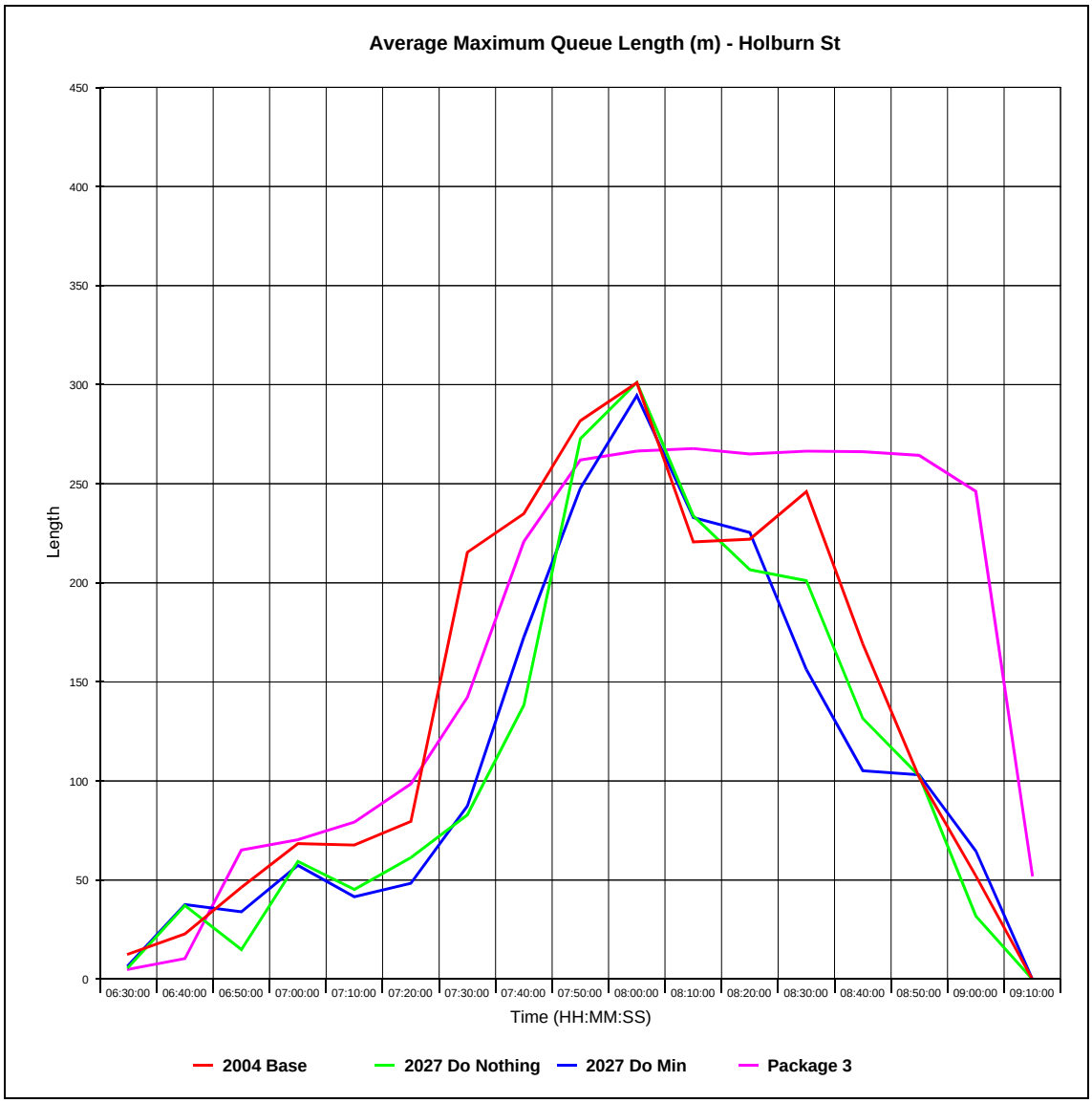


Figure C.4 : Queue Comparison (Holburn St WB) – AM Peak

Figure C.4 shows a more prolonged period of queueing on Holburn Street in Package 3, with the average queue length remaining over 250m until 09:00.

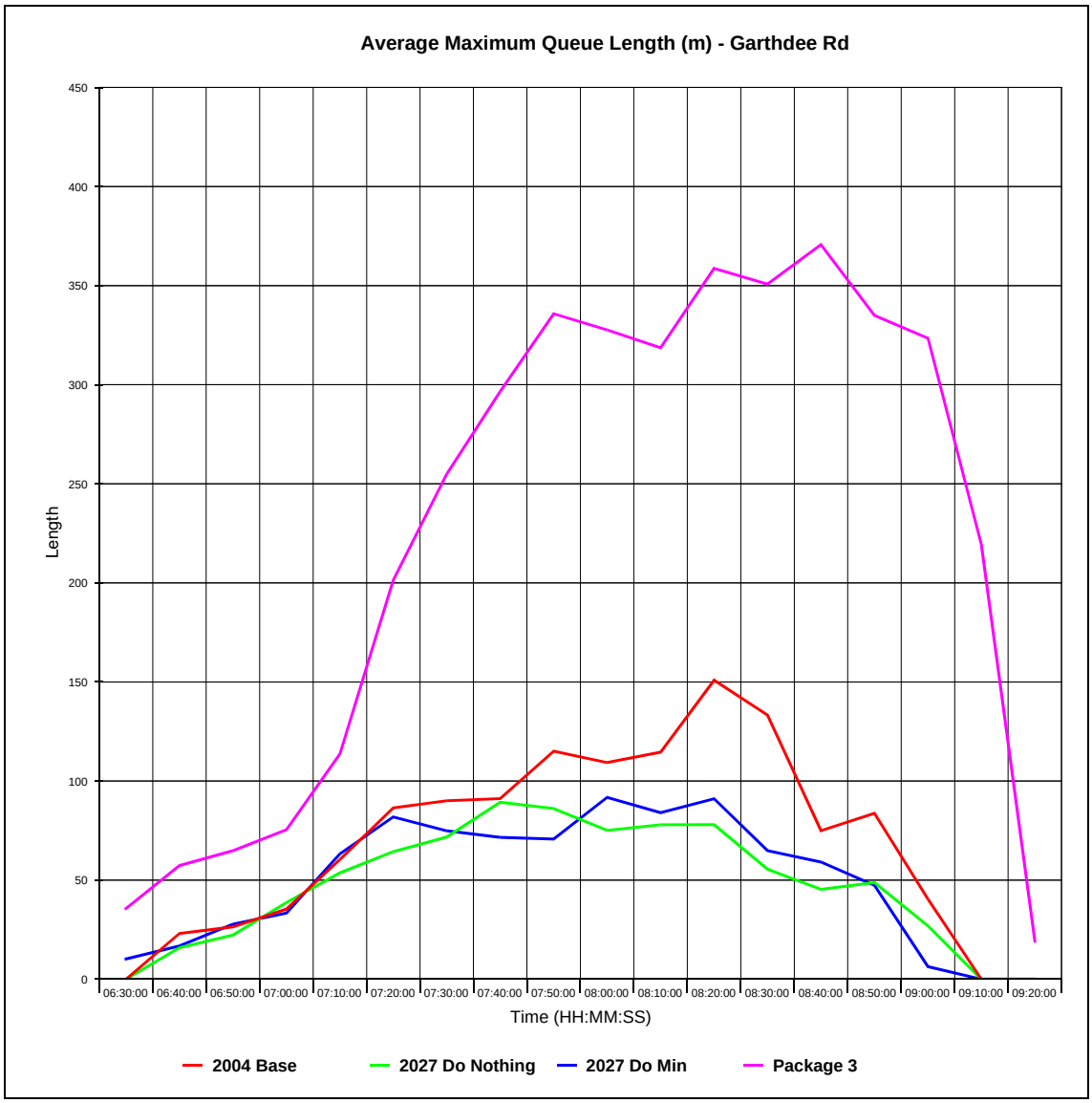


Figure C.5 : Queue Comparison (Garthdee Road EB) – AM Peak

Figure C.5 shows that the gyratory option increases average queue lengths on Garthdee Road in the AM peak to over 350m.

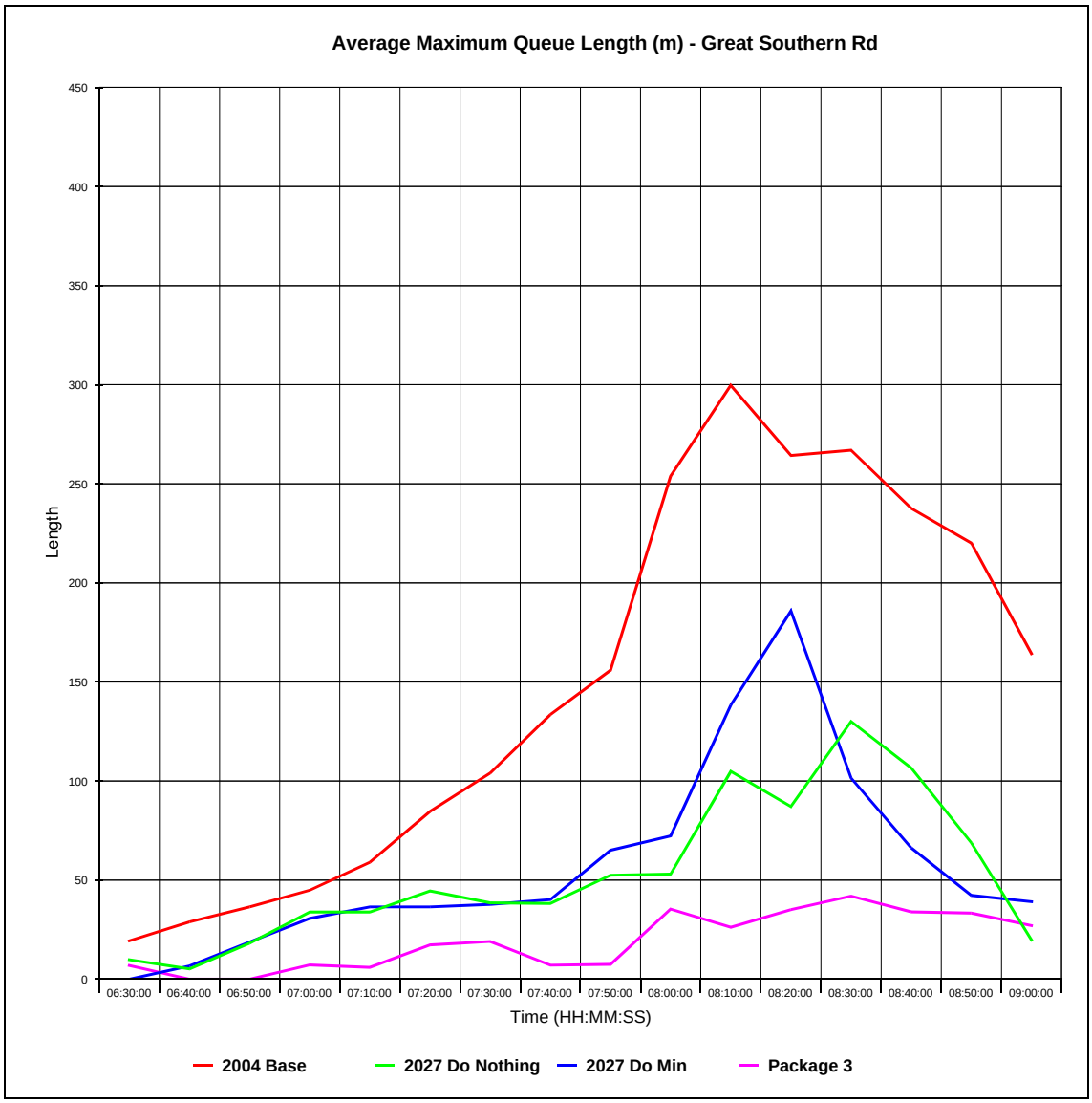


Figure C.6 : Queue Comparison (Great Southern Road EB) – AM Peak

Figure C.6 shows that average maximum queue lengths on Great Southern Road do not exceed 50m in Package 3.

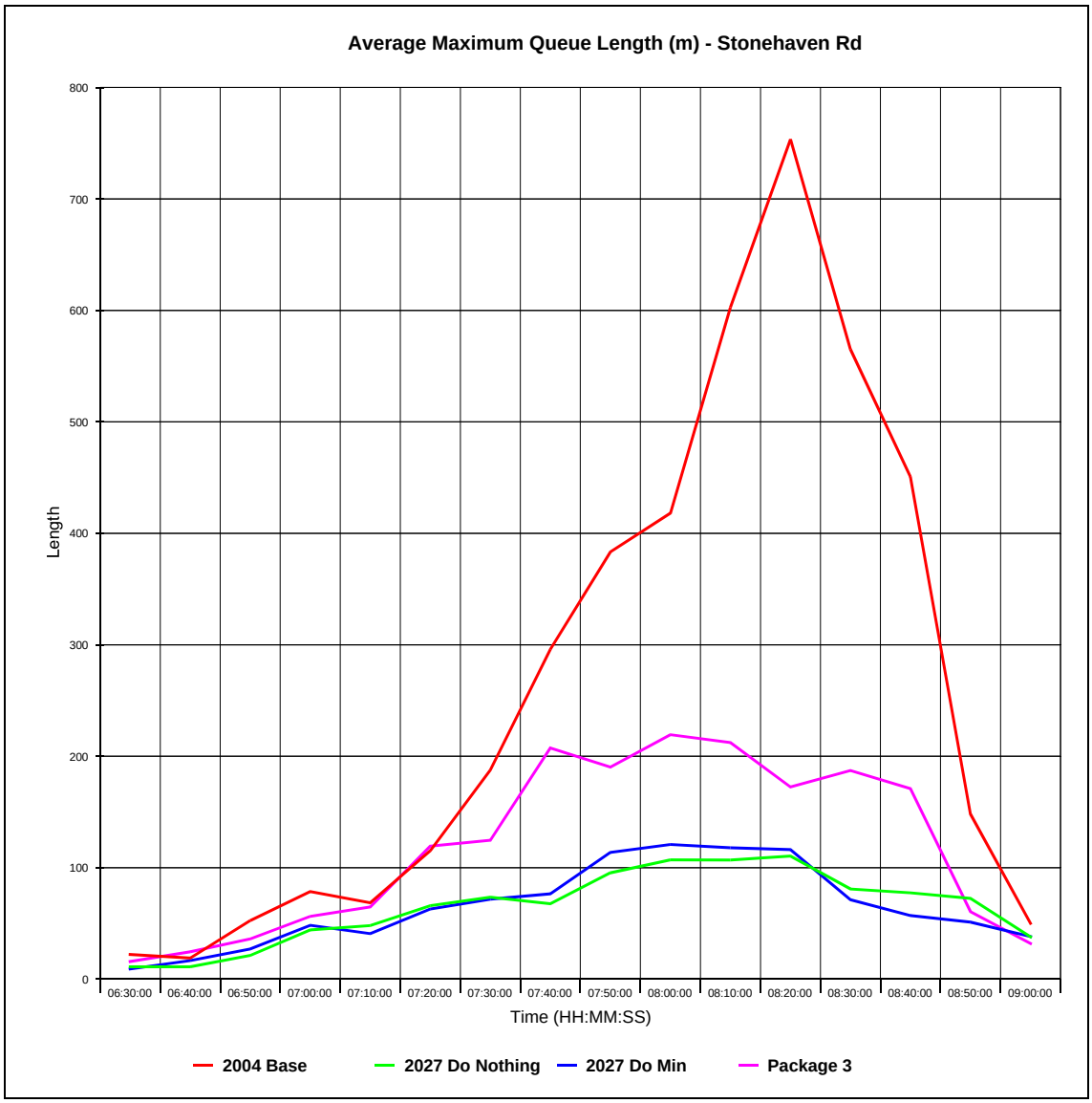


Figure C.7 : Queue Comparison (Stonehaven Road NB) – AM Peak

Figure C.7 shows increased queueing on Stonehaven Road, which is partly due to Leggart Terrace being diverted onto Stonehaven Road. Note this graph uses a different scale to the rest of the AM graphs.

Queue graphs for the PM peak are shown in Figure C.8 to Figure C.12.

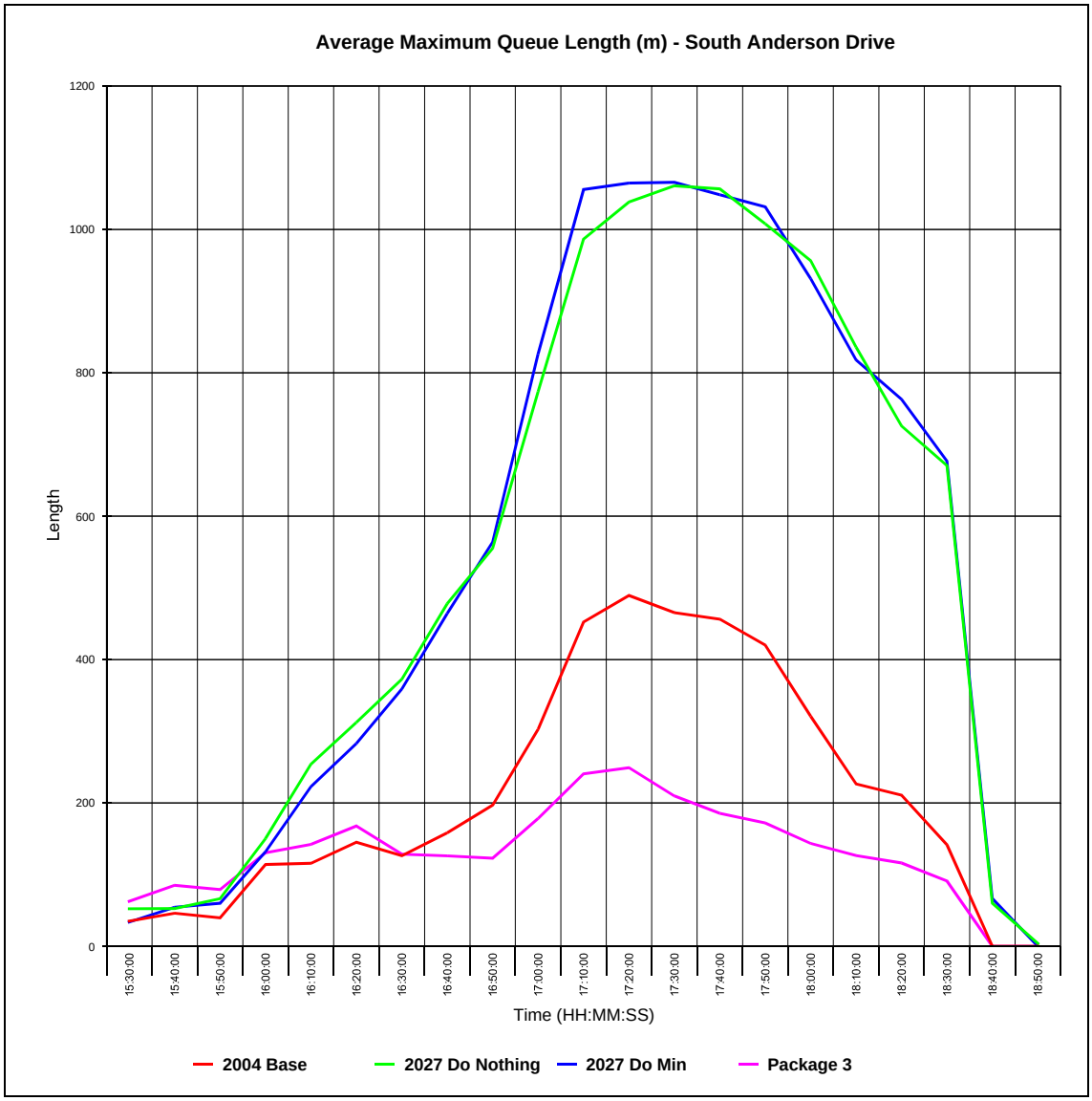


Figure C.8 : Queue Comparison (South Anderson Drive SB) – PM Peak

Figure C.8 shows the average maximum queue length on South Anderson Drive is reduced from approximately 1050m (the model extents) in the 2027 Do-Nothing and Do-Min scenarios to approximately 200m in Package 3. Note this graph uses a different scale to the remaining PM graphs.

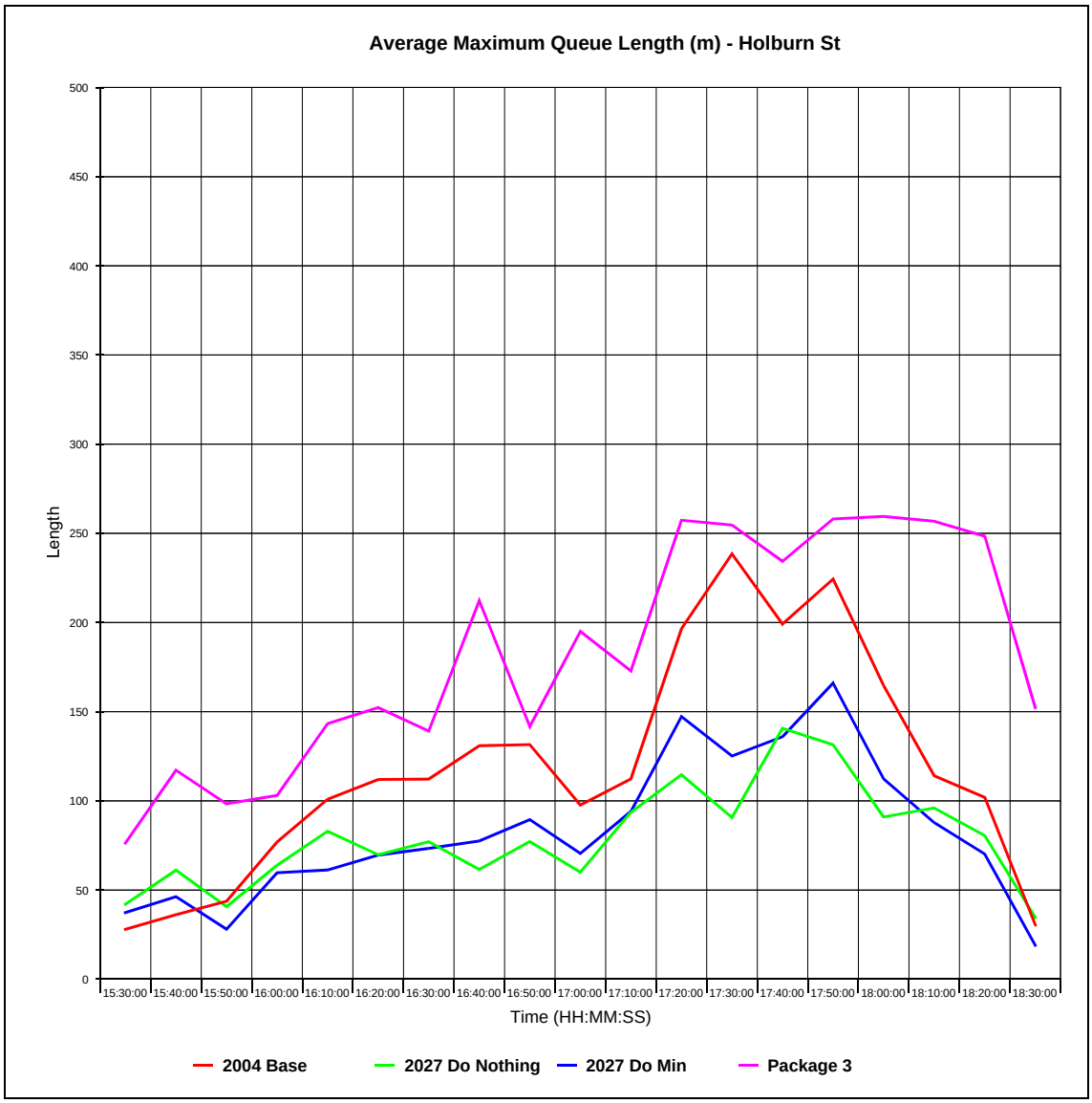


Figure C.9 : Queue Comparison (Holburn St WB) – PM Peak

Figure C.9 shows an increase in queue lengths on Holburn Street of approximately 100m to 250m in Package 3 compared to the 2027 Do-Nothing and Do-Min scenarios.

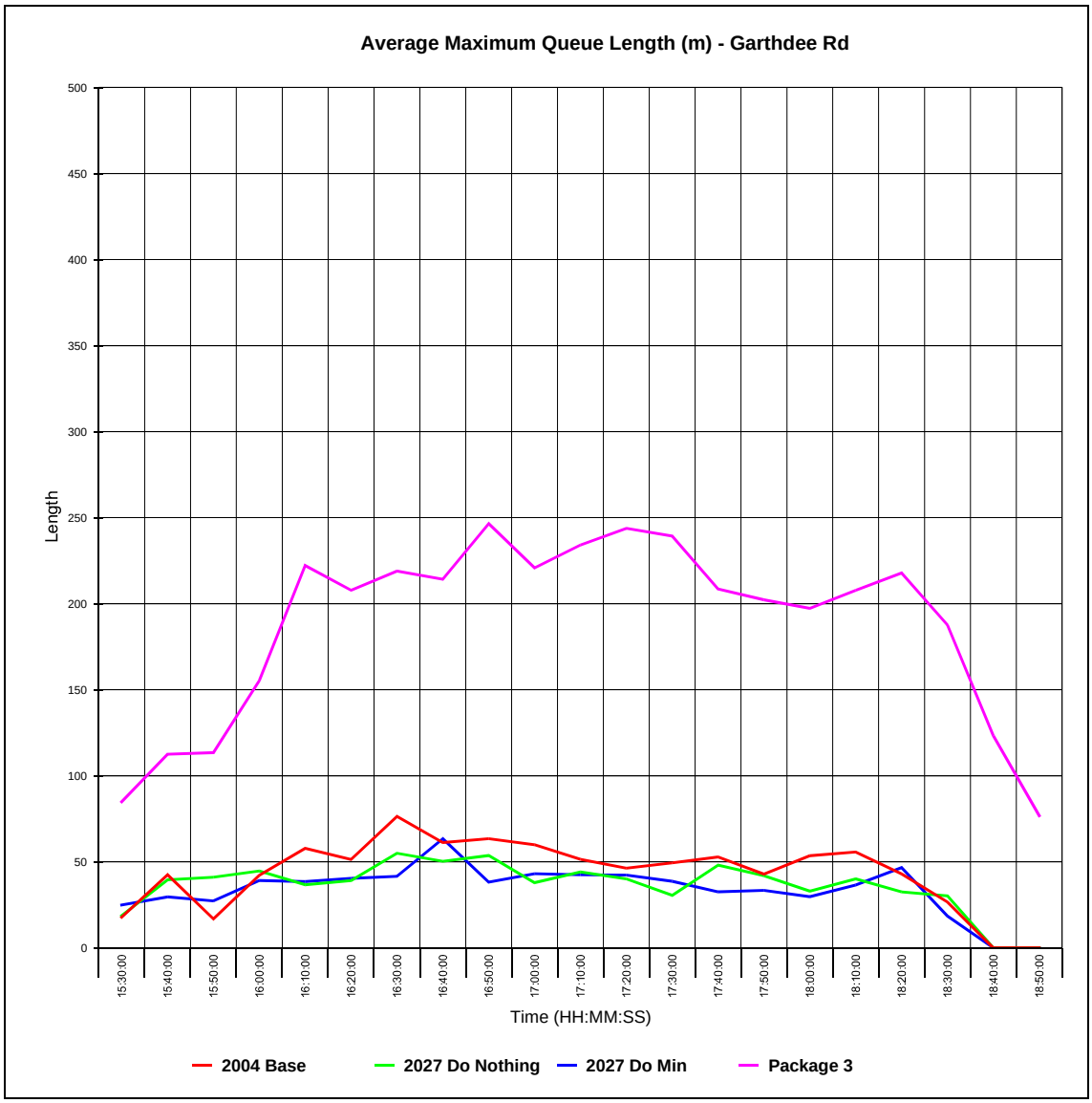


Figure C.10 : Queue Comparison (Garthdee Road EB) – PM Peak

Figure C.10 shows Package 3 causes an increase in queue length on Garthdee Road in the PM peak, from approximately 50m in the 2027 Do-Nothing and Do-Min to 200-250m in Package 3.

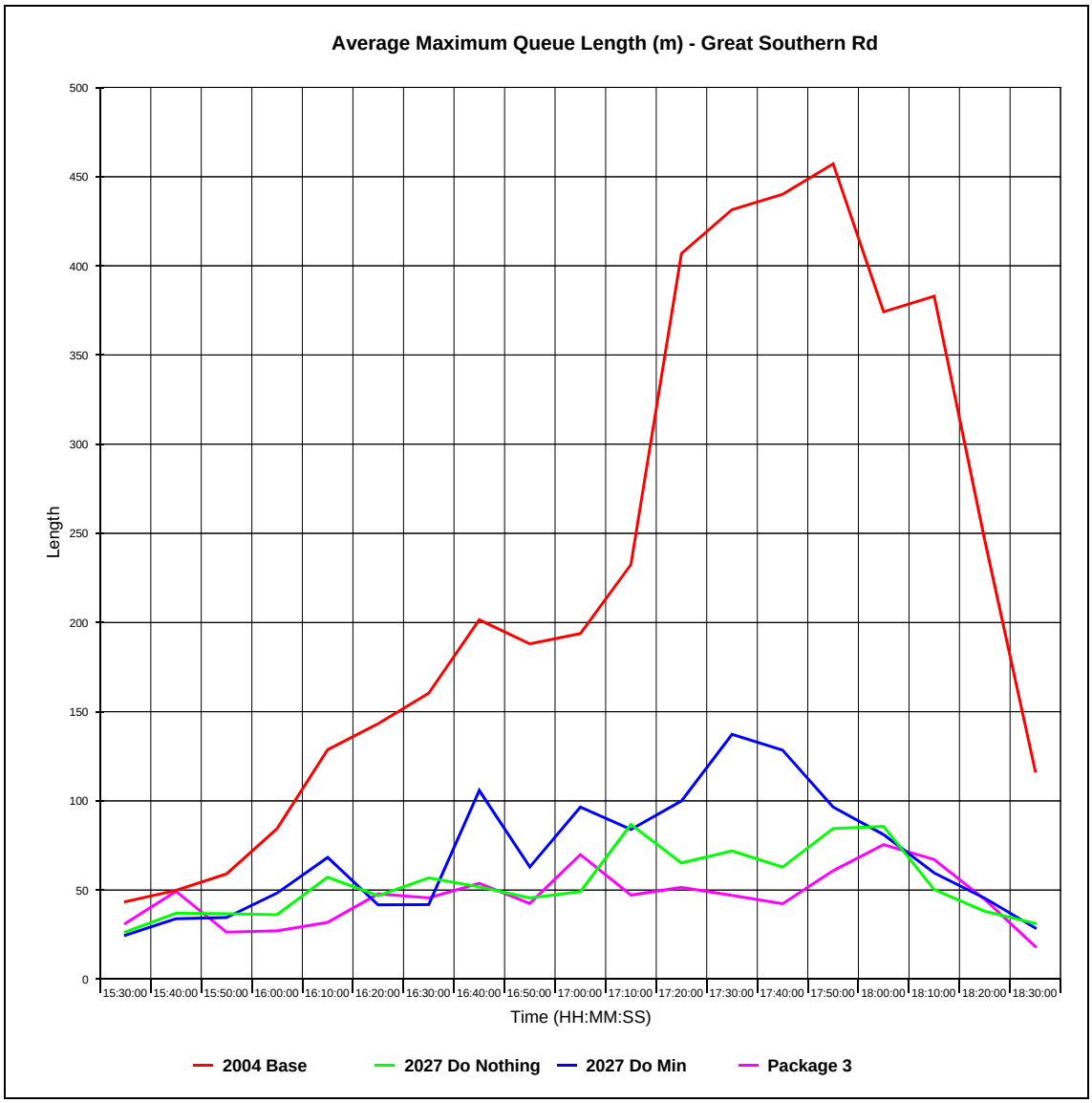


Figure C.11 : Queue Comparison (Great Southern Road EB) – PM Peak

Figure C.11 shows Package 3 has similar queue lengths to the 2027 Do-Nothing scenario at around 100m, significantly less than the 2004 base.

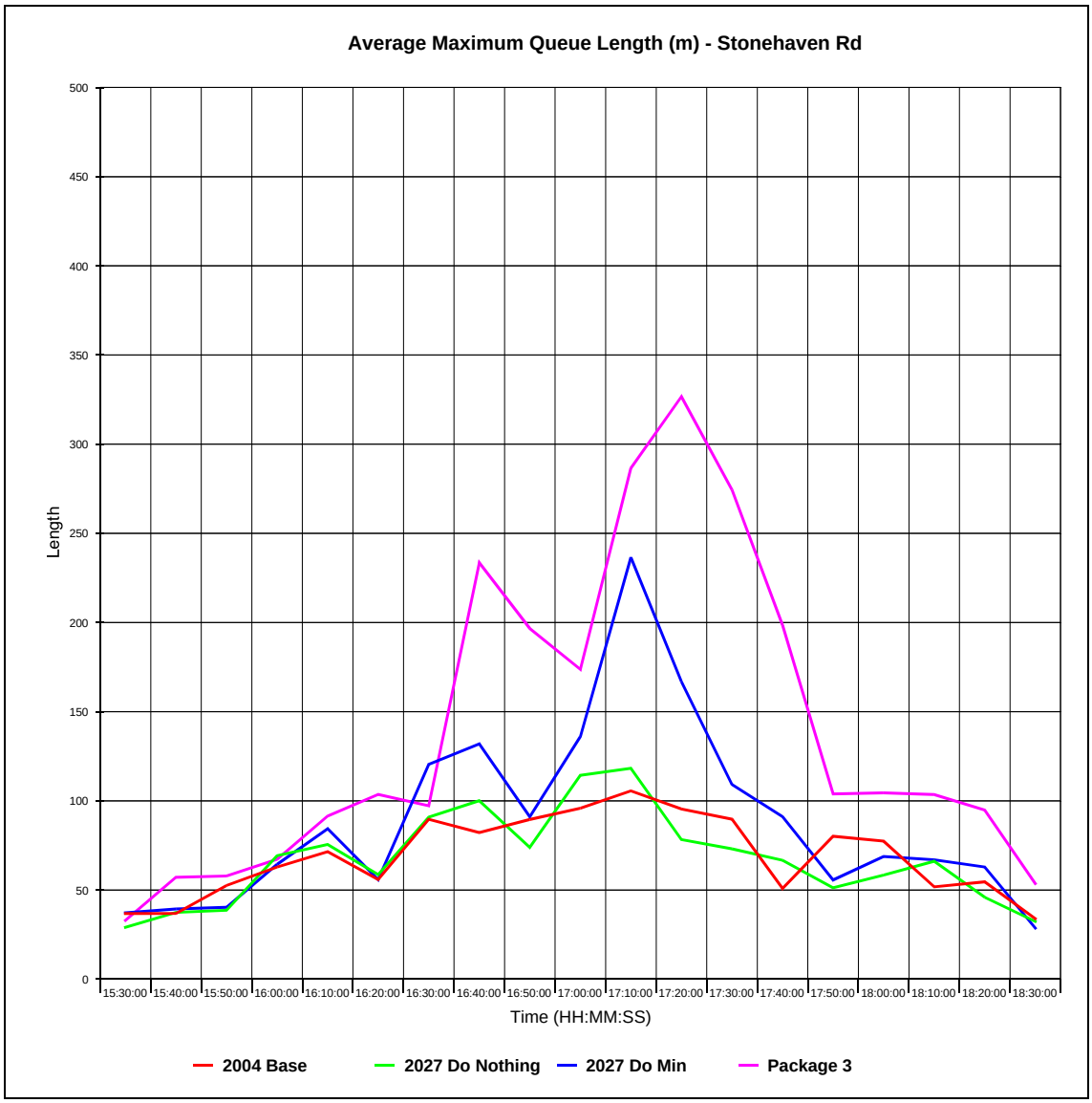


Figure C.12 : Queue Comparison (Stonehaven Road NB) – PM Peak

Figure C.12 has an average maximum queue length on Stonehaven Road approximately 50-100m longer than the 2027 Do-Minimum scenario at 350m, due to Leggart Terrace being diverted onto Stonehaven Road, longer than 2004 base.

C.3 Package 3 Unreleased Vehicle Graphs

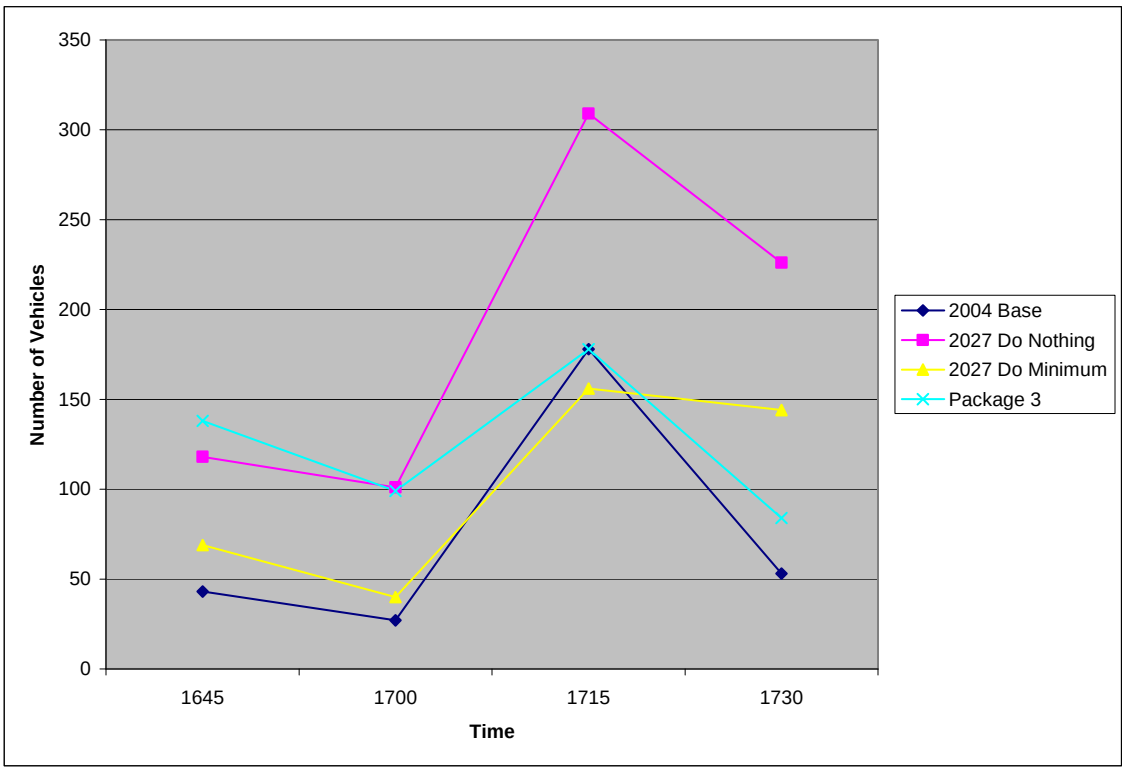


Figure C.13 : Total Number of Unreleased Vehicles – PM Peak Hour

Figure C.13 the total number of unreleased vehicles in Package 3 is greater than the 2027 Do-Minimum.

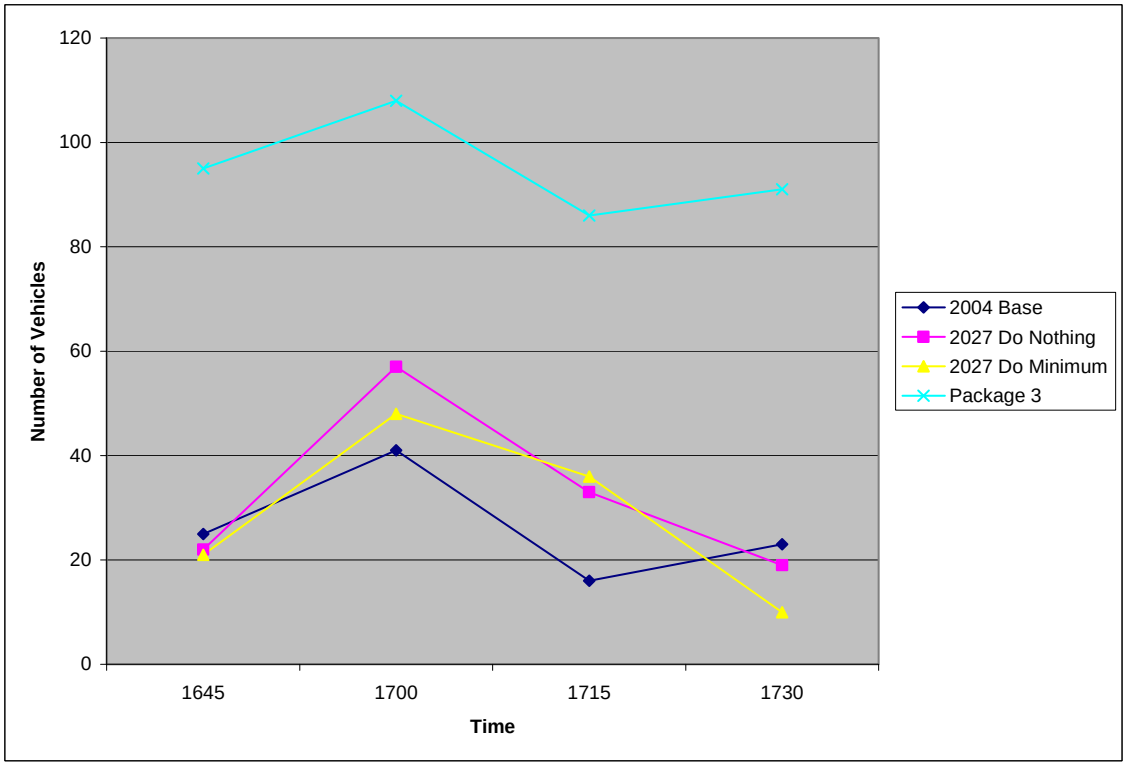


Figure C.14 : Number of Unreleased Vehicles in Garthdee Area – PM Peak Hour

Figure C.14 shows the number of unreleased vehicles in the Garthdee area reaches a peak of over 100 vehicles between 17:00 and 17:15 compared to less than 60 for the 2027 Do-Nothing. This is due to the high proportion of traffic following the gyratory in an eastbound direction, resulting in queues from the developments in the Garthdee area.

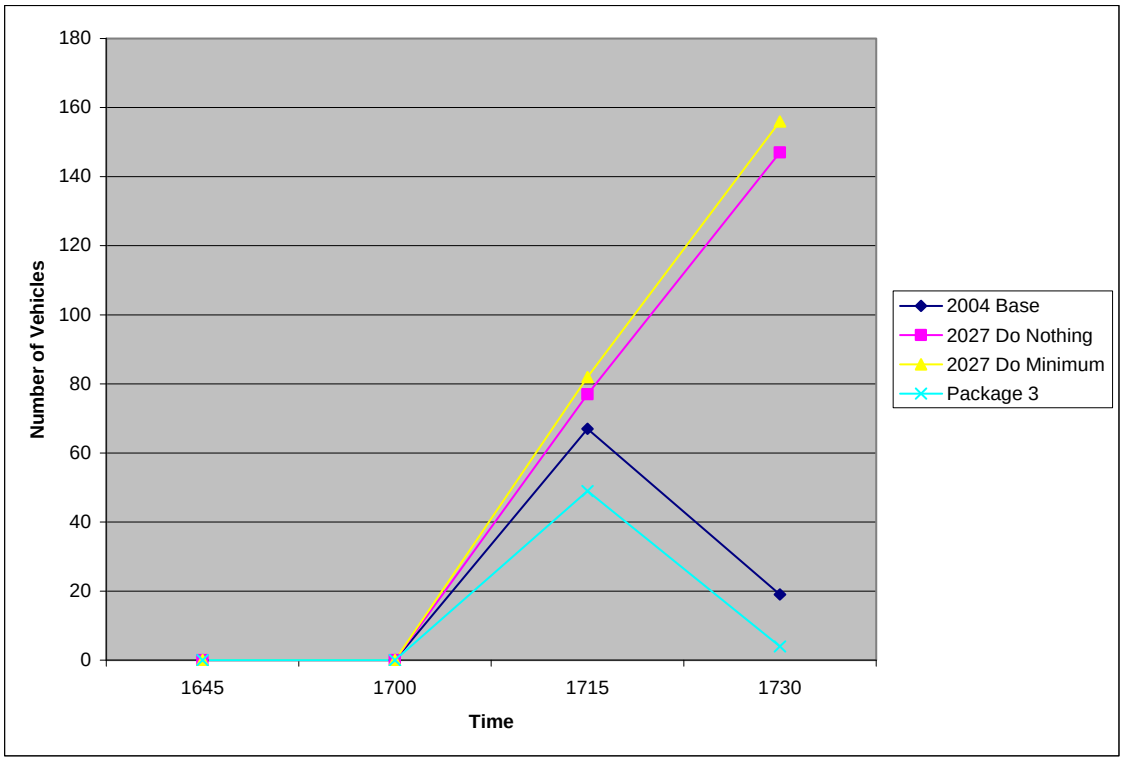


Figure C.15 : Number of Unreleased Vehicles in Anderson Drive Area – PM Peak Hour

Figure C.15 shows that Package 3 has less unreleased vehicles in the Anderson Drive area than the 2004 Base.

D PACKAGE 4 GRAPHS

D.1 Package 4 Queue Length Graphs

Figure D.1 to Figure D.5 show the AM queue length graphs.

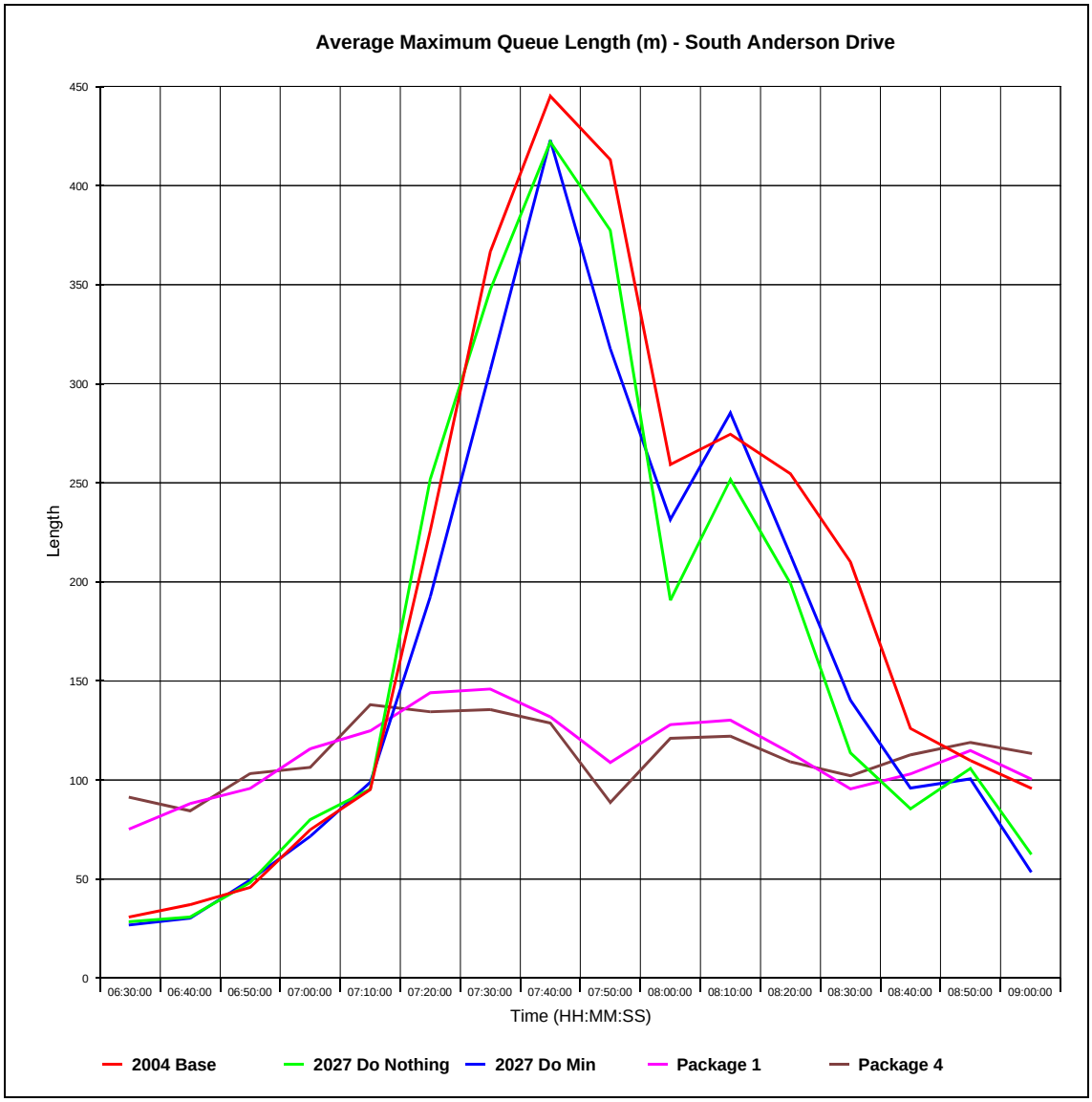


Figure D.1 : Queue Comparison (South Anderson Drive SB) – AM Peak

Figure D.1 shows that Package 4 reduces queue lengths on South Anderson Drive from over 400m in the 2027 Do-Nothing and Do-Min scenarios to less than 150m.

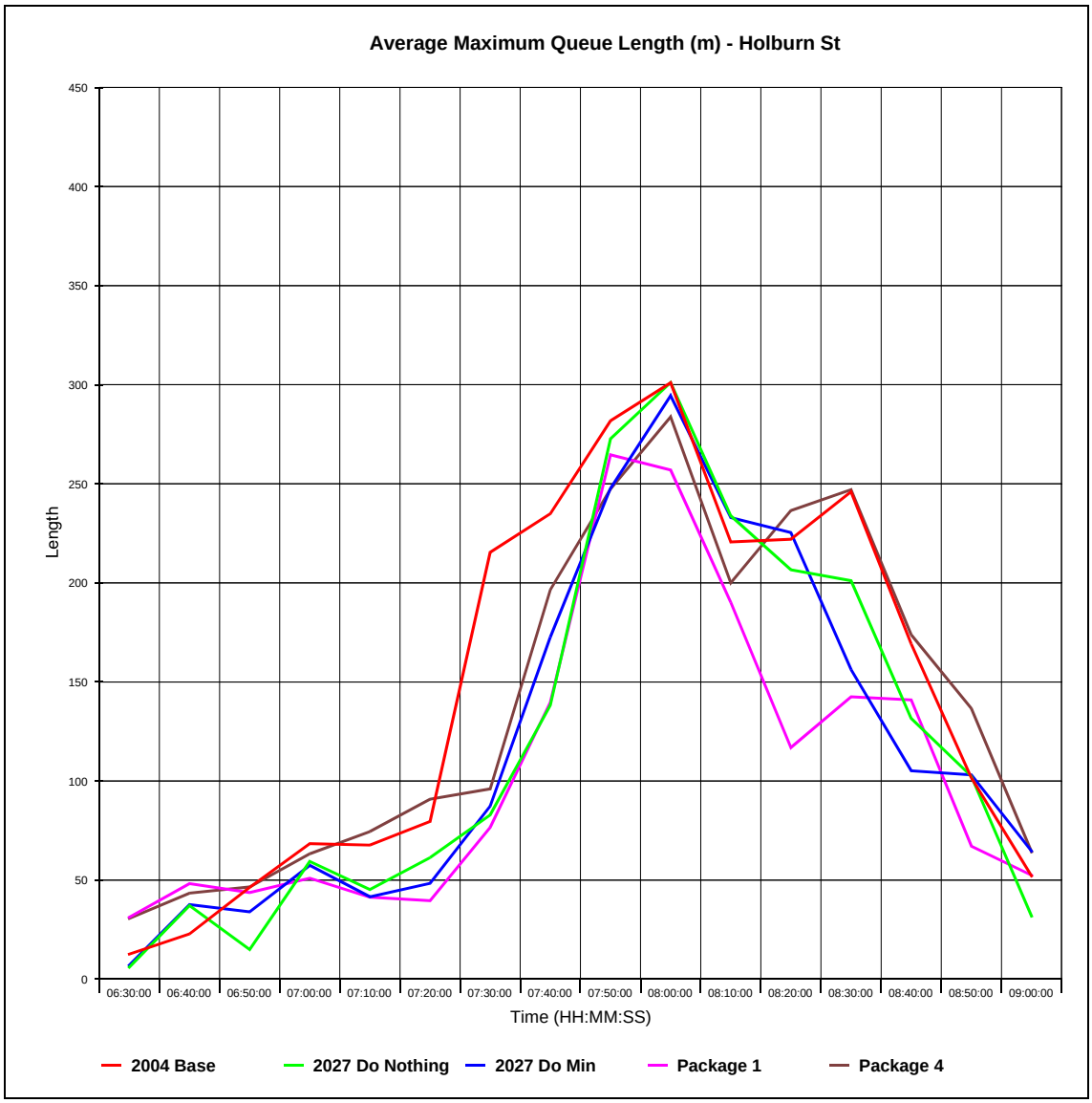


Figure D.2 : Queue Comparison (Holburn St WB) – AM Peak

Figure D.2 shows the average maximum queue lengths on Holburn Street in the AM peak are similar in the 2027 Do-Nothing, 2027 Do-Min and Package 4.

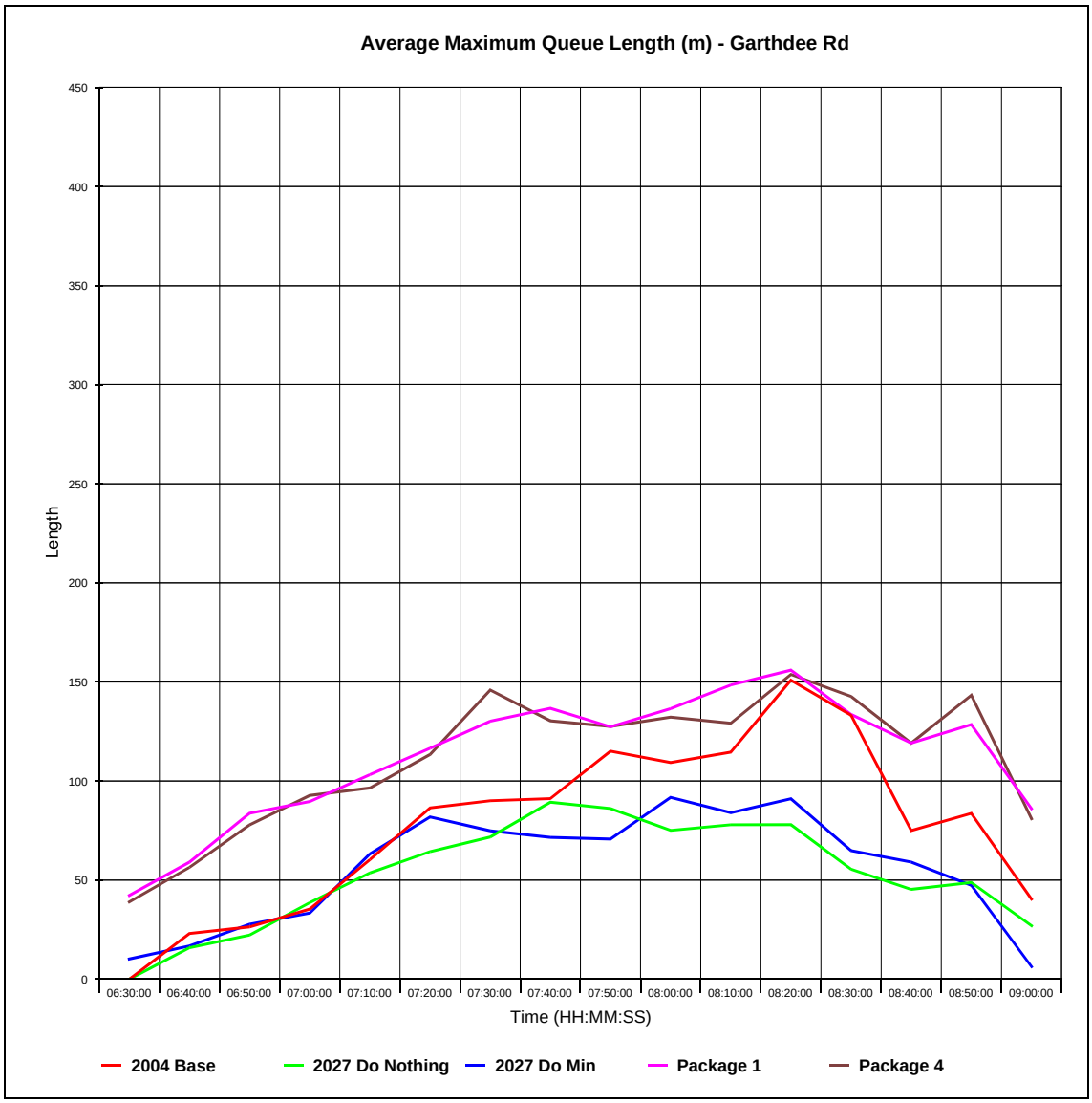


Figure D.3 : Queue Comparison (Garthdee Road EB) – AM Peak

Figure D.3 shows that Package 4 causes an increase in queue length of approximately 50m compared to the 2027 Do-Nothing and Do-Min scenarios.

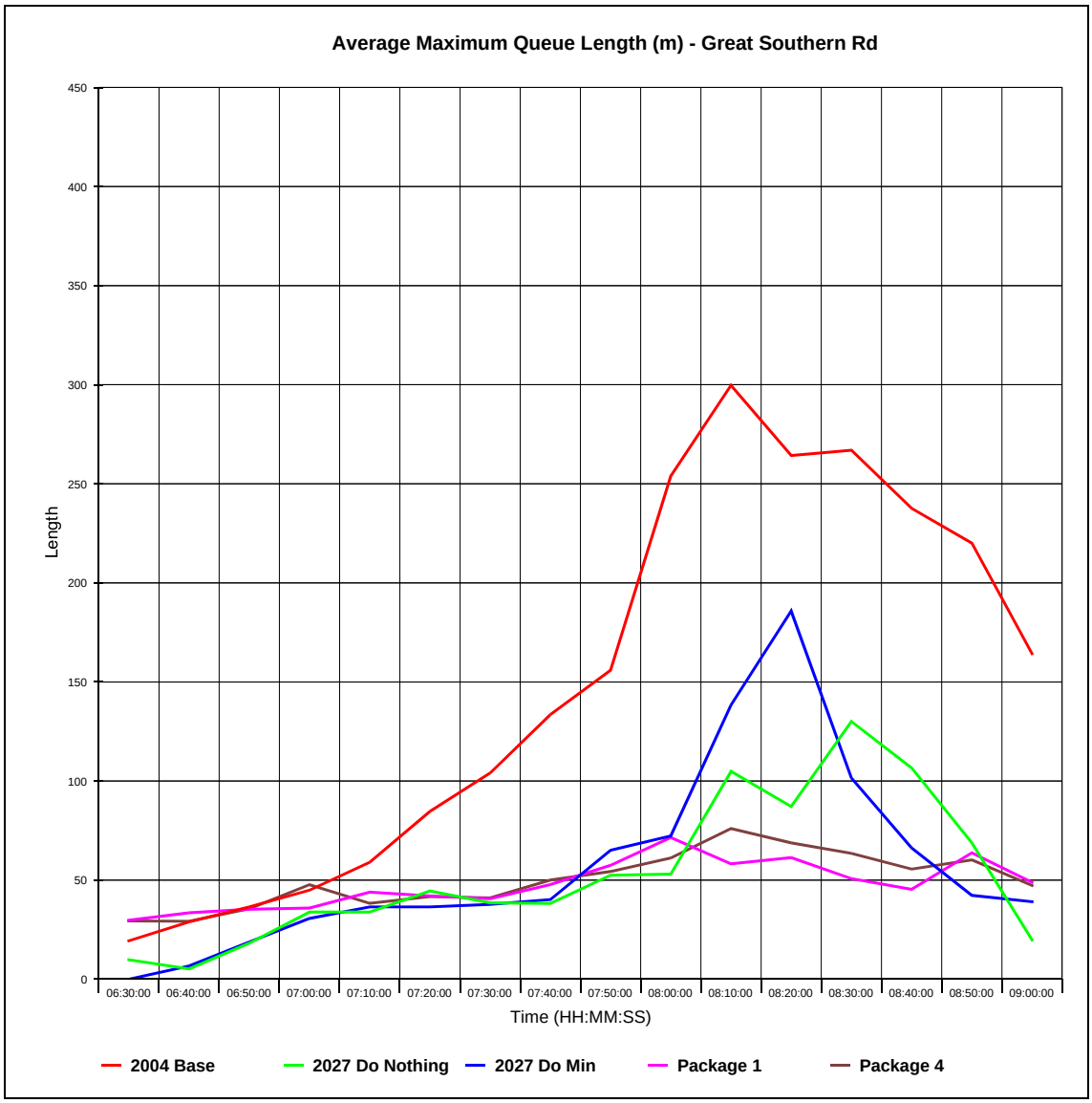


Figure D.4 : Queue Comparison (Great Southern Road WB) – AM Peak

Figure D.4 shows that the peak of maximum queue lengths between 08:10 and 08:40 is reduced in Package 4.

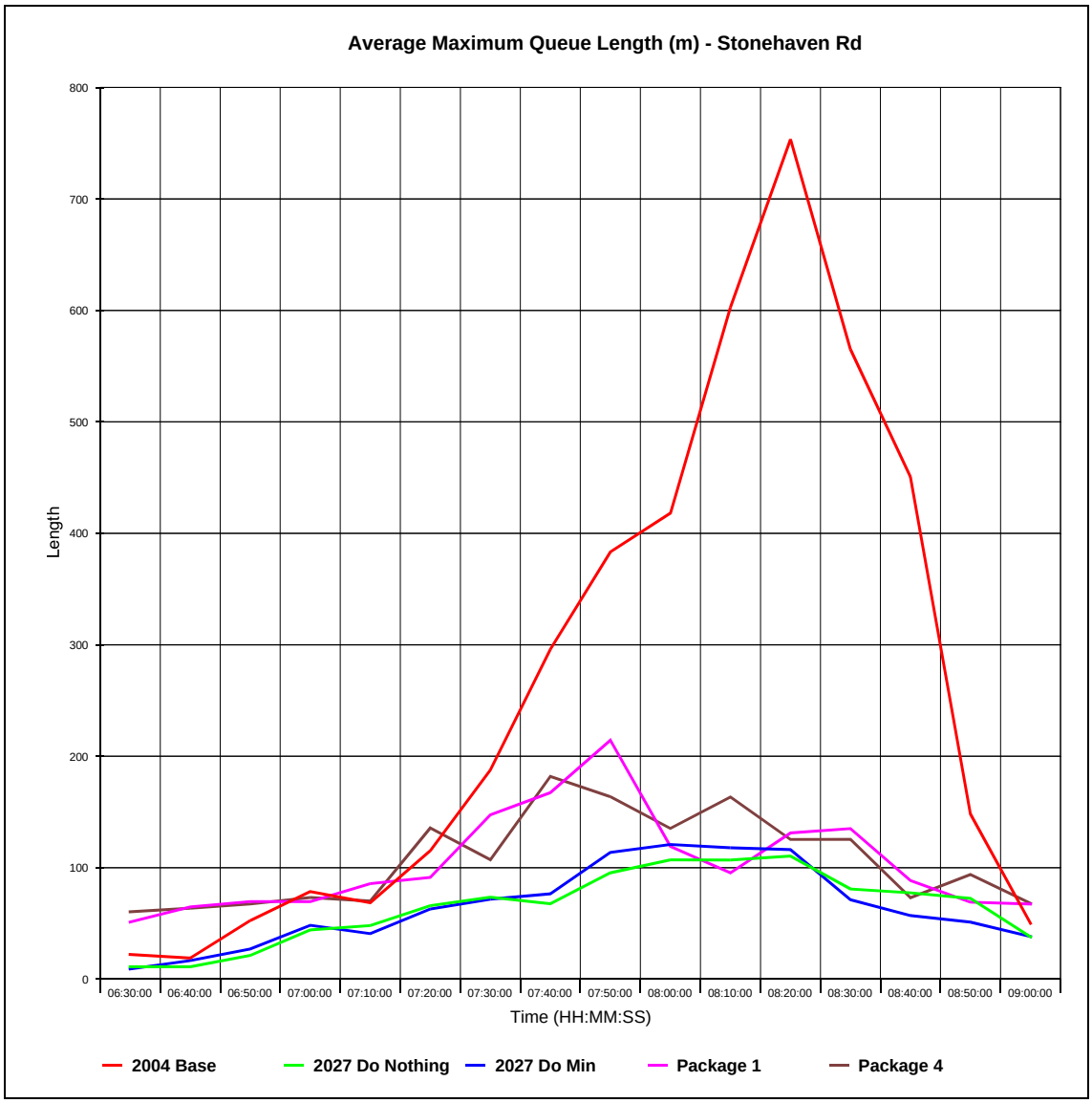


Figure D.5 : Queue Comparison (Stonehaven Road NB) – AM Peak

Figure D.5 shows Package 4 to have average queue lengths approximately 50m greater than the 2027 Do-Nothing and Do-Min scenarios, due to Leggart Terrace being diverted onto Stonehaven Road. Note this graph uses a different scale to the rest of the AM graphs.

PM queue results are shown in Figure D.6 to Figure D.10.

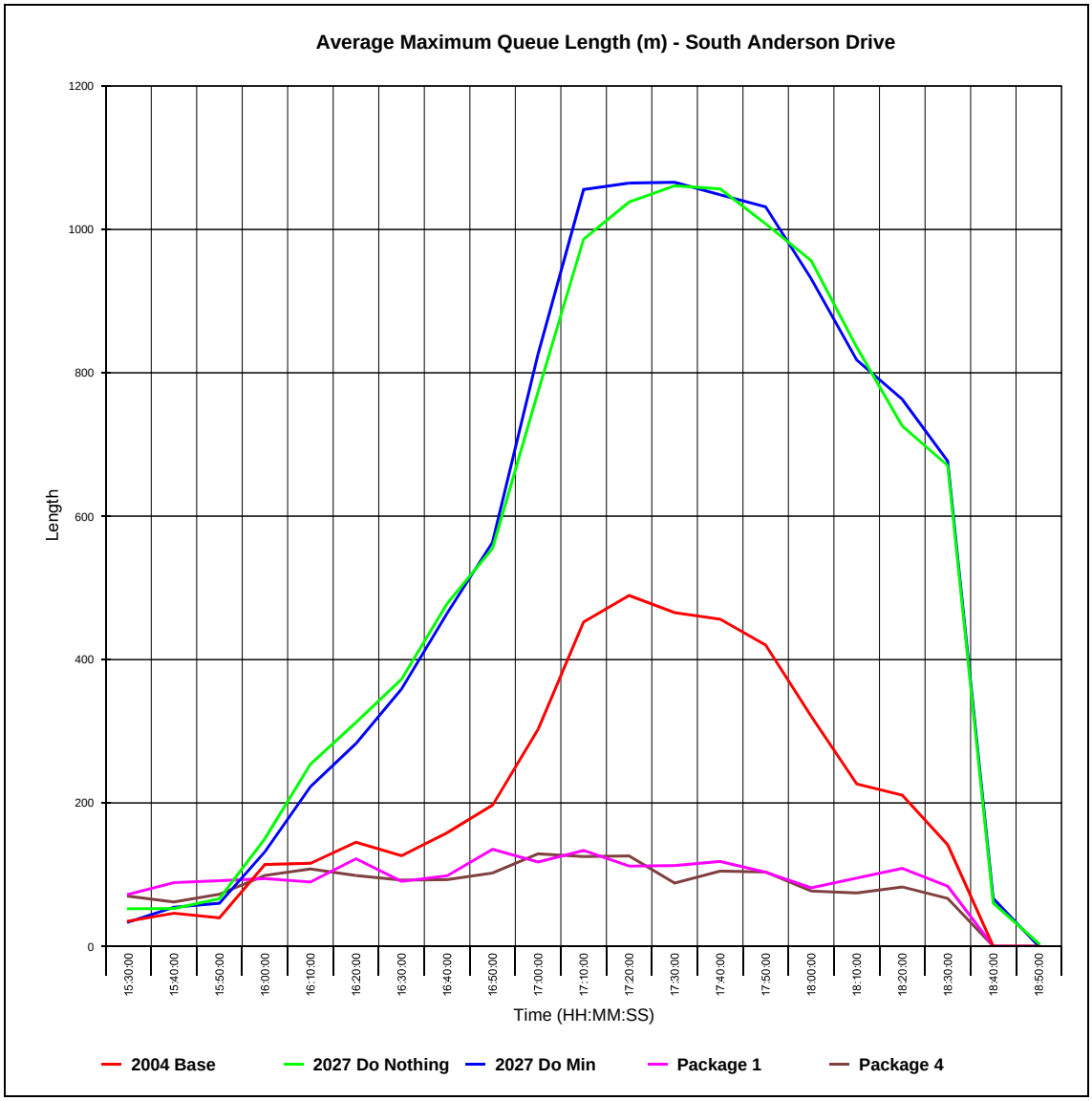


Figure D.6 : Queue Comparison (South Anderson Drive SB) – PM Peak

Figure D.6 shows that the average maximum queue length on South Anderson Drive is significantly reduced, from approximately 1050m in the 2027 Do-Nothing and Do-Min to approximately 100m in Package 4. Note this graph uses a different scale to the remaining PM graphs.

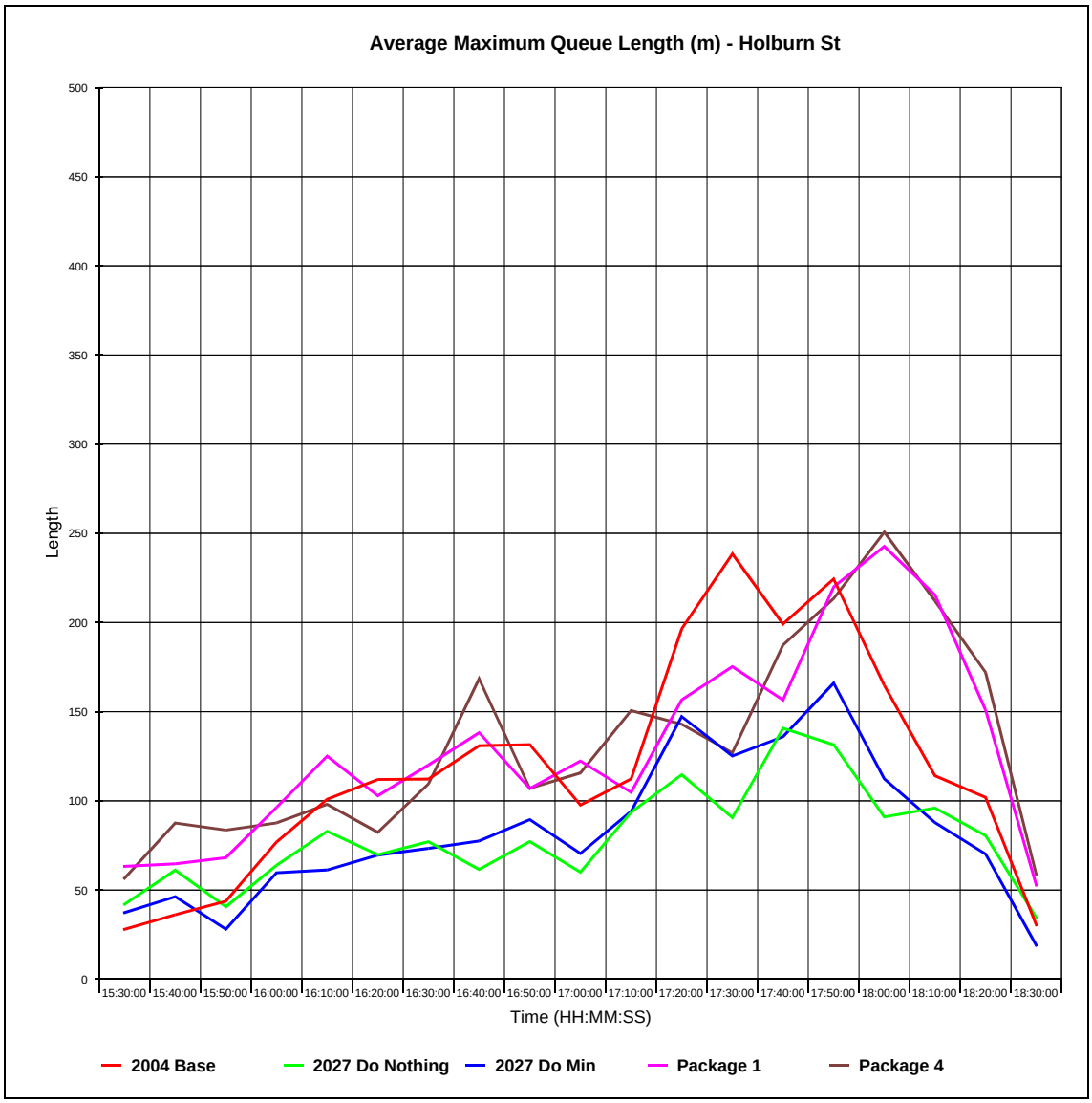


Figure D.7 : Queue Comparison Length (Holburn St WB) – PM Peak

Figure D.7 shows that in Package 4 the average queue length on Holburn Street is approximately 50-100m longer than in the 2027 Do-Nothing and Do-Min scenarios.

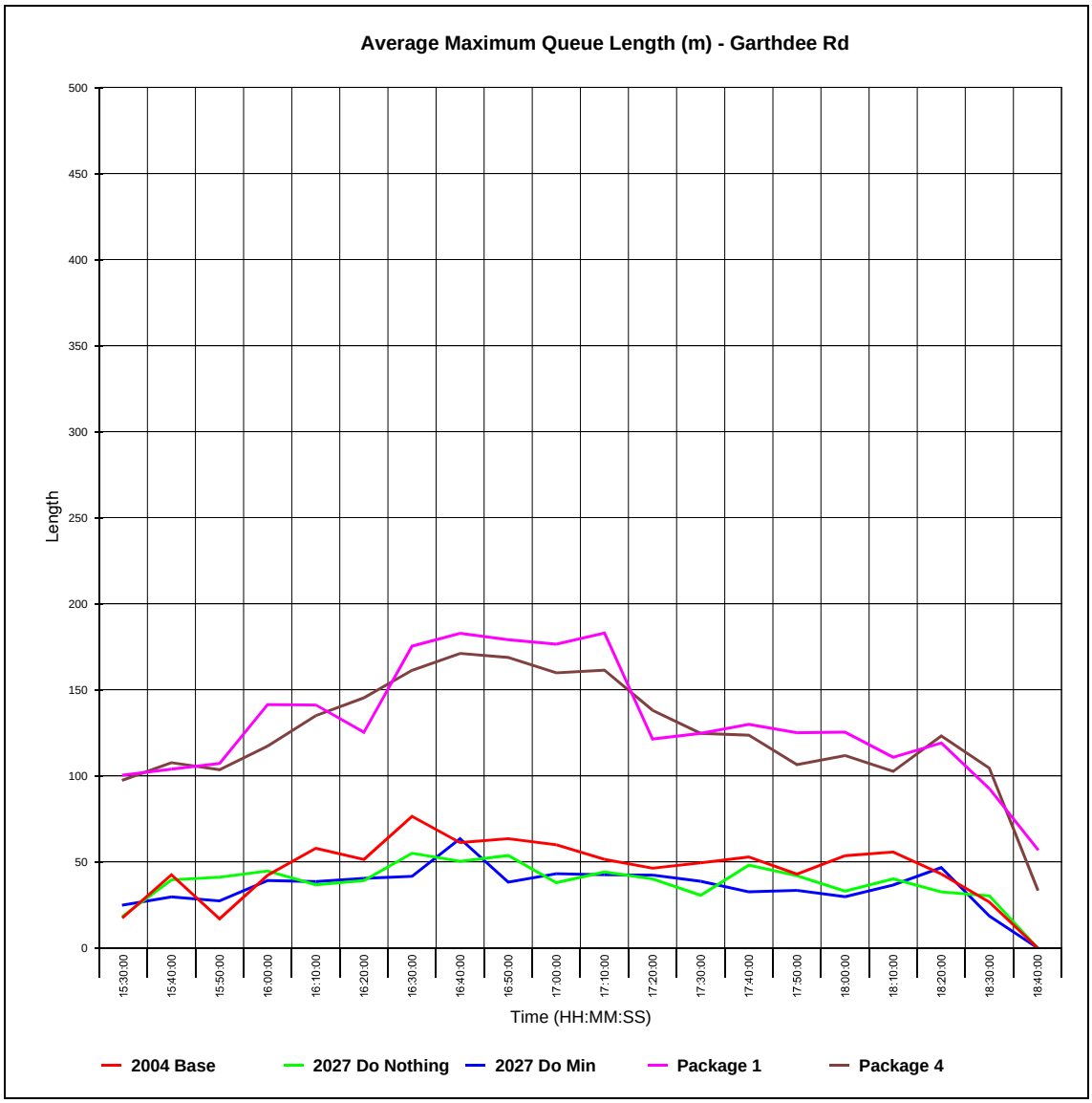


Figure D.8 : Queue Comparison (Garthdee Road EB) – PM Peak

Figure D.8 shows that queue lengths on Garthdee Road are approximately 100m greater in Package 4 than in the 2027 Do-Nothing and Do-Min scenarios.

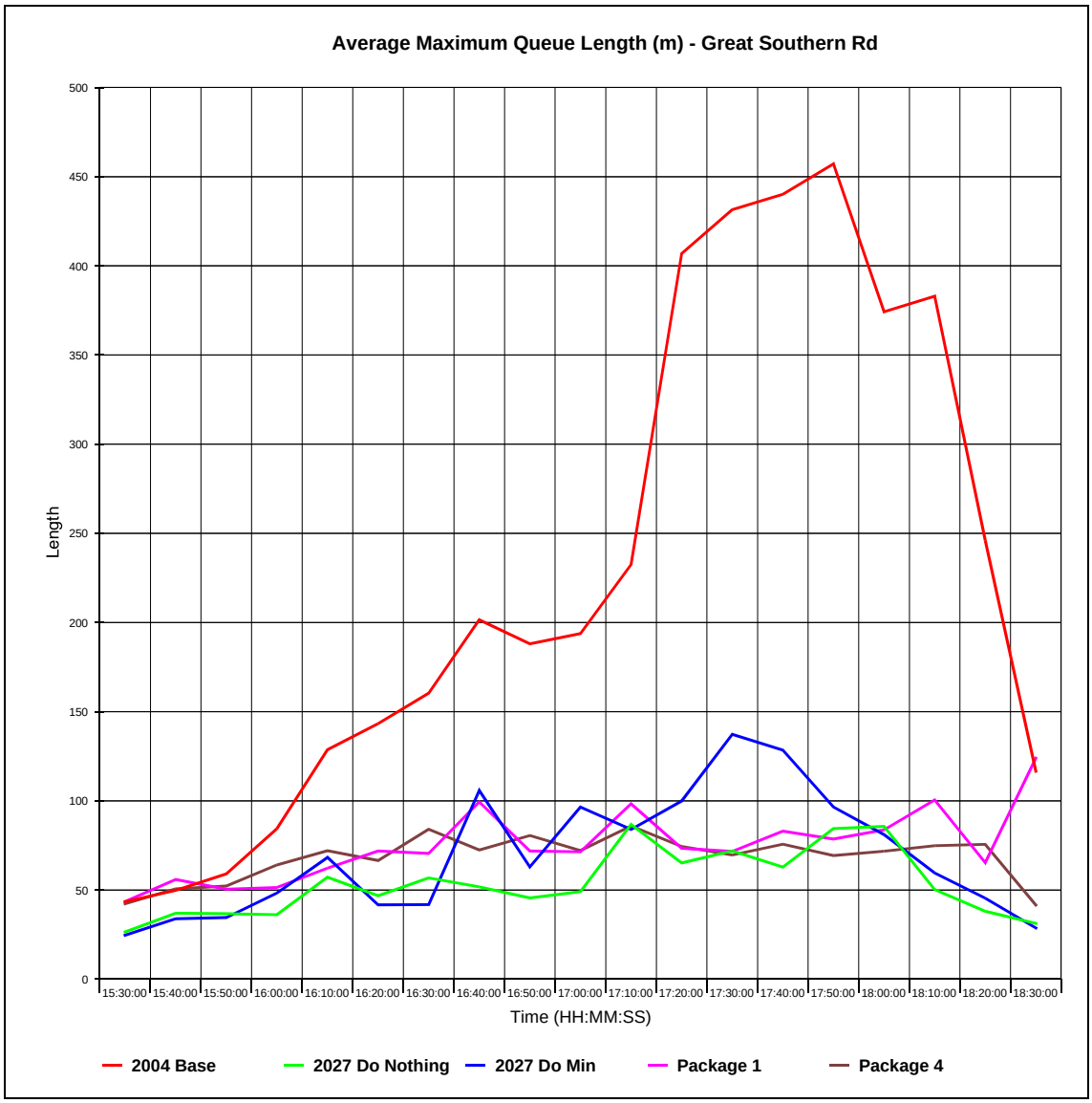


Figure D.9 : Queue Comparison (Great Southern Road WB) – PM Peak

Figure D.9 shows that there is no significant difference between the three scenarios.

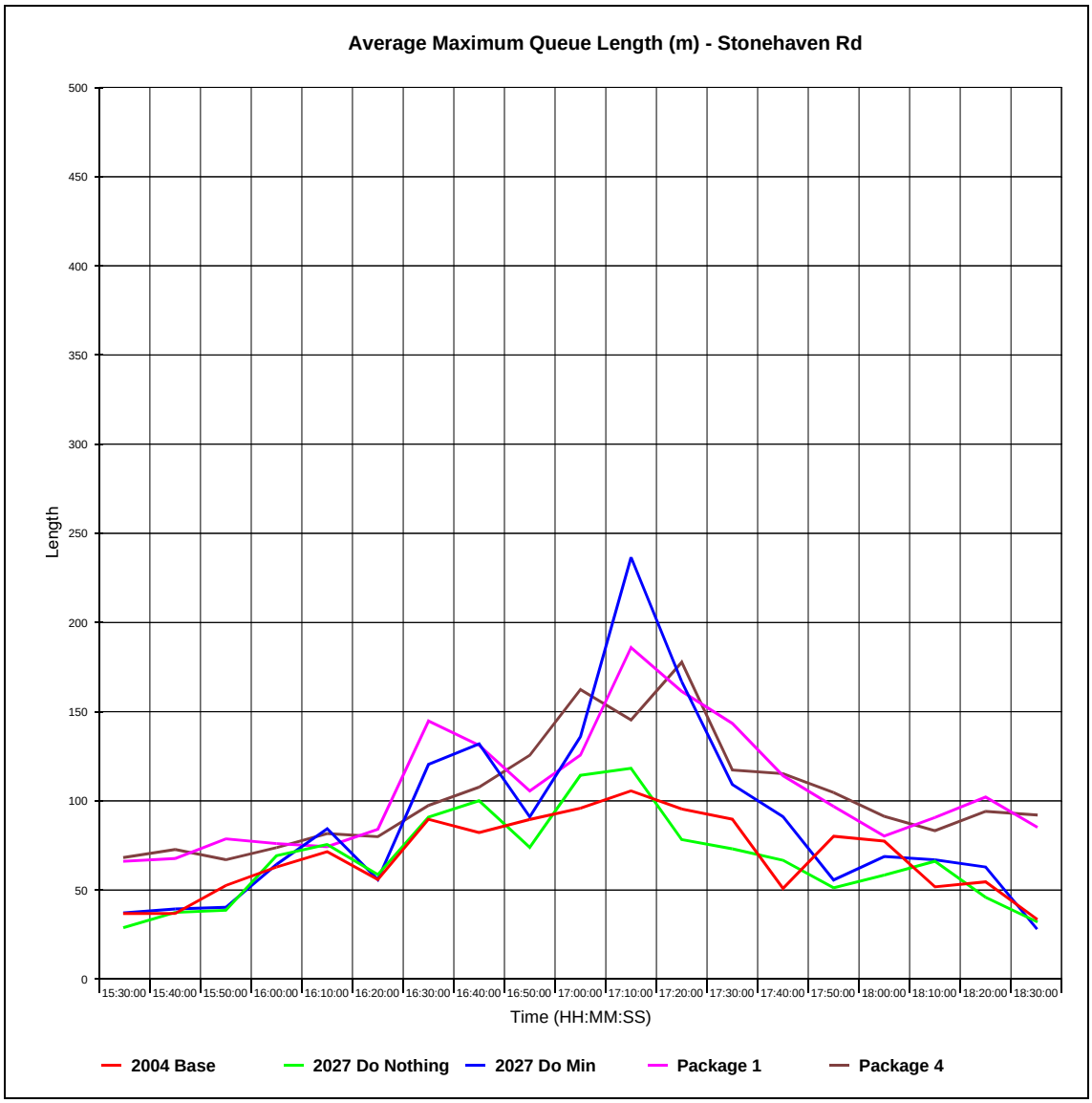


Figure D.10 : Queue Comparison (Stonehaven Road NB) – PM Peak

Figure D.10 shows there is no significant difference between the three scenarios.

D.2 Package 4 Unreleased Vehicle Graphs

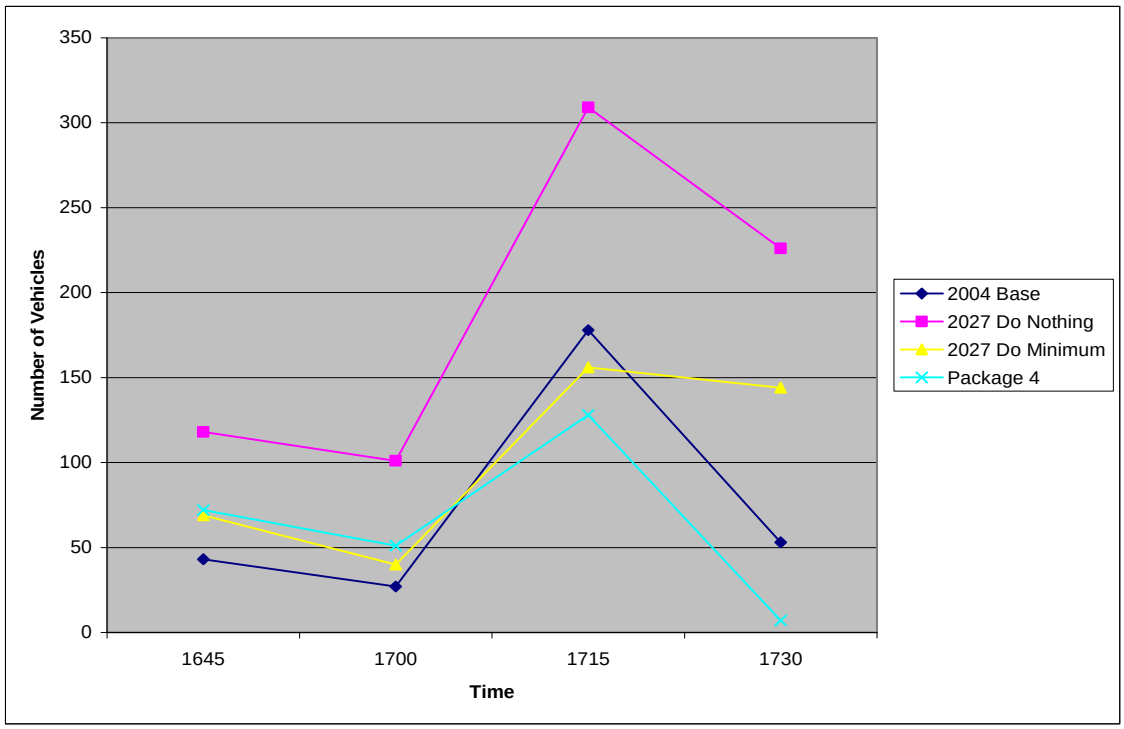


Figure D.11 : Total Number of Unreleased Vehicles – PM Peak Hour

Figure D.11 shows the total number of unreleased vehicles in Package 4 is less than the number observed in the 2004 Base.

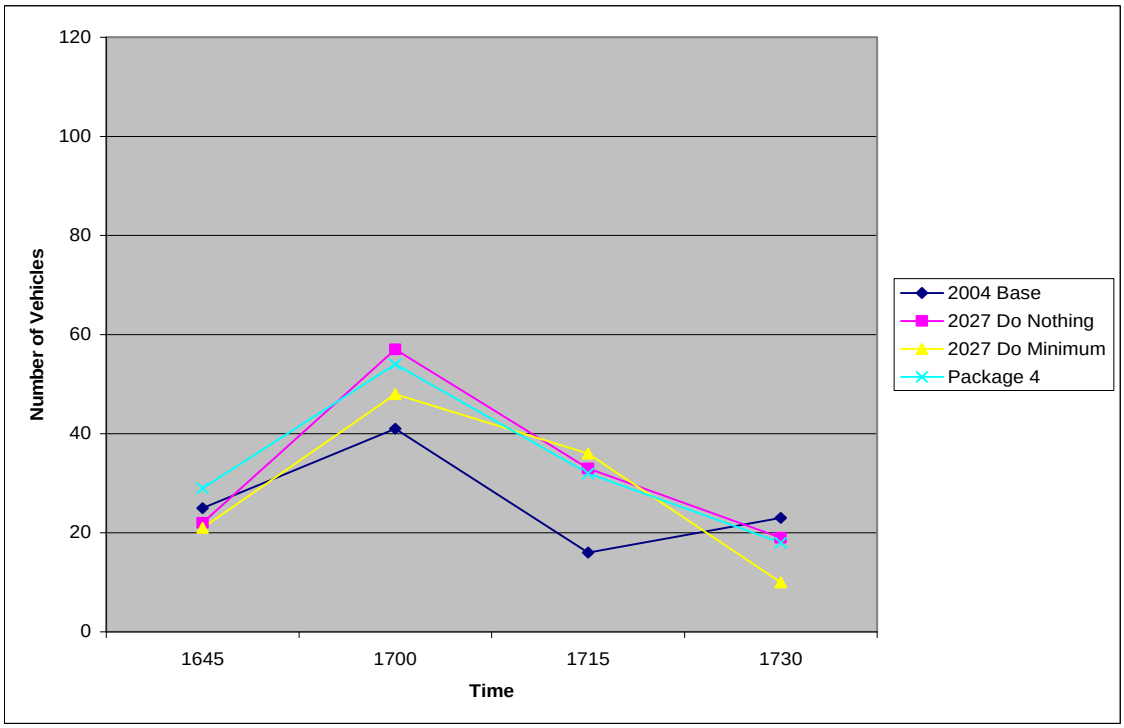


Figure D.12 : Number of Unreleased Vehicles in Garthdee Area – PM Peak Hour

Figure D.12 shows the number of unreleased vehicles in the Garthdee area is similar in Package 4 to the 2027 Do-Minimum.

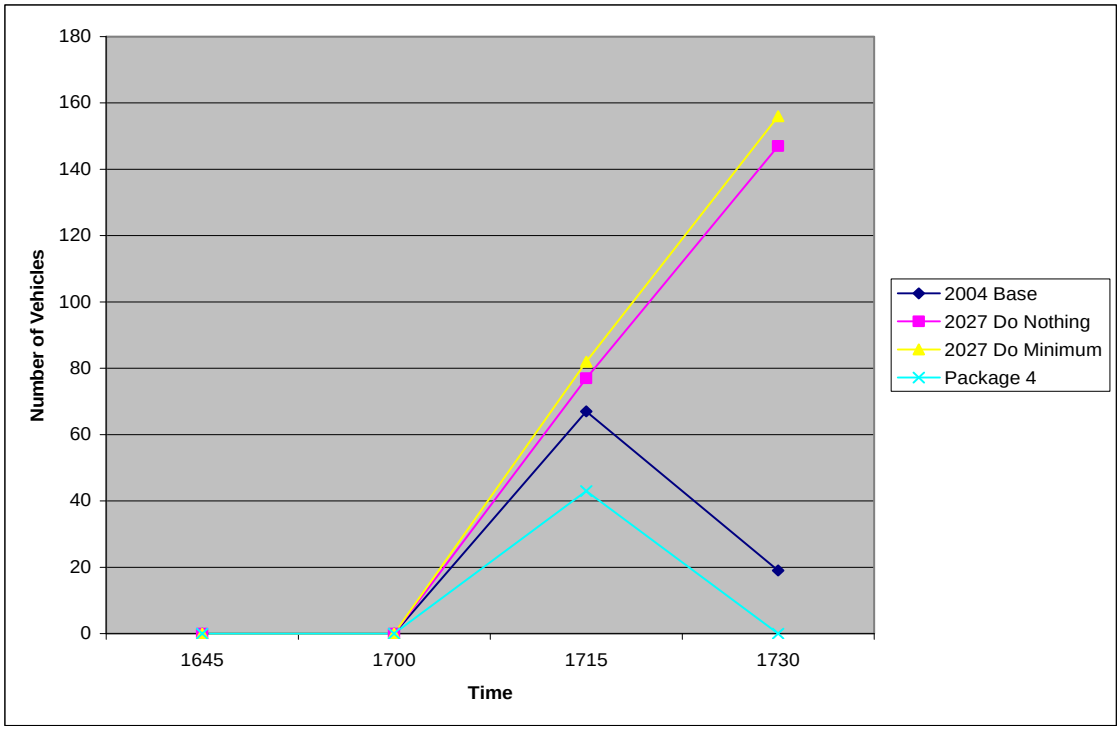


Figure D.13 : Number of Unreleased Vehicles in Anderson Drive Area – PM Peak Hour

Figure D.13 shows that in the Anderson Drive area, Package 4 reduces the number of unreleased vehicles to less than the number observed in the 2004 Base.