Warwickshire County Council

Warwick Strategic Transport Assessment

Warwick STA - Phase 2 Assessment

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Appendices

1 Executive Summary

1.1 Overview

Arup have been commissioned by Warwickshire County Council (WCC) to undertake additional testing of the Warwick District Council (WDC) Core Strategy allocations, identify the potential impacts and investigate mitigation schemes. The impacts of two different allocation strategies have been assessed, namely:

- WDC Southern Focus (SF) – whereby the growth associated with the Core Strategy has been focussed in sites to the South of Warwick
- WDC Preferred Option (PO) – whereby growth has been focussed within the areas of Warwick and Leamington in line with the preferred approach outlined by WDC.

1.2 Scenario Demand

The two scenarios that have been tested both contain consistent assumptions regarding dwellings and employment rates; the primary change between the two options is the allocation of development. Both scenarios have been subjected to mode shift, internalisation and peak spreading procedures. Growth within both scenarios has been capped so as not to exceed the levels of growth predicted by the TEMPRO database, after adjustments for national trends (NTEM Adjusted TEMPRO).

1.3 Stages of Assessment

A number of objectives have been addressed within this study through a staged approach to the assessment. The initial assessment stage required the undertaking of an assessment to understand whether the growth proposed within the Southern Focus option could actually be accommodated within the existing network and what mitigation would be required to facilitate the delivery of such a growth option. The conclusion of this initial stage of the assessment was that the full extent of the SF growth allocation could be accommodated within the local network but wider effects such as redistribution and impacts in areas further away from the Europa Way corridor need to be considered in more detail.

Following on from this the following stages of assessment were undertaken:

- Stage 1 – Assessment of the impacts of the 2028 PO and SF allocation strategies, against the 2028 Reference conditions.
- Stage 2 – Identification of any changes, to the previous scenarios, which occurred as a result of the additional draw between the sites and the Coventry and Warwickshire Gateway development.
- Stage 3 – Assessment of the need for the Northern Relief Road and identification and analysis of potential scheme alternatives.
- Stage 4 – Review of the impact of the various options on vehicle flows into and out of the towns as well as around key AQMA locations.

- Stage 5 – Assessment of the impact of the SF allocation on the Europa Way corridor and immediate surrounding area.

The methodology for establishing the Reference Case conditions used in the aforementioned stages of assessment are outlined within Section 3 of this report.

1.4 Stage 1 Assessment

The first stage of the assessment was to review the performance of the SF and PO options in comparison to the existing 2028 Reference Network.

The initial comparisons between the 2028 SF and PO network performance reveals the following conclusions:

- Inclusion of either option will result in an increase in journey times and a reduction in the average speeds experienced by all vehicles travelling within the network when compared to the 2028 Reference Conditions.
- There is little difference, between either the PO or SF network, in the PM when considering the analysis of network wide statistics.
- That the SF network performs better than the PO network in the AM period.
- The areas where the PO performs poorly, in the AM analysis, are to the south and east of Warwick and around the M40. The SF option contains mitigation in both of these areas, some of which would also be beneficial if provided as part of the PO mitigation package.
- That both options accommodated between 5 and 7% greater levels of demand than the reference case and, with the exception of the PO AM network performance, both options result in more trips being completed (as a ratio of those released on the network) than is achieved within the 2028 Reference Case.
- Both options have the potential to improve queuing conditions in certain areas despite the additional demand being assigned to the network.
- Some areas are consistently identified as requiring further attention irrespective of the option assessed (although the severity of the impacts can differ). These are:
    - M40 Junction 15
    - Europa Way NB in the area of Shires Retail Park roundabout
    - South and East of Warwick Town Centre
    - A452/Stoneleigh Road roundabout
    - Heathcote Lane/Tachbrook Road signalised junction

1.5 Stage 2 Assessment

The second stage of the assessment was to look into the effects of Coventry and Warwickshire Gateway (C&WG) on the performance of the respective options. It is estimated the C&WG will create up to 10,000 jobs for the area. Therefore it was determined that the potential for this site to draw development traffic away from Warwick and Leamington, and the likely associated impacts, should be assessed.

The initial comparisons of the model network performance both with and without C&WG reveal the following conclusions.

- The SF AM period mitigated network is more able to accommodate the additional pressures incurred as a result of the C&WG inclusion than the PO
- There is a potential need for the Warwick Town Centre improvements and managed motorway schemes to be considered in both PO and SF options should the C&WG be included.
- During the AM period, conditions to the south and east of Warwick appear to worsen when C&WG is included, this could indicate a need for further mitigation in this area.
- The area of Shires Retail Park has again been identified as requiring further attention.

1.6 Stage 3 Assessment

The next stage of this study was intended to assess whether there was potential for the PO allocation to come forward without the need to deliver the Northern Relief Road (NRR).

Two scenarios were initially tested:

- PO NRR01 – NRR removed and A452 upgraded to two lanes from just north of Northumberland Avenue to the A46. Additional SB merge provided so vehicles can merge onto the A46 SB from two lanes.
- PO NRR02 – As above but with two critical junctions along the A452 (Blackdown & Bericote) reconfigured to signalised crossroads.

Initial analysis indicated that the reconfiguration of roundabouts along the A452 to signalised junctions provided improved network performance. Meaning the more detailed stages of analysis focussed only on the PO NRR2 described previously.

Based on the analysis of the outputs from this stage of testing, the following conclusions were drawn:

- That the network is likely to become more unstable as a result of the removal of the NRR and that these effects are most obvious within the AM model period. Furthermore, the level of instability exemplified within the scenario models is comparable to that which is contained within the PO + C&WG assessment. It is reasonable to conclude that the cumulative effects of both scenarios in unison (i.e. PO + C&WG and PO + no NRR combined) will be further amplified and may require significant additional mitigation to facilitate.
- Removal of the NRR will result in a general increase in delay experienced by all vehicles travelling along the network and a lowering of average speeds. Furthermore the impacts appear larger in the AM than the PM period.
- The overall improvements in network performance as a result of the inclusion of the A452 signal schemes, when compared to the A452 roundabout option, indicates that signals may provide the optimum control strategy for the A452 irrespective of whether the NRR is included or not.

- Mean speed analysis indicates that routes into Warwick town centre are likely to suffer more from the effects of congestion, during the AM period, when the NRR is removed compared to when it is included. Coupled with the poor AM performance of the PO network in this area, this indicates that town centre works are likely to become essential if the PO allocation strategy is progressed without the NRR.

1.7 Stage 4 Assessment

More detailed analysis of the changes in two-way vehicular flow across various locations was also undertaken during the final stage of the strategic level assessment. Two stages of analysis were undertaken; firstly,

- Cordon flows have been extracted and analysed to assess town centre traffic movements around both Warwick and Leamington towns.
- Analysis was then undertaken to look at the potential impacts in and around the AQMA areas of both Warwick and Leamington.

Based on the initial analysis of the changes in two-way flow across a number of town centre cordon points around both Warwick and Leamington, the following conclusions have been drawn:

- That the number of vehicles crossing the cordon points surrounding Warwick Town centre reduce in the AM PO scenario network when compared to the 2028 Reference case as the lack of mitigation in this area makes it less attractive to vehicles.
- Within the SF scenario there are more vehicles crossing the Warwick Town Centre Cordon points, compared to the PO network, as a result of the town centre mitigation but, in both options, during the AM, the area to the Southeast experiences a drop in the number of vehicles crossing the cordon points compared to the Reference Case.
- Within both PO and SF scenario networks, the number of vehicles crossing the Leamington cordon points increases. The increase is far greater within the PO scenario than the SF scenario indicating that when Warwick town centre is less attractive, and managed motorways is not implemented, greater vehicular movements are likely around Leamington town centre

The final point above does not necessarily indicate that the Warwick town centre mitigation will result in less vehicles travelling through Leamington, rather it is indicative of the fact that if traffic is more easily able to travel through the area around the Warwick town centre cordon then the number of vehicles using this area will increase. Those vehicles would otherwise reassign and use routes on the outer Warwick network which will, in turn push traffic off these routes and into the Leamington area, thus by including the Warwick town centre mitigation strategy a greater level of demand can be accommodated across the entire network due to the improved capacity within Warwick town centre.

Assessing the impact of the removal of the NRR reveals the following:

- When the NRR is removed, within the AM period, the number of trips crossing the Warwick town centre cordon points actually reduces further despite the removal of an alternative route around the town centre.

Indicating that the conditions in the town centre must worsen, as a result of the removal of the NRR, to such an extent that the network is able to accommodate even less trips and be even less attractive without the NRR than when it is included.

- In the PM, when the effects of congestion within Warwick town centre are less severe, there is likely to be a substantial increase in vehicles crossing the cordon points when the NRR is removed compared to the numbers presented with the NRR in place.

Consideration has also been given to the impacts on the Warwick and Leamington AQMA area and this has revealed the following:

- That the movements across the Warwick AQMA area, within both AM and PM peak hours, are likely to reduce in both PO and SF scenarios.
- These reductions in movements are likely to be accompanied by a reduction in average speeds within the area indicating that the positive benefits accrued as a result of the reduction in vehicular movements may be outweighed by a reduction in average speeds within the area.
- The implementation of the Warwick Town Centre mitigation measures appears to have the potential to draw traffic away from the core AQMA area by making Cape Road, Priory Road and Coten End more attractive routes. Further investigation of this is required.
- There are fewer changes in the movements captured across the Leamington AQMA area but there are still reductions in average speeds on the links within the same area. There is potential for the signalised scheme that has been proposed within this area to be further optimised, meaning that these impacts could be reduced.
- Furthermore, when the signalised scheme was not in place there were significant reductions in the average speed that vehicles could achieve within this area indicating that the implementation of the scheme is still likely to be beneficial regardless of which allocation strategy is adopted.

1.8 Stage 5 Assessment

Once the condition of the 2028 SF model network was deemed of a sufficient standard to inform the overall analysis a set of cordon demands were extracted from the 2028 SF model and transposed into origin-destination matrices which could be assigned within the M40 PARAMICS model and rerun. The purpose of this assessment is to review, in more detail, the mitigation schemes proposed within the M40 and Europa Way areas. In particular a review was undertaken of the performance of these schemes when the reassignment of routes away from the area was accounted for.

Based on the initial analysis of the changes in network conditions, within the M40 model, between the 2028 Reference Case and 2028 Cordon SF Demand scenarios, the following conclusions have been drawn:

- That, in general, network wide statistics improve in the scenario containing the developments and schemes during the AM and assessment of the changes in AM network conditions, between the two scenarios, indicates that conditions are likely to improve along Europa way between

the M40 and Europa Way roundabout as well as along Gallows Hill. The schemes either side of Myton road will require further attention to minimise impacts of congestion in those areas.

- Differences in the PM network performance between the two 2028 scenarios reveals that low speeds experienced by vehicles travelling SB along the Europa Way corridor towards the M40 increase when the schemes and developments are included. The problems within the PM network appear to manifest at the Ford Foundry roundabout indicating that further optimisation of this scheme is required to improve conditions in this area. Similarly low speeds on the Myton Road and Banbury Road approaches to the Myton Road/Banbury Road junction indicates that further optimisation of this scheme is required within the PM period.

1.9 Recommendations For Further work

Once the preferred option to the allocation of growth has been determined there are number of recommendations that should be considered during a second, more detailed stage of testing:

1.9.1 Modelling Assumptions

Model Shift and Internalisation assumptions have been attributed to the trip generation figures associated with the sites that have been tested within this modelling. It is recommended that, once the final option for the allocation of growth is determined, testing is undertaken both with and without these assumptions attributed to the developments.

Assumptions on the limiting of growth in line with TEMPRO predictions have also been applied within the modelling. It is recommended that a sensitivity test be undertaken during the next stage of testing whereby unadjusted growth is assigned to the model network in order to identify further areas that may require additional mitigation.

1.9.2 Mitigation Refinement

Any subsequent stage of testing should look to refine and improve the mitigation that has been tested within this phase of the assessment. Certain areas such as southeast Warwick and the Heathcote Lane/Tachbrook Road signalised junction have been identified as being areas that may benefit from the implementation of mitigation.

Other areas such as the Shires Retail Park and Ford Foundry Roundabouts are areas that have been identified as performing poorly despite the inclusion of mitigation within these areas, consideration should be given to the optimisation of these and other mitigation schemes proposed throughout the modelling.

1.9.3 Widening the Scope

The focus of this stage of assessment has always used the existing Warwick and Leamington and the M40 Corridor PARAMICS models to inform the assessment. The strength of using the Corridor model is that is calibrated and validated to a higher degree of accuracy within the corridor area. The problem is that the M40

corridor model does not take account of the wider effects if route choice and congestion across the wider area. Thus it is proposed that any future assessment should continue with the same hierarchical approach to the modelling of impacts as has already been adopted. Any further assessment scope should, however, be widened to include the Kenilworth and Stoneliegh and the A452 Corridor models in a manner consistent with the approach taken to date.

2 Introduction

2.1 Scope

Arup have been commissioned by Warwickshire County Council (WCC) and Warwick District Council (WDC) to undertake additional testing of the Warwick District Council (WDC) Core Strategy (CS) allocations, identify the potential impacts and investigate mitigation schemes. The impacts of two different allocation strategies have been assessed, namely:

- WDC Southern Focus (SF) – whereby the growth associated with the Core Strategy has been focussed in sites to the South of Warwick
- WDC Preferred Option (PO) – whereby growth has been focussed within the areas of Warwick and Leamington in line with the preferred approach outlined by WDC.

2.2 Study Objectives

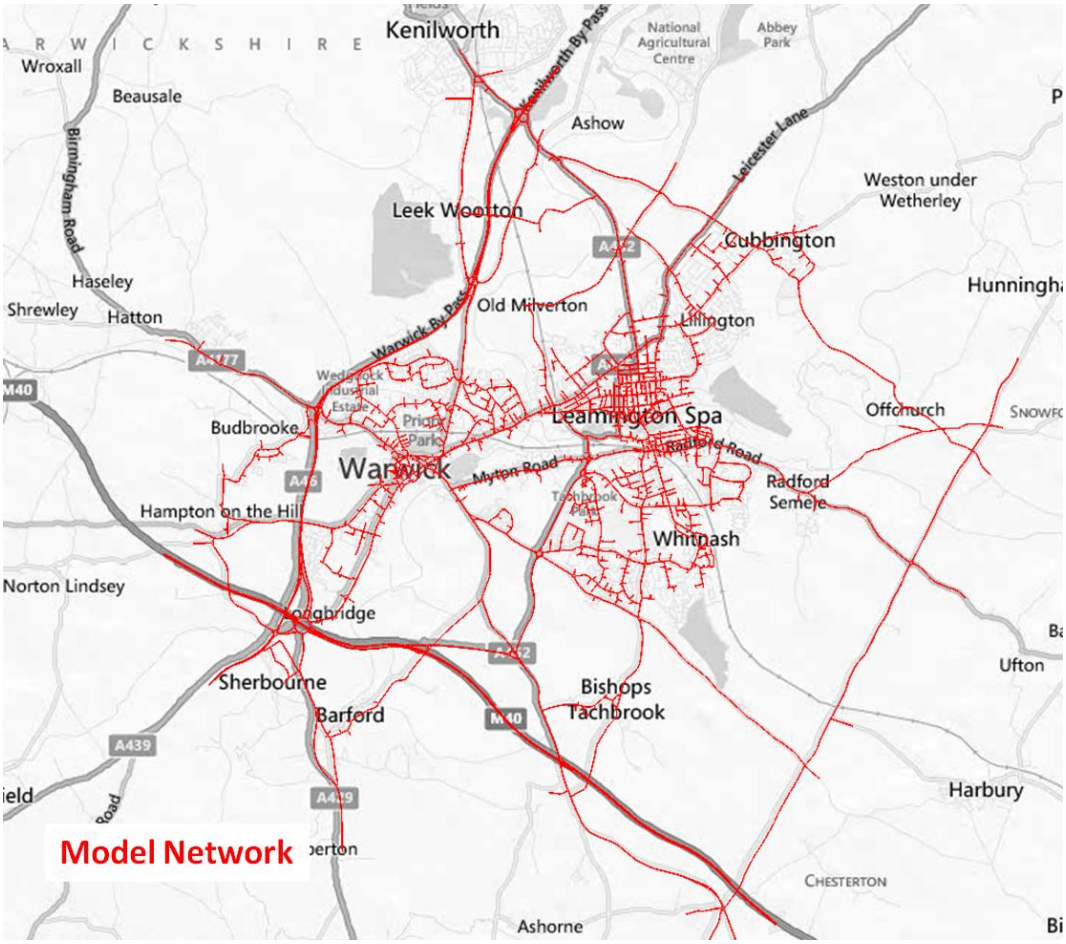
There are a number of different objectives to be realised and addressed through this study:

- To ascertain suitable 2028 Reference Case conditions against which the impacts of the two CS options can be compared. In particular, the need to establish suitable PM peak conditions as analysis of the impacts, in the PM period (16:00 to 19:00) has not previously been undertaken.
- To determine whether an option that focuses growth south of Warwick and Leamington is feasible and whether there is a limit to the level of growth that can be accommodated within that area
- To assess, in as much detail as is possible, the network mitigation required to enable a SF growth option to be realised.
- To assess, in as much detail as possible, the network mitigation strategy required to deliver the PO growth option.
- To compare, against the Reference Case, the relative impacts of both the PO and SF growth allocations, alongside the proposed mitigation packages.
- To assess the likely impacts of both SF and PO options should the Coventry and Warwickshire Gateway development come forward, in particular, the need to establish whether the additional draw of traffic to the North is likely to require further mitigation over and above that which has been proposed for each of the CS Options.
- To assess the feasibility of the implementation of the PO alongside the outlined mitigation but without the Northern Relief Road (NRR) and whether further network mitigation is required to enable this option to be delivered.
- To look at the specific impacts of the SF along the Europa Way corridor, in the context of the current queuing conditions, using the existing M40 PARAMICS model.

2.3 Study Area

The focus of the study area is encompassed within the Warwick and Leamington Wide Area (WLWA) PARAMICS model. An overview of the coverage of this model is provided within the following Figure 1:

Figure 1 -Warwick and Leamington PARAMICS model Coverage

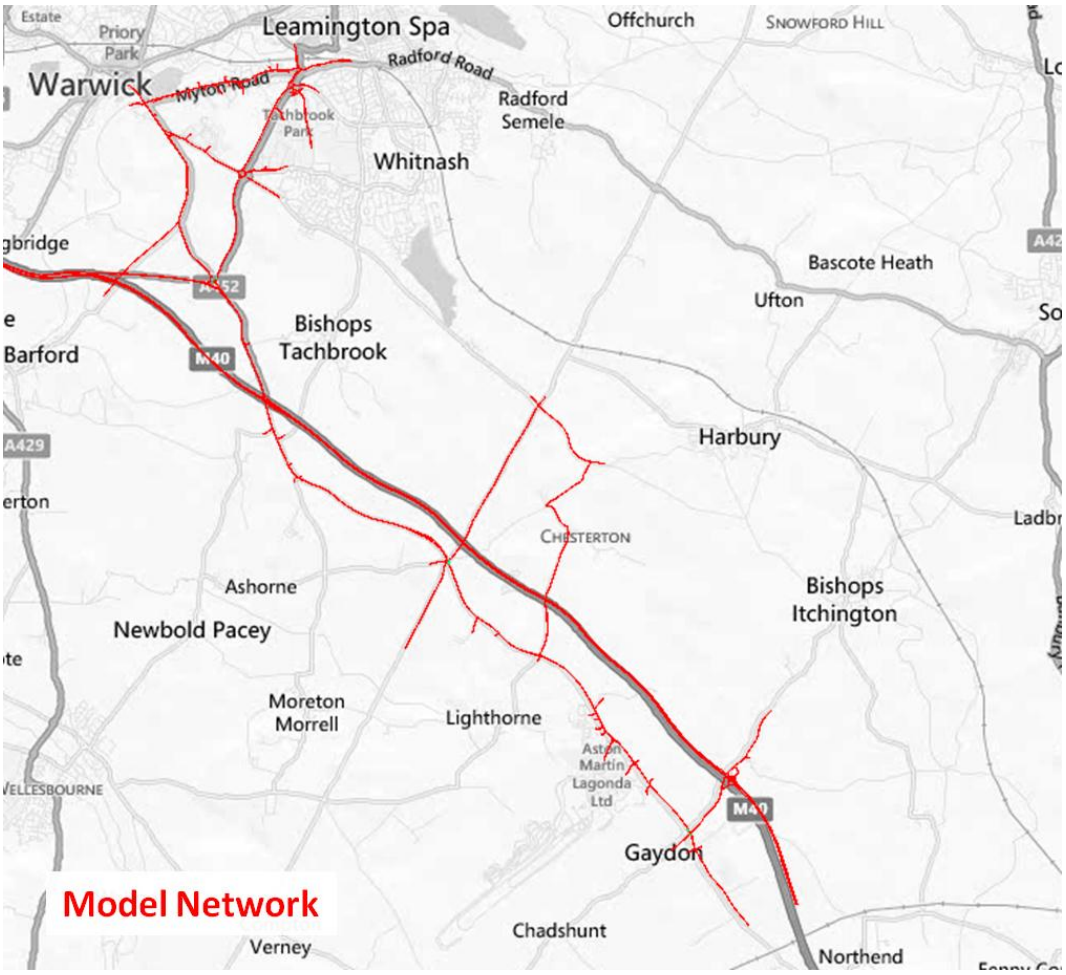


Testing has been undertaken using both the WLWA model and the M40 Corridor model. The M40 Corridor model was developed by Arup, on behalf of WCC, to include the M40 between Junction 14 and Junction 12. As well as the motorway the model contains the A452 and A425 corridors between the A452/Europa Way/Banbury Road roundabout and Myton Road.

This smaller corridor model was developed to ensure that queuing along the Europa Way corridor was accurately replicated within the modelling as well as to ensure that a model with a high degree of calibration in this area was available to test specific junction arrangements at both Junction 14 and Junction 12.

The coverage of the M40 corridor model is illustrated within the Figure 2 on the following page.

Figure 2 - M40 PARAMICS model Coverage



2.4 Core Strategy Options

Two different development CS schedules have been proposed for testing. The SF option looks to deliver the majority of growth to the South of Warwick and Leamington whilst the Preferred Option adopts a wider dispersal of growth across the Warwick and Leamington Areas.

The location of the sites that have been tested within both the SF and PO options are presented within **Appendix A** of this report.

The development schedule associated with the both options, which has been tested within the modelling, is presented within Table 1 on the following page.

Table 1- PARAMICS Model Scenario Development Schedule

Site Number	Location	Preferred Option Housing	Southern Focus Housing	Employment
1	Warwickshire College	300		
2	Ridgeway School	80	80	
3	Leamington Fire Station	50	50	
4	Riverside House	50	50	
5	Myton Gardens	1100	1105	% of 18 Ha
6	South of Gallows Hill	1600	1600	% of 18 Ha
7	North of Milverton	810		
8	Blackdown	1170		
9	Whitnash	650	650	
10	Woodside Farm	250	250	
11	Red House Farm	200	200	
12	Warwick Gates Employment Lane	200	200	% of 18 Ha
13	Loes Farm	180		
14	Fieldgate Lane	90	95	
15	Thickthorn	770	770	6Ha
16	Land South of Harbury Lane		2350	
17	Station Approach			
18	Leamington Cricket Club			
19	IBM Car Park		100	
20	Sustainable Villages	850	850	
		8350	8350	24 Ha

Housing and employment numbers remain consistent between options, only the location of the allocations has changed.

3 Scenario Development

3.1 2028 Reference Case Model Revisions

During the original LDF testing[1] it was not possible to analyse outputs from the PM modelled period as the model appeared to be unable to accommodate the level of demand which had been assigned. At that early stage of assessment it was decided that testing should be progressed using AM outputs only.

Such an approach is acceptable due to the highly strategic nature of the testing; however, as the purpose of this stage of testing is beginning to focus on the options in more detail it is necessary for PM analysis to be undertaken alongside the AM.

In order that this could be achieved a number of amendments to the Reference Case were implemented in an attempt to increase model stability and improve throughput. A breakdown of the changes applied is provided within **Appendix B** of this report.

The changes applied were primarily minor changes to calibration and have been included in areas where problems have been identified that may not necessarily be realistic. For instance, on a number of occasions queuing on junction approaches within the model can extend back and block adjacent junction entry and exit arms. This can cause severe congestion due to vehicles waiting to turn right or vehicles waiting to exit a junction not having space to do so. In reality there would undoubtedly be some element of courtesy let in behaviour exhibited with vehicles in stationary and slow moving queues leaving gaps rather than blocking entry points entirely. Within PARAMICS this is modelled by using clear exit adherence rules which enable this to occur. Clear exit adherence factors are applied to the movements which are most likely to suffer from exit blocking and so should leave space accordingly.

In addition to the changes outlined in **Appendix B** the shaped loops at The Butts in Warwick were switched to standard loops and a clearance plan was written to prevent the junction from locking up as a result of non-detection.

Concerns regarding the overall stability of the 2008.1 version of the model meant that it was desirable to undertake testing within the more recent 2008.3 version of the PARAMICS software. Initially the version change was applied to the 2009 base model and the resultant changes in calibration and validation assessed. Once it was ascertained that the impact on calibration and validation was acceptable this change was then carried forward through the other scenario models.

A separate Technical note outlining the impact on model calibration and validation is available[2].

[1] Warwick District Council Strategic Transport Assessment Modelling, - PARAMICS Testing and Results, JMP Consultants, 17 April 2012
[2] 211439-19-TN016 Warwick and Leamington Recalibration overview

3.2 Core Strategy Demand Forecasting

An important element of this study was the forecasting of the demands associated with the two CS options. The AM and PM peak hour (08:00 to 09:00 and 17:00 to 18:00) trip generation totals for each development were provided by WCC.

The resultant peak hour trip generation for the Southern Focus option is presented within the following Table 2:

Table 2- Southern Focus Trip Generation

SITE	0800 to 0900		1700 to 1800	
	Destination	Origin	Destination	Origin
Stoneleigh Park	891	131	107	788
Thickthorn	328	418	405	293
Red House Farm	24	96	96	24
Fieldgate Lane	11	46	46	11
Woodside Farm	30	120	120	30
South of Sydenham	78	312	312	78
Warwick Gates	51	101	100	47
Myton Garden	281	561	552	259
Castle Park	407	812	800	375
South of Harbury Ln.	599	1192	1175	551
Leam Fire Station	6	24	24	6
ibm Car Park	12	48	48	12
Montague Road	10	38	38	10
Riverside House	6	24	24	6
Lapworth	12	48	48	12
Hampton Magna	12	48	48	12
Barford	12	48	48	12
Bishops Tachbrook	12	48	48	12
Radford Semele	12	48	48	12
Rowington	7	26	26	7
Shrewly	7	26	26	7
Hatton	7	26	26	7
Norton Lindsey	7	26	26	7
Cubbington	7	26	26	7
Leek Wootton	7	26	26	7
Burton Green	7	26	26	7

The resultant peak hour trip generation for the Preferred Option is presented within Table 3 on the following page.

Table 3 - Preferred Option Trip Generation

SITE	0800 to 0900		1700 to 1800	
	Destination	Origin	Destination	Origin
Stoneleigh Park	891	131	107	788
Thickthorn	328	418	405	293
Red House Farm	24	96	96	24
Fieldgate Lane	6	24	24	6
Woodside Farm	30	120	120	30
South of Sydenham	78	312	312	78
Warwick Gates	53	102	100	49
Myton Garden	292	560	552	268
Castle Park	424	815	802	389
Leam Fire Station	6	24	24	6
Montague Road	10	38	38	10
Riverside House	6	24	24	6
Lapworth	12	48	48	12
Hampton Magna	12	48	48	12
Barford	12	48	48	12
Bishops Tachbrook	12	48	48	12
Radford Semele	12	48	48	12
Rowington	7	26	26	7
Shrewly	7	26	26	7
Hatton	7	26	26	7
Norton Lindsey	7	26	26	7
Cubbington	7	26	26	7
Leek Wootton	7	26	26	7
Burton Green	7	26	26	7
Warwickshire College	36	144	144	36
North of Milverton	215	413	406	197
Loes Farm	22	86	86	22
Blackdown	310	596	587	285

Stoneleigh Park has been included within both options although it is not part of the allocation. It is, however, a committed development of sufficient magnitude to be likely to influence the routeing and distribution of trips within the model network.

A separate distribution for Stoneleigh Park was derived from CITEware across the wider Warwickshire area. This was translated into a distribution for the WLWA model which resulted in around 25% to 35% of all trips associated with the development being assigned within the scenario models.

3.3 CS Trip Discounting and Factoring

In line with the earlier STA analysis it was important to ensure that the peak hour trip generation figures were factored to account for the shoulder hours of the

respective model periods. In the AM the model period runs from 07:00 to 10:00 whilst in the PM the model period runs from 16:00 to 19:00.

During previous STA work, peak to shoulder hour factors were derived for the residential and employment trip types and these are presented within the following Table 4 and Table 5 for Residential and Employment factoring respectively:

Table 4 - Residential Trip Profiling

	0700 to 0800	0800 to 0900	0900 to 1000	1600 to 1700	1700 to 1800	1800 to 1900
In	65.1%	100.0%	101.9%	72.6%	100.0%	76.0%
Out	68.5%	100.0%	46.1%	96.4%	100.0%	97.9%
Average	66.8%	100.0%	74.0%	84.5%	100.0%	87.0%

Table 5 - Employment Trip Profiling

	0700 to 0800	0800 to 0900	0900 to 1000	1600 to 1700	1700 to 1800	1800 to 1900
In	55.6%	100.0%	58.0%	120.3%	100.0%	51.1%
Out	64.7%	100.0%	88.2%	87.3%	100.0%	35.6%
Average	60.2%	100.0%	73.1%	103.8%	100.0%	43.4%

In addition to profiling the peak hours into the respective shoulder hours a number of discounts were applied in an attempt to replicate prospective trip modal shift and trip internalisation for each of the sites.

A modal shift allowance was made for all sites of 15% whilst sites which contained an element of Residential and Employment were subject to a further 10% reduction to allow for internalisation. At this stage these factors have been applied on the basis that they are in line with what was adopted during the earlier STA work. ***It is recommended that, once the final option for the allocation of growth is determined, testing is undertaken both with and without these assumptions attributed to the developments.***

The internalisation and modal shift factors were assigned to the developments as outlined within the following Table 6 whilst the resultant derived hourly trip generation that has been attributed to each of the sites is presented, for both CS options, within **Appendix D** of this report.

Table 6 - Internalisation & Modal Shift Adjustments

SITE	Option	Modal Shift	Internalisation
Stoneleigh Park	Both	×	
Thickthorn	Both	×	×
Red House Farm	Both	×	
Fieldgate Lane	Both	×	
Woodside Farm	Both	×	
South of Sydenham	Both	×	
Warwick Gates	Both	×	×
Myton Garden	Both	×	×
Castle Park	Both	×	×

Cont…

Leam Fire Station	Both	×	
Montague Road	Both	×	
Riverside House	Both	×	
Lapworth	Both	×	
Hampton Magna	Both	×	
Barford	Both	×	
Bishops Tachbrook	Both	×	
Radford Semele	Both	×	
Rowington	Both	×	
Shrewly	Both	×	
Hatton	Both	×	
Norton Lindsey	Both	×	
Cubbington	Both	×	
Leek Wootton	Both	×	
Burton Green	Both	×	
Warwickshire College	PO	×	
North of Milverton	PO	×	
Loes Farm	PO	×	
Blackdown	PO	×	

The total demand, by hour, produced as a result of the aforementioned process is presented within the following Table 7:

Table 7 - CS Demand Allocation

	0700 to 0800	0800 to 0900	0900 to 1000	1600 to 1700	1700 to 1800	1800 to 1900
Southern Focus	3112	4753	2770	3387	4464	3293
Preferred Option	3231	4930	2844	3513	4635	3411

3.4 CS Redistribution and Peak Spreading

As well as applying modal shift and internalisation assumptions the earlier STA work had also allowed for peak spreading of the development trips to also be assumed within the models.

The previous stage of this assessment assumed a simple 33% per hour assignment of development trips. However, it was felt that a more refined approach to the application of peak spreading was required for the next stage of the assessment.

In addition, an initial analysis of the CS demands revealed that the levels of growth predicted were particularly high. These high levels of growth are particularly important when considering the need to assess the PM period through the PARAMICS model.

Because of the high levels of growth it was decided that consideration should be given to the application of a ‘capping’ procedure informed by analysis of the TEMPRO database.

3.4.1 Guidance

Latest guidance on forecasting within transport models indicates that growth rates should be corrected to avoid double counting and that this 'correction' should be based on a view as to the plausible overall likely growth within an area, informed by TEMPRO, rather than whether a development, or set of developments, is interpreted as being 'additional'.

The purpose of this approach is to minimise the potential for over estimation of forecasts which could, in turn, lead to over-engineered solutions to problems that may not necessarily be realistic. Furthermore, if growth within the scenario models is allowed to remain too high there is a chance that one or more scenarios may be discounted on the basis that the demand impacts cannot be satisfactorily accommodated on the network irrespective of the proposed mitigation measures.

The relevant extracts from the WebTAG guidance (3.15.2) are outlined as follows:

> ***"Where a particular development proposal is likely to have a significant impact on demand for transport on one of the roads or rail services where transport measures are being considered, this should be allowed for by explicit modelling of trips associated with that development. Methods adopted for doing this need where possible to be consistent with those set out in the Transport Assessment for the development. It is important to ensure that modal split assumptions are realistic in the context of current planning policy guidance. The growth factors applied to non-development trips may then have to be adjusted downwards, to avoid double-counting of trips within the model."***
>
> ***"Similarly, the correction of growth rates to avoid double-counting should be informed by a view as to the plausible overall population, household or employment growth in the zone, not by a local argument as to whether or not the development can be seen as "additional" in terms of the derivation of the TEMPRO figures."***

It is recommended that a sensitivity test be undertaken during the next stage of testing whereby unadjusted growth is assigned to the model network in order to identify further areas that may require additional mitigation. Such schemes would be difficult to secure in the short term as the growth levels required to trigger the need for these schemes is hard to justify. The purpose of any sensitivity test would be to provide an indication of any further mitigation that may be required over and above that which can be attributed, and delivered, by the respective CS growth options.

The need to apply a capping procedure is further demonstrated by the fact that, during the previous modelling exercise, it was not possible to undertake an assessment of the impacts of each option within the PM model period on account of the inherent model instability within the respective options during the PM period. By applying a cap the impacts of model instability would be minimised.

3.4.2 Redistribution Methodology

The application of the cap to the levels of growth within the model was based on NTEM Adjusted TEMPRO factor for Warwickshire County. The AM and PM NTEM adjusted factors currently stand at **19.19%** and **19.92%** respectively.

Due to the relatively fixed nature of Education and HGV trips across the network it was decided that these should be excluded from the calculations as including them could result in a reduction in either Education or HGV demand that may not necessarily be realised as a result of the inclusion of the CS sites. Particularly as, at the moment, the details CS site compositions provided by WDC focus on housing and employment rather than education, thus they should not be included within the calculations.

Furthermore, the original 2028 Reference Demands were interrogated for instances were internal growth was retained and this was removed. This is on the presumption that all growth that occurs in addition to committed developments is associated with the CS sites. This approach is valid as analysis of the demands determined that the growth within the models, before redistribution, exceeded TEMPRO predictions and, therefore, the internal element of the growth could be removed to reduce the potential for double counting to occur.

The methodology for applying the capping procedure was as follows:

- Education and HGV trips were excluded from the calculations;
- External growth was allocated via the standard TEMPRO/NTEM factoring methodology.
- The level of demand within the 2011 model, less education and HGV, was calculated
- The level of internal demand likely to be assigned as a result of the interrogation of the TEMPRO database was calculated
- The resultant level of demand assigned to the model as a result of the two CS options was calculated.
- If the level of demand assigned within the model as a result of the CS options was in excess of the TEMPRO predicted level then the net difference is assumed to be the volume of trips that redistribute as a result of the inclusion of the CS developments.
- The redistribution of trips in response to the inclusion of CS developments was calculated by subtracting the applying the aforementioned reduction proportionally across the background matrices. This was done by comparing the demand within the CS matrices to the Background matrices. This process meant that the reduction in trips was targeted to those zones which had the highest level of interaction with CS sites.
- The reduction was calculated firstly by O-D (Origin – Destination) movements, secondly by O-D totals and finally proportionally across the entire matrix. The purpose of this approach is to ensure that the reductions that are applied are as focussed as possible. Simply reducing the entire matrix, proportionally, by the required level would result in a reduction in

background trips in areas where there is little or no interaction with CS sites.

Redistributing trips in the means that reductions in the number of background trips were achieved on a zone by zone basis, informed by the level of interaction between the existing zones and the new CS demands. This means that zones which had a high level of trip interaction with CS zones were likely to experience greater reductions in the background traffic generation totals than those with limited or no interaction with CS zones. This limits the potential for reductions in background trips to materialise in areas where there is little or no interaction with CS sites.

The impact of the redistribution procedure is outlined within the following Table 8 and Table 9 for the SF and PO options respectively.

Table 8- Southern Focus TEMPRO Capping Overview

	07 to 08	08 to 09	09 to 10	16 to 17	17 to 18	18 to 19
Base Model Demand (excluding HGV & Education)	32174	38778	29127	38790	44134	32609
Periodic	100078			115532		
2028 Reference Demands (Less HGV& Education & External Growth)	39033	39948	33684	43455	46928	39559
Periodic	112665			129942		
2009 to 2028 Ref	***12.6%***			***12.5%***		
SF Demands:	3112	4753	2770	3387	4464	3293
2028 + SF	41298	44700	36001	46802	51378	42769
Periodic	122000			140949		
2009 to 2028 + SF Original	***21.9%***			***22.0%***		
TEMPRO NTEM Target	119285	(19.2%)		138549	19.9%	
Reduction	-2714			-2399		
Proportion of CD Demand	-794	-1213	-707	-729	-961	-709
SF Revised Demand Totals	42824	52931	38676	49574	52462	43821
Periodic	119285			138549		
2009 to 2028 + SF Adjusted	***19.2%***			***19.9%***		
Total Demand (Including HGV & Growth)	42824	52931	38676	49574	52462	43821
Periodic	134431			145856		
Net Growth	**18.0%**			**19.4%**		

Table 9- Preferred Option TEMPRO Capping Overview

	07 to 08	08 to 09	09 to 10	16 to 17	17 to 18	18 to 19
Base Model Demand (excluding HGV & Education)	32174	38778	29127	38790	44134	32609
Periodic	100078			115532		
2028 Reference Demands (Less HGV& Education & External Growth)	39033	39948	33684	43455	46928	39559
Periodic	112665			129942		
2009 to 2028 Ref	12.6%			12.5%		
SF Demands:	3231	4930	2844	3513	4635	3411
2028 + PO	41418	44878	36075	46928	51548	42887
Periodic	122371			141363		
2009 to 2028 + PO Original	22.3%			22.4%		
TEMPRO NTEM Target	119285	(19.2%)		138549	19.9%	
Reduction	-3086			-2813		
Proportion of CD Demand	-906	-1382	-797	-855	-1128	-830
SF Revised Demand Totals	40512	43496	35278	46072	50420	42056
Periodic	119285			138549		
2009 to 2028 + SF Adjusted	19.2%			19.9%		
Total Demand (Including HGV & Growth)	42831	52940	38660	49574	52465	43817
Periodic	134431			145856		
Net Growth	**18.0%**			**19.4%**		

3.5 Peak Spreading Methodology

Peak spreading assumptions were applied post-redistribution as the latter deals with demand across the entire period whilst peak spreading deals with hourly changes.

Once the revised CS demand totals had been derived peak spreading assumptions were applied. Since peak spreading assumptions had already been applied to the 2028 Reference Demands[3] then the application of further peak spreading assumptions has been applied only to the growth that could be considered as occurring in addition to the original 2028 Reference Case. Because of this principle, peak spreading assumptions were only applied to the difference in demand between the 2028 Reference Case model and the 2028 SF or 2028 PO model.

The peak spreading assumptions applied were initially consistent with those outlined within the 2028 Future Year model development report and are summarised, for the AM and PM model periods, within the Table 10 and Table 11 on the following page.

[3] Warwick District Council Strategic Transport Assessment Modelling, - PARAMICS Testing and Results, JMP Consultants, 17 April 2012

Table 10 – AM Peak Spreading Proportions

0700 to 0800	0800 to 0900	0900 to 1000
68%	6%	26%

Table 11 – PM Peak Spreading Proportions

1600 to 1700	1700 to 1800	1800 to 1900
54%	26%	20%

Peak spreading evidence and the derived trend data was based on observed Automatic Traffic Count (ATC) data collected annually at WCC cordon monitoring locations around the modelled area. After application of the above proportions it was apparent that there was a substantial shift in demand within the PM model period. The shift occurred to such an extent that the 16:00 to 17:00 demand levels exceeded those within the 17:00 to 18:00. Whilst there is potential for this situation to occur, the principle of peak spreading is such that vehicles are redistributed away from the most congested peak hour in response to congestion. As a result the PM peak spreading proportions were readjusted within the PM period to ensure that demand in the 1600 to 1700 hour did not exceed the level of demand within the 17:00 to 18:00 peak hour.

Whilst testing without any application of peak spreading assumptions is not likely to yield acceptable results due to the general bias towards the peak hour, it is recommended that, once the final option for the allocation of growth is determined, testing is undertaken both with and without the revised PM spreading assumptions attributed to the model demands.

In order that this principle could be achieved 30% of the 16:00 to 17:00 increase was redistributed, proportionally, back across the 17:00 to 18:00 and 18:00 to 19:00 hours. By redistributing 30% the goal of ensuring that demand within the 17:00 to 18:00 hour was retained as the highest level across the entire period.

The resultant peak spreading proportions assigned to the PM period are summarised within the following Table 12:

Table 12 – Revised PM Peak Spreading Proportions

1600 to 1700	1700 to 1800	1800 to 1900
24%	43%	33%

The peak spreading proportions were intended to be applied to only those levels of growth that occur in excess of the levels contained within the 2028 Reference Case as these had already been subject to some element of peak spreading.

The specific differences between the two scenarios relates primarily to the inclusion of the demand associated with the CS options. If, however, peak spreading assumptions were applied only to those demands then it would result in a disproportionate shift in CS demand away from the traditional peak hour.

As a result, a more refined methodology was adopted whereby the assumption was that only 50% of the total traffic growth would be subjected to peak spreading. Furthermore 50% of the growth that was subjected to peak spreading would be associated with the CS option demands whilst the remaining 50% would be associated with the background matrices. It was felt that this approach was reasonable given that Committed Developments and Forecast growth had already been subjected to peak spreading during the development of the Reference Case

whilst acknowledging that the Education and HGV trips are unlikely to be affected by peak spreading.

An overview of changes resulting from the application of the peak spreading procedure to both SF and PO demands is illustrated within the following Tables 13 and Table 14:

Table 13- Peak Spreading Overview, Southern Focus Demands

	07 to 08	08 to 09	09 to 10	16 to 17	17 to 18	18 to 19
2028 Reference Demands	41353	49392	37066	46956	48973	41320
2028 SF Demands	42824	52931	38676	49574	52462	43821
Growth from 2028 Ref	1471	3540	1610	2617	3489	2501
Periodic Growth	6620			8608		
50% Peak Spread Total	3310			4304		
Peak Spreading Proportions	68%	6%	26%	24%	43%	33%
LDF Adjustments	1125	99	430	516	924	711
Background Adjustments	1197	-1655	458	905	-2152	1247
Assigned Hourly Demands	44662	50636	39133	50342	50372	45142
Difference	1838	-2296	457	768	-2090	1322

Table 14 - Peak Spreading Overview, Preferred Option Demands

	07 to 08	08 to 09	09 to 10	16 to 17	17 to 18	18 to 19
2028 Reference Demands	41353	49392	37066	46956	48973	41320
2028 PO Demands	42831	52940	38660	49574	52465	43817
Growth from 2028 Ref	1479	3548	1594	2617	3493	2498
Periodic Growth	6620			8608		
50% Peak Spread Total	3310			4304		
Peak Spreading Proportions	68%	6%	26%	24%	43%	33%
LDF Adjustments	1125	99	430	516	924	711
Background Adjustments	1197	-1655	458	905	-2152	1247
Assigned Hourly Demands	44668	50642	39121	50342	50375	45140
Difference	1837	-2297	460	768	-2090	1323

3.6 Demand Summary

The resultant Hourly demands assigned within the three key modelling scenarios are summarised within the following Table 15:

Table 15 - Scenario Demand Summary

	07 to 08	08 to 09	09 to 10	16 to 17	17 to 18	18 to 19
2028 Reference Demands	41353	49392	37066	46956	48973	41320
2028 SF Demands	44662	50636	39133	50342	50372	45142
2028 PO Demands	44668	50642	39121	50342	50375	45140

4 Mitigation Overview

4.1 Introduction

During the course of the modelling a number of issues on the network were identified and schemes were introduced within the model network in an attempt to overcome these issues

The initial Preferred Option mitigation strategy utilised the original Option 4B model network which was completed during early 2012[4] as this already included a number of mitigation schemes. These were initially based on known existing congestion hotspots and an iterative process of model runs and mitigation development. This included the Northern Relief Road (NRR).

The initial Southern Focus mitigation strategy starting point was the 2028 Reference Case model network. . The first stage of mitigation that was added was that which was identified during the initial M40 threshold testing (some of which had been previously identified in the original LDF option test modelling). This process has been detailed within Section 5 of this report.

4.2 Outline Mitigation Schemes

The mitigation strategies that were derived as a result of this process, for both options, could be divided into general broad area strategies. In some options certain areas are more likely to require mitigation than in others whilst it should also be remembered that elements from anyone area can, generally, be implemented without the need for the entire corridor strategy. Rather the areas identify the corridors where the cumulative impacts of applying mitigation are likely to be of greater overall benefit than the individual schemes.

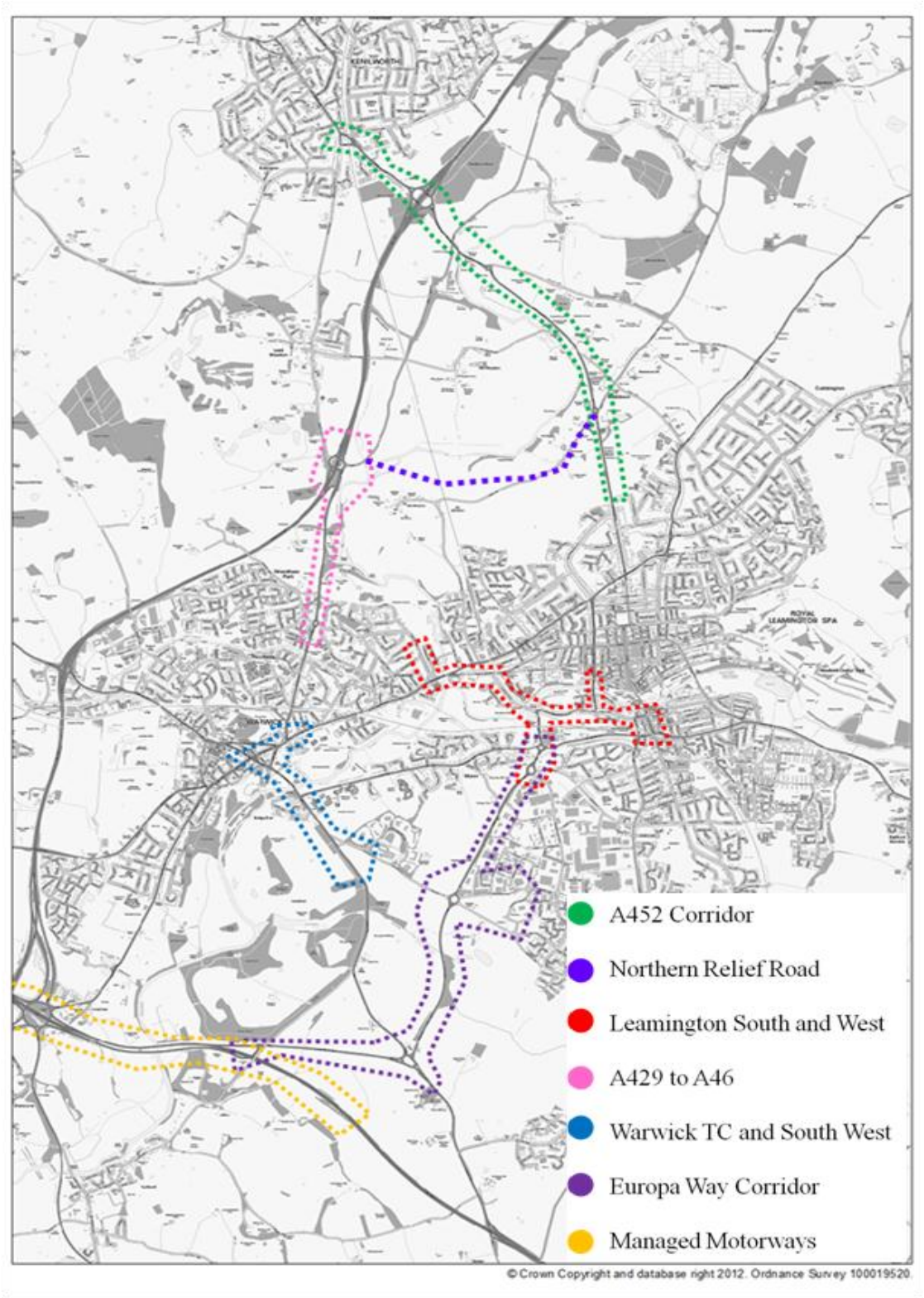
In most cases any single element of mitigation could be implemented in isolation with the rest of the mitigation for that area to follow later.

Further investigation of the potential benefits of area wide mitigations strategies and the cumulative benefits of the schemes therein is recommended to be undertaken once the final option for the allocation of growth has been determined.

An overview of the broad locations of the various mitigation strategies is provided within Figure 3 on the following page, after which the following section provides an overview of the changes incorporated within one or both model networks in an attempt to mitigate the impacts of the assigned demands.

[4] Warwick District Council Strategic Transport Assessment Modelling, - PARAMICS Testing and Results, JMP Consultants, 17 April 2012

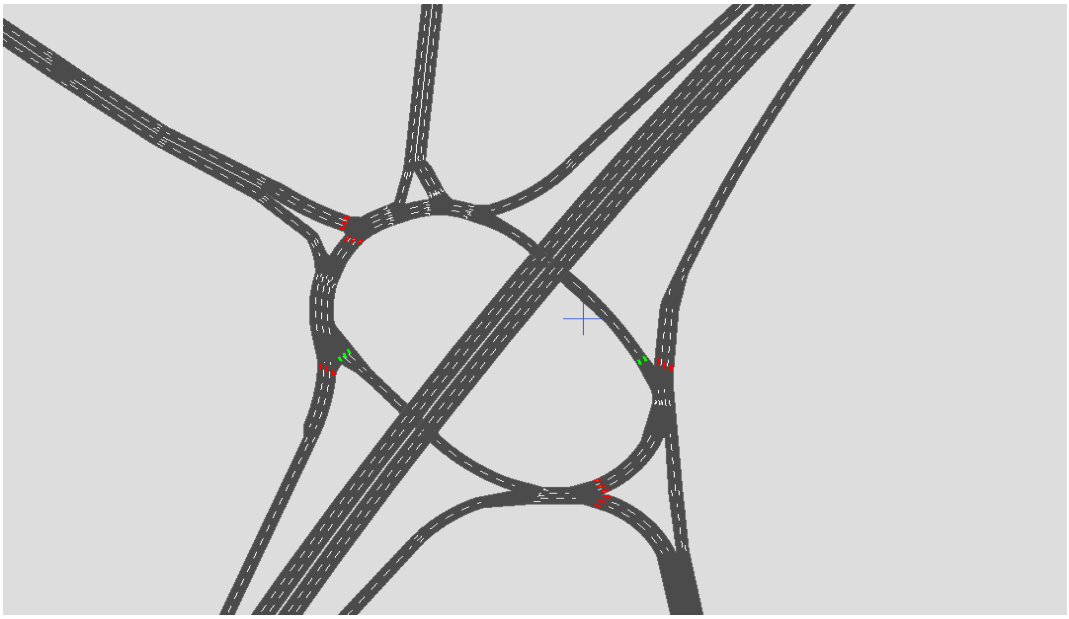
Figure 3 - Broad Mitigation Areas



A452 Thickthorn Roundabout

This scheme involves signalisation of the existing 4 arms of the roundabout and widening of the north eastern section of the roundabout to 4 lanes and the south western section of the roundabout to 3 lanes. The sections over the A46 are retained as 2 lanes to minimise physical changes to the bridges. A new 5th arm into the roundabout has been added with a link that would go through the site and join with Glasshouse Lane most likely to the north of Canterbury Close.

Figure 4- Thickthorn Model Scheme Amendments



A452 Kenilworth Gyratory

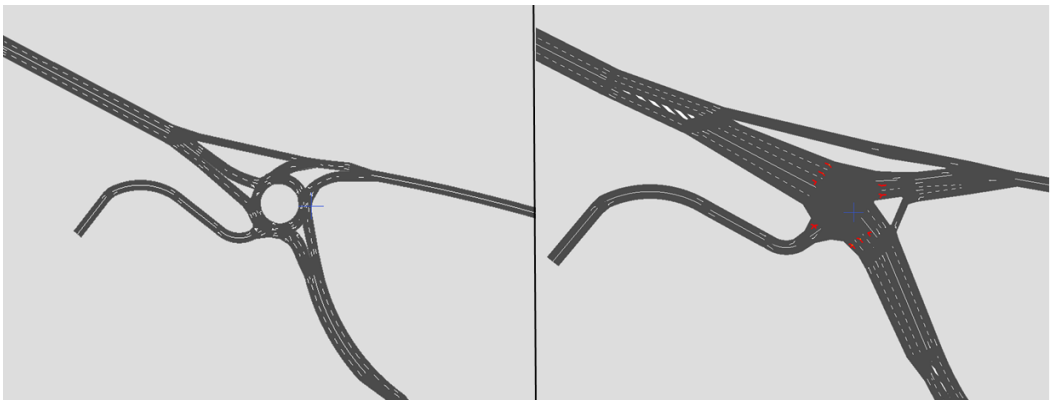
This scheme involves signalisation of the existing entry arms to the A452/Birches lane gyratory within Kenilworth. No further changes were required at this stage but further consideration will be required with regards the method of accessing the garage and the office use which is located within the centre of the gyratory.

A452/Bericote Road Roundabout

The initial scheme that was modelled for this area involved widening of all approaches to the roundabout, circulating carriageway and inclusion of an A452 to Bericote Rd WB slip to draw traffic out of the junction. This was included within both the Preferred Option and Southern Focus models.

During testing of an alternative Preferred Option Scenario a signalisation scheme of the same junction has been identified. Further investigation is required to identify which is the optimum configuration for the junction. Signalisation would adhere better to the K2L Cycle provision aspirations.

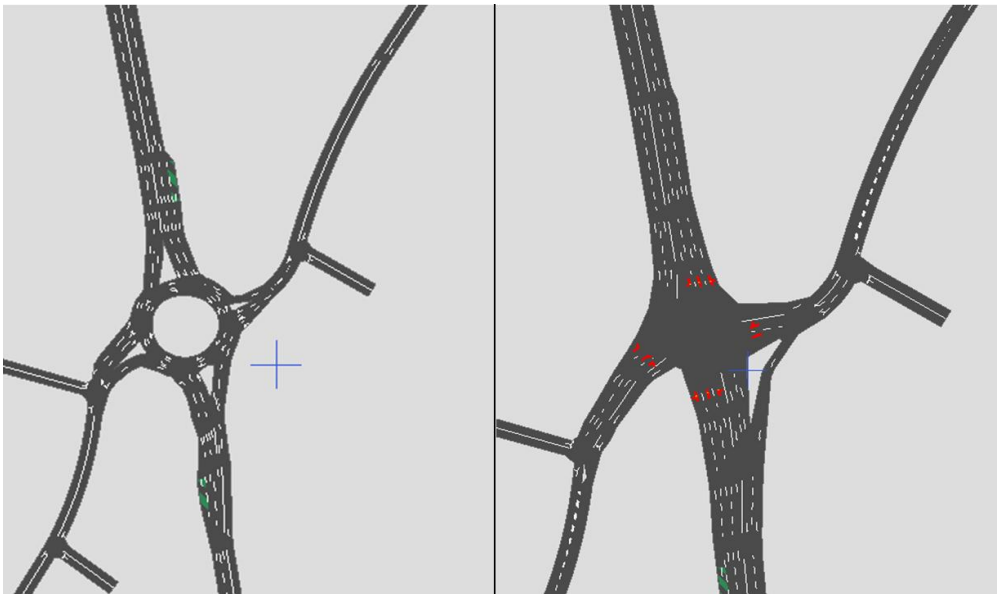
Figure 5 - A452/Bericote Road Modelled Scheme



A452/Blackdown Roundabout

The initial scheme that was modelled for this area involved widening of all approaches to the roundabout and circulating carriageway. As with A452/Bericote Road a signalisation scheme has also been identified. Further investigation is required once the allocation of CS growth becomes more certain.

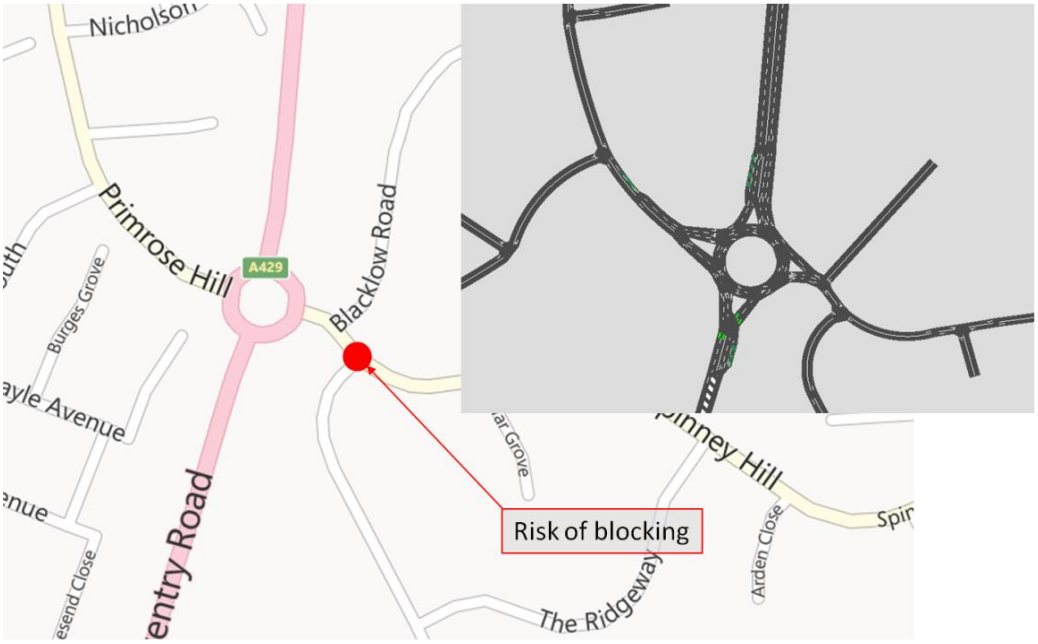
Figure 6 - A452/Blackdown Modelled Scheme



A429/Spinney Hill Roundabout

The scheme that was modelled for this area involved widening of all approaches to the roundabout. A yellow box, or similar, may be required to prevent traffic that is travelling WB along Spinney Hill from blocking access to Montague Rd. This blocking is partly caused by an increase in flow on the Spinney Hill WB approach which occurs as a result of the Emscote / Greville Road scheme proposals.

Figure 7 - A429/Spinney Hill Roundabout Model Configuration



B4099 Warwick New Road Princess Drive/ Roundabout

The existing roundabout has been reconfigured into a signalised junction. The constraints imposed by the adjacent railway bridge mean that the Warwick New Road WB section, travelling away from the junction, may need to utilise the second available railway arch to ensure that two EB lanes can be accommodated. The cycling of these signals has been implemented in unison with the Emscote Rd/Warwick New Rd and Emscote Rd/Greville Rd junctions despite the relatively large distance between them. These 3 junctions form a strategic corridor, the operation of which is critical for overall network performance, particularly when considering the maintenance of a link between the two towns.

A452 Adelaide Road/Avenue Road

This area has been identified as a congestion hotspot; the junction has been reconfigured from a mini-roundabout to a signalised junction. Vehicle detection has been used to allocate green time to vehicles using Station Approach.

A452 Adelaide Road /Dormer Place

Large queue formation on Dormer Place has been observed, within the model, to extend back to the Parade. If this occurs the network can quickly become blocked and the congestion effects are both severe and widespread. The propensity for this situation to occur was observed as being higher when testing the SF allocation although the potential for this to occur when the PO allocation is assigned should not be ruled out.

B4087 Bath Street/Spencer Street/High Street/Lower Avenue

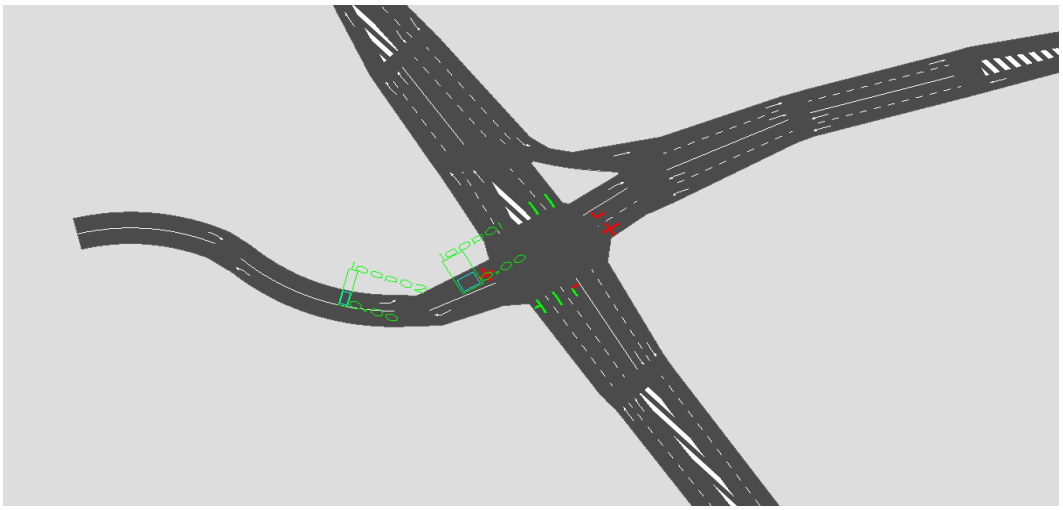
Early modelling work identified this location as a congestion hot spot. The initial scheme proposals contained within the model require High Street and Spencer Street to both be reconfigured to one way links (WB and EB respectively). Three corners of the revised gyratory would be signalised whilst the Lower Avenue/Spencer Street corner could be reconfigured into a priority merge. Lower Avenue to Avenue Road would be a major movement with no opposing flow.

Figure 8 - Bath Street/High Street Gyratory Configuration

A425 Myton Road/Banbury Road Roundabout

This junction has been reconfigured into a signalised priority junction with a dedicated SB left turn merge. Vehicle detection was adopted to control the exit flow from Bridge End. Widening of all approaches and a right turn facility provided for Banbury Rd NB to Myton Rd EB movement.

Figure 9 - Myton Road Roundabout Reconfiguration



A429Smith Street/St Nicholas/Priory Rd

This junction has been reconfigured into a signalised priority junction. Synchronisation with St John's/Coten End Junction allows for better control of traffic flow through the town centre.

Castle Hill/Mill Street Gyratory

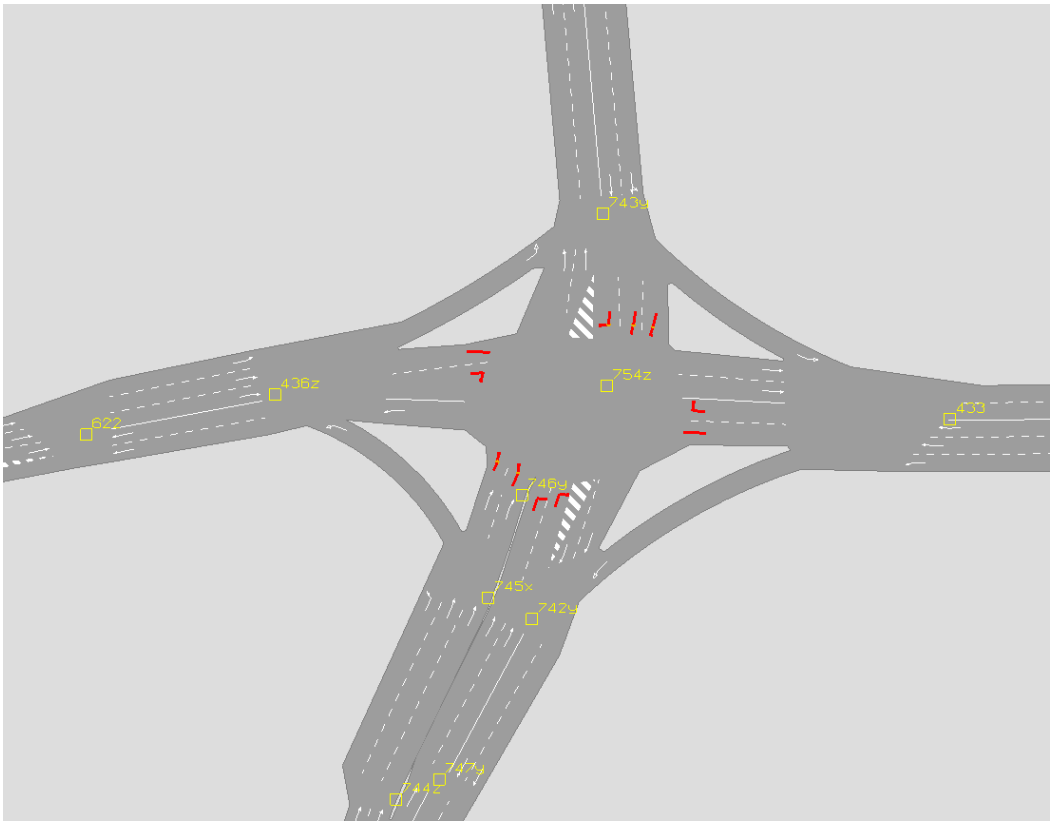
The current modelled scheme involves part signalisation of the roundabout with realignment of St Nicholas Church Street entry arm to allow a left turn priority junction with Banbury Rd SB. This moves a considerable amount of traffic away from the signals. Synchronisation with the aforementioned Priory Road/Smith Street and St John's Coten End junctions as well as the fore mentioned Myton Road junction significantly improves the control of flow through the town centre.

A452 Europa Way/Myton Road Roundabout

The existing roundabout has been completely reconfigured into a signalised junction. The available land from the footprint of the roundabout has been utilised to implement Left turn slips from all approached. 2 right turn lanes from Europa Way NB to Myton Rd WB have been implemented alongside considerable widening of all junction approaches

.

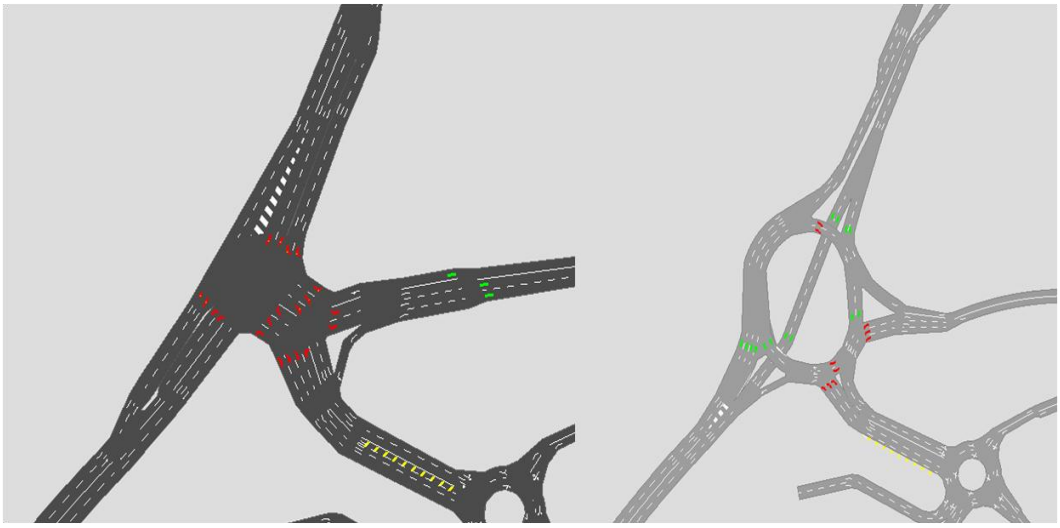
Figure 10 - Europa Way/Myton Road Reconfiguration



Shires Retail Park Roundabout

Within the current modelling the existing roundabout has been completely reconfigured into a signalised junction. The Queensway and Tachbrook Park drive tie-in in advance of the junction and a single approach feeds into a junction of considerable size, 4 lanes NB and SB. It is highly likely that the junction that has been included within the modelling has been over-engineered as it is based on a layout derived from the M40 cordon model before any redistribution effects have been considered. Furthermore the principles of the scheme are fundamentally those represented by the configuration of a hamburger roundabout. At this stage further investigation is required to identify the likely optimum solution.

Figure 11 – Shires Retail Park Roundabout – potential layouts



A452 Europa Way Roundabout

The modelling has assumed part signalisation of the roundabout. The current scheme assumes signalisation of four out of the five entry arms. Only the Harbury Lane Entry arm has been retained as free-flowing. A considerable amount of widening has been included both on the circulating carriageway and on the approaches. The scheme has been identified as necessary in both options although, when considering the impact of PO allocations, it is likely that the need for widening would be reduced.

A452 Grey's Mallory Roundabout

Within the SF testing a signalisation scheme has been assigned to Grey's Mallory Roundabout. All entry arms have been signalised whilst a dedicated merge facility has been included to accommodate traffic travelling from the B4100 EB to the M40.

A452 Europa Way Corridor Part 1

Dual carriageway has been introduced for the entire length of the corridor between M40 J14 and Europa Way roundabout. Testing of J14 schemes has identified this as necessary work to prevent queuing extending back onto the M40 mainline post-implementation of the proposed Grey's Mallory and Europa Way

roundabout schemes. Currently provision for two lanes SB until at least the other side of the bridge has been included. This is likely to be required up to and including the point of merge onto the M40 NB.

A452 Europa Way Corridor Part 2

Dual carriageway has been introduced for the entire length of the corridor between Europa Way roundabout and Europa Way/Myton Road roundabout. This was identified as necessary during the initial threshold testing, allowing for the redistribution of some trips away from this area, as predicted by the WLWA model, may reduce the need for this element of infrastructure. Further investigation is recommended.

C43 Gallows Hill/Warwick Tech Park

Two lanes have been introduced between the two Technology park entrances which have also, in turn, been reconfigured to roundabouts. Two lanes between the Western entrance and the junction with Banbury Road, this allows traffic heading SB along Banbury Road and then EB along Gallows Hill to merge with traffic travelling NB along Banbury Road to Gallows Hill rather than the signals that are in place at the moment.

A425 Banbury Road

Two lanes have been introduced, in both directions, between the Junction with Gallows Hill and the Junction with Myton Road. Further consideration is required with regards the access strategy for Warwick School off Banbury road as the assumed configuration would require right turning traffic to cross two lanes of opposing flow.

A429 Gaveston Roundabout

Part-signalisation of the A46/A429 Junction, Application of MOVA to control queuing on approaches from A46 as well as to facilitate right turn from A429 to A46 SB on-slip. This is particularly important in the context of the Preferred Option (with NRR).

4.3 Mitigation Prioritisation

Each of the mitigation measures included within the modelling has been categorised based on a review of the performance of the model networks in operation in conjunction with the results analysis presented within the following sections of this report. The categorisation process is intended to provide an indication of the likely level of necessity for inclusion of the scheme. At this stage the grading should be considered as indicative as it is envisaged that further, more detailed testing, will be undertaken once the allocation of growth within the area has been determined. At that stage it is anticipated that a more detailed assessment of each mitigation measure will be undertaken. More detailed analysis is required, firstly, to determine the necessity of the mitigation and, secondly, to determine the optimum configuration of the mitigation measures that are proposed. At this stage

the level of assessment has been relatively coarse so it is unlikely that the optimum mitigation measures will have been determined.

In light of the above is should be noted that the results of this more detailed assessment process will be likely to yield additional benefits and further reduce the impacts over and above those identified within the following sections of this report. Thus, the results that are presented herein should be considered as a worst case assessment.

4.4 Mitigation Grading

The following provides an overview of the grading system applied to the current mitigation measures.

- **GRADE 1 - Included Essential** – A scheme identified at an early stage of the assessment that has been included within the modelling and is likely to be essential in maintaining network operation and conditions should the respective CS option come forward
- **GRADE 2A - Included Desirable -** A scheme identified during the assessment that has been included within the modelling, implementation of the scheme is desirable to ensure maintenance of network operation and conditions should the respective CS option come forward. Further investigation may be required to determine whether the scheme is essential.
- **GRADE 2B – Desirable** – A scheme not included within the assessment but likely to have benefits should it be implemented alongside the respective CS option.
- **GRADE 3 -Not Determined** – A scheme not included within the assessment that may still have potential benefits, further investigation may be required before this scheme is ruled out for implementation alongside the respective CS option.

The mitigation schedule, indicative costs and associated grading, is presented in detail within **Appendix C** of this report. A summary of the schedule and grading is provided within the following Table:

Table 16 - Outline Mitigation Schedule

Scheme	Status	
	SF	PO
Thickthorn Roundabout	Grade 1	Grade 1
Kenilworth Gyratory	Grade 1	Grade 1
A452/Bericote Roundabout	Grade 2A	Grade 1
A452/Blackdown Roundabout	Grade 2A	Grade 1
A452 Spinney Hill Roundabout	Grade 2A	Grade 1
Emscote Road/Greville Road	Grade 1	Grade 1
Princes Drive/Warwick New Road	Grade 1	Grade 1
Bath Street/High Street	Grade 1	Grade 1
Adelaide Road/Avenue Road	Grade 1	Grade 2A
Dormer Place/Adelaide Road	Grade 1	Grade 2B
Myton Road Roundabout	Grade 1	Grade 2B
Priory Road/Smith Street/St Nicholas	Grade 1	Grade 2B
Castle Hill Gyratory Signals	Grade 1	Grade 2B
Europa Way/Myton Road Roundabout	Grade 1	Grade 2B
Shires Retail Park Roundabout	Grade 1	Grade 2B
Europa Way Roundabout	Grade 1	Grade 1
Grey's Mallory Roundabout	Grade 1	Grade 3
Europa Way Corridor – Part 1	Grade 1	Grade 1
Europa Way Corridor – Part 2	Grade 2A	Grade 3
Gallows Hill – 2 Lanes	Grade 1	Grade 3
Banbury Road – 2 Lanes	Grade 1	Grade 3
ATM "Managed Motor Ways"	Grade 1	Grade 2B/3
Junction 13 improvements	Grade 2B	Grade 2B
A46/Gaveston Roundabout Signalisation	Grade 2A	Grade 2A
Leamington Northern Relief Road (LNRR)	NA	Grade 2A
Further Capacity/PT Improvements on A452 between Kenilworth and Leamington	Grade 3/ NA	Grade 1/3
Dalehouse Lane roundabout flare extensions, A46/C32 Signalisation and C32/B4115 Roundabout	Grade 2B	Grade 2B
Kenilworth Station	Grade 2A	Grade 2A
Town Centre Improvements	Grade 2B	Grade 2B
Sustainable Travel Infrastructure	Grade 2A	Grade 2A
Virtual P&Rs	Grade 2A	Grade 2A

5 Southern Focus Threshold Testing

5.1 Introduction

One of the first test objectives was to ascertain whether the initial level of growth, proposed within the Southern Focus, could be accommodated within the existing network and what potential mitigation measures would be required to enable that growth to be accommodated.

The first stage of the assessment was undertaken qualitatively. The peak CITEware[5] outputs for the SF trip generation, within the M40 model area, where extracted and transposed into hourly trip generation matrices for assignment within the M40 model.

The purpose of this initial assessment was to identify whether such an approach to the allocation of growth was feasible and what the necessary mitigation requirements would be.

By extracting the demands directly out of the CITEware run and allocating them within the cordon model no account for the potential for reassignment of routes in response to congestion has been undertaken. The assumption was that if the peak hour network could be developed to accommodate the required demand levels then this would be more than sufficient to enable a judgement as to whether such an option is feasible or not to be made.

Furthermore, the demands assigned straight from CITEware did not take into consideration any of the effects of peak spreading. Nor were any internalisation factors applied. Thus, the initial test conditions were robust.

5.2 Process

As mentioned previously, the current methodology does not allow for any reassignment of routes away from the M40 area in response to increased congestion, nor does it account for an increased draw of traffic in response to the implementation of a successful mitigation strategy.

An overview of the assessment process is presented within Figure 12 on the following page.

Using output demands from CITEware provides a worst case scenario. Testing the mitigation within this environment provides a robust basis for the assessment of development impact and effectiveness of mitigation proposals. It is important to ensure that any schemes that do come forward are designed to accommodate realistic levels of demand, particularly if the initial test demands are unlikely to be realised. Demands and mitigation were added to the 2028 WLWA model to create the initial Southern Focus option model, thus ensuring that reassignment onto the wider network was possible. The wider impacts of the demand allocation were then assessed alongside the performance of the schemes within the M40 Europa Way area allowing for the potential for reassignment of routes.

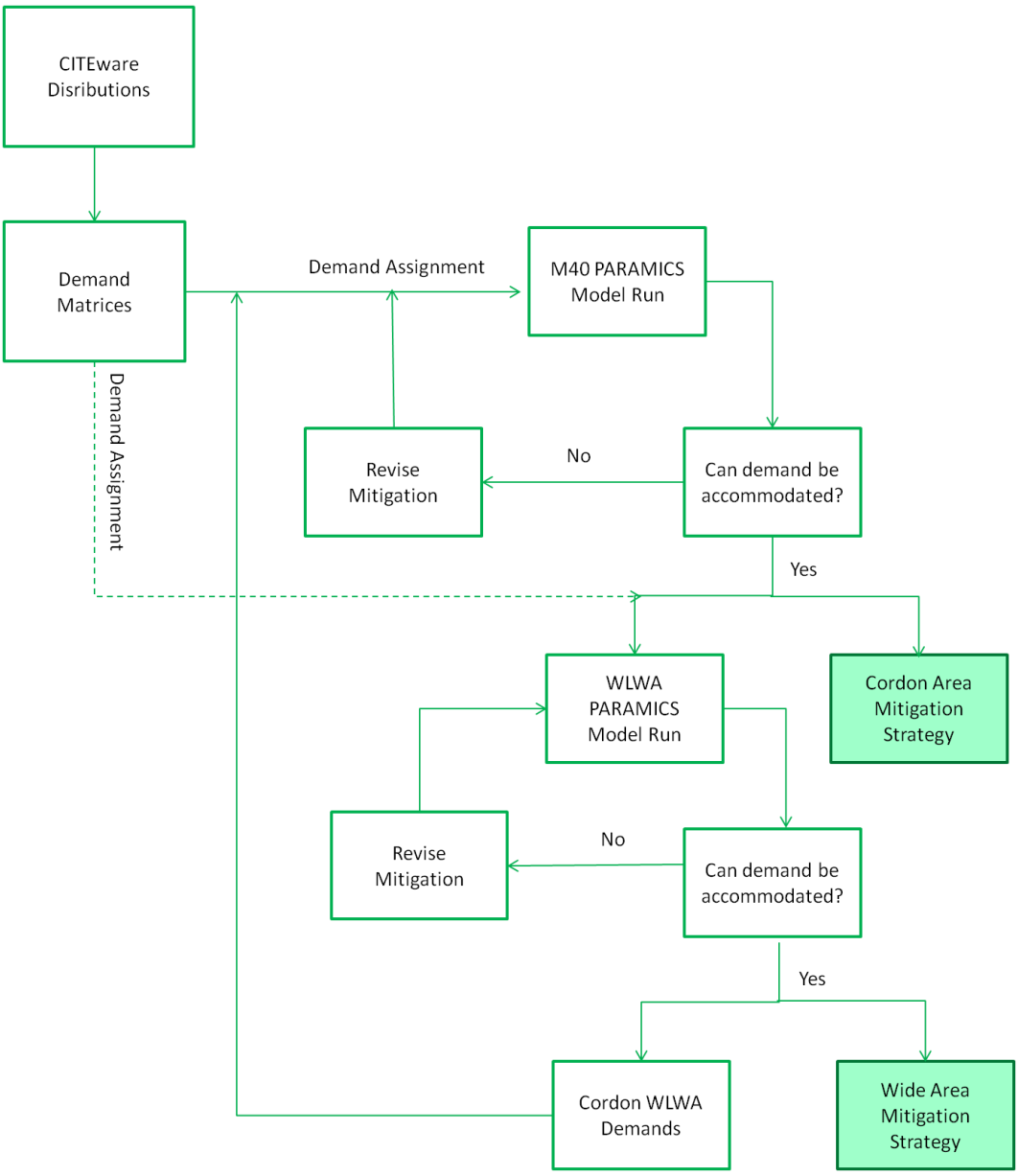
By testing first with the output demands from CITEware the assessment is looking at a worst case scenario. By testing the mitigation within this environment it

[5] MID3410-N001 Distribution and Matrix Generation in CITEware, JMP Consultants, 21/12/2012

provides a robust basis for the assessment of the impact of the implementation of the scheme. It is, however, important to ensure that any schemes that do come forward are designed to accommodate realistic levels of demand. Particularly if the initial test demands are unlikely to be realised. To ensure that this was the case the mitigation was then added to the 2028 WLWA model to create the initial Southern Focus option model. The wider impacts of the demand allocation were then assessed alongside the performance of the schemes within the M40 Europa Way area allowing for the potential for reassignment of route.

Finally, once this scenario was completed the Core Strategy and Committed Developments demands for the cordon area were then extracted and fed back into the M40 model. The impact of the schemes was then reassessed using these demands to ensure everything still operated in a satisfactory manner. An overview of this methodology is presented within the following Figure 12:

Figure 12 - Threshold Testing Methodology



5.3 Extracted Demands

An overview of the different demand scenarios assigned within the M40 PARAMICS model are as follows:

- **2011 Baseline** – As per the 2011 calibrated and validated base model.
- **2028 Reference Case** – Forecast via TEMPRO as outlined within the M40 PARAMICS Model Development Report.
- **2028 Full CITEware Demand** – all development demand assigned within the model with no account of redistribution.
- **2028 Cordon Demands** – A cordon output of the CS and Com Dev demands extracted from the WLWA model which includes the full allocation of development but allows for the effects of route reassignment.

A summary of the resultant, peak hour demands allocated through this process is provided within the following Table 17:

Table 17 – M40 PARAMICS Model, Peak Hour Demand Summary

	08 to 09	17 to 18
2011 Base	18831	18336
2028 Reference (TEMPRO)	22462	22622
Growth from 2011	*16.17%*	*18.95%*
2028 Full CITEware	24281	24073
Growth from 2011	*22.45%*	*23.83%*
2028 WLWA Cordon	22292	22128
Growth from 2011	*15.53%*	*17.14%*

It is interesting to note that the demands allocated to the M40 model network as a result of cordoning trips from the WLWA model (including full SF allocation) is not too dissimilar to the overall growth levels predicted by TEMPRO analysis.

The primary difference between the two scenarios is that all of the growth in the cordon model will be focussed to the north of the model area, whilst in the Reference Case a more general approach to the allocation of growth has been undertaken.

5.4 Initial Findings

The purpose of the initial assessment was to establish network operation under the aforementioned high demand conditions.

The initial assessment was largely qualitative and was based on viewing the operation of the network and proposing mitigation to overcome any constraints that became apparent when reviewing the network in operation.

It was during this review that it was concluded that schemes were required at all of the junctions along Europa Way between the M40 and the Europa Way/Myton Road Roundabout.

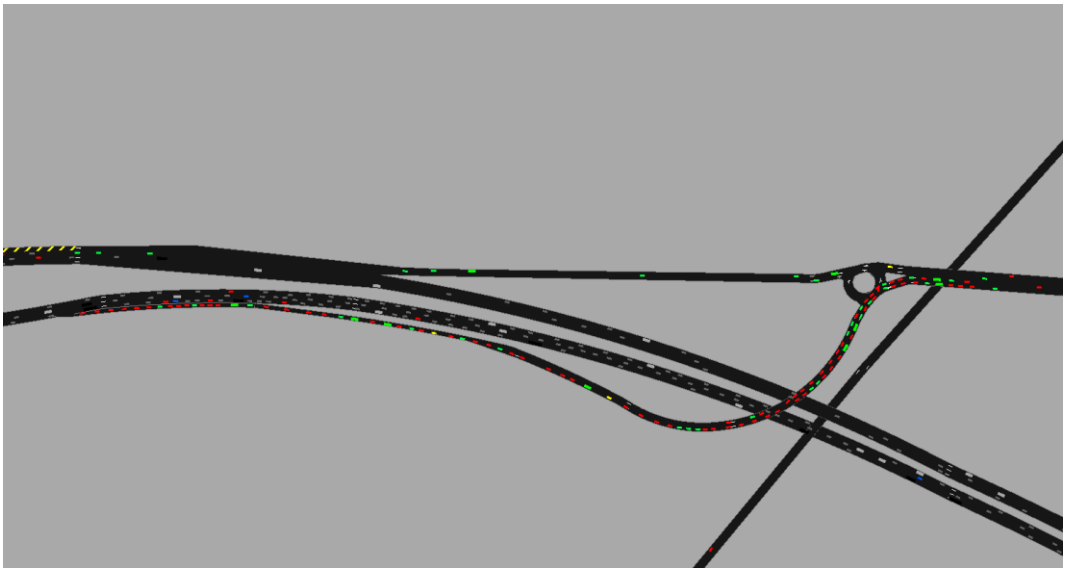
Additionally, a two lane section was also identified as necessary between the same junctions. Furthermore the proximity of one of the new access points to

Myton Gardens, just north of the Europa Way roundabout, needed to be removed as the NB demand was such that the link capacity was adversely affected to such an effect that the queue propagated back into the Europa Way roundabout. ***Further investigation into this is likely to be required should the decision be made to proceed with the southern focus option***

Once the mitigation had been determined and assigned within the model the AM peak hour network appeared to operate satisfactorily. A number of significant problems were still apparent in the form of heavy queues on all approaches to the Foundry Roundabout. During the PM period these problems became even more severe and queuing was observed to extend back from the Park Drive/Princes Drive roundabout to the Europa Way roundabout.

Similarly problems appeared to manifest at the SB merge onto the M40 during the PM period due to the high volume of trips trying to merge onto the M40. Figure 13 illustrates the conditions from a snap shot of the model running.

Figure 13 - Queuing at M40 Junction 14



Whilst there was potential for further optimisation of the signalisation schemes at both the Myton/Europa Way and Shires Retail Park junctions it was first felt necessary to determine how realistic these issues were in the context of the wider model. This is partly because some trips may reassign south in response to the inclusion of managed motorways, whilst some trips which are currently travelling northbound along Princess Drive may reassign northbound along Myton Road due to the new Myton Road/Banbury Road roundabout and improved capacity in that area. Finally some trips may elect to avoid the area altogether due to the effects of congestion in both Warwick and Leamington town centre. These are effects which are not accounted for within the M40 cordon model.

Despite the apparent problems on the network, it was concluded that the delivery of a high level of growth scenario with a southern focus was likely to be feasible and a mitigation strategy could potentially be identified. As a result the decision was made to proceed with the testing in the wider area.

6 Results Analysis

6.1 Overview

The following sections of the report are intended to present the results obtained from the detailed testing undertaken with both the WLWA and M40 models.

A tiered assessment has been adopted Results analysis is still focussed on a strategic level assessment at this stage. Undertaking a more detailed level of assessment should only be considered when there is sufficient confidence that the mitigation being proposed has been fully optimised. Furthermore, variations in the options (i.e. SF or PO, with/without NRR and C&WG) mean that a detailed level of analysis would be impossible at this stage. Further detailed impact analysis should be undertaken once the number of options has been reduced.

6.2 Model Stability

Due to the deterministic nature of assignment within PARAMICS it is possible for vehicles to continue to attempt to enter a network even when congestion has reached such an extent that the network is effectively 'grid-locked'. In some cases the grid-lock can occur due to problems that will require mitigation, in other cases it can be something as simple as vehicles entering a mini-roundabout from all three approaches at exactly the same time.

When a model becomes grid-locked vehicles still continue to be assigned to the network and so delay begins to increase exponentially. It should be acknowledged that these issues may be occurring due to a need for mitigation in one or more areas of the model but, if the models do not lock up every time it can be concluded that the problem is not severe enough to cause the network to cease to function. Furthermore, the fact that some model runs are completed without mitigation indicates that a mitigation strategy can only provide additional improvements and should be deliverable.. If it is model error causing the issues then these results should also be discounted due to the fact that they cannot be considered realistic.

It should also be acknowledged that experience gained elsewhere in the application of PARAMICS micro simulation modelling, in projects of a similar size, has highlighted that the level of instability within the models is frequently improves as the options are looked at in more detailed. Part of the detailed assessment stage is to look more closely at the impacts of any one option and frequently, at this stage, the cause of the grid-lock can be understood and, if necessary, mitigated.

Ten model runs were initially undertaken, where model stability has been particularly poor, the propensity for a model to lock up (and thus to be considered to have failed, is assessed to allow the reliability of the model network across the various scenarios to be better understood.

Additional runs were then collected to ensure model outputs were based on a minimum of ten runs per time period.

6.3 Network Wide Statistics

A number of statistics used in the analysis have been obtained from analysing each individual trip that has occurred within the network. This information is collected within PARAMICS through the Trips-all file and contains information specific to each individual trip that has been completed within the model period. This information is then aggregated and processed to provide the following comparative statistics:

- **Average Distance (Km)** – The average distance travelled by a vehicle that completed their journey during the model simulation period.
- **Average Time (seconds)** – The average travel time of a completed trip during the model simulation period.
- **Average Speed (Km/h)** – The average speed travelled by all vehicles that completed a journey during the model simulation period.
- **Completed Trips (vehicles)** – The number of completed trips recorded during the model simulation.

The first three measurements are averages so can be used to compare between the various scenarios. The final measurement is an absolute and is dependent on congestion on the network (as this will prevent trips from completing) and the demand within the model (i.e. the number of trips actually trying to complete). As demand differs between scenarios, as well as small variations between runs of the same scenario, we cannot expect the number of completed trips to be the same. However, as the demands do not differ significantly it can still provide an indication of the relative congestion on each network.

The use of these statistics is in line with the methodology adopted during the previous Strategic Transport Assessment work.

6.4 Mean Speed Analysis

In order that an overview of the network performance can be obtained, mean speed plots for each option network have been produced.

One of the primary purposes of this stage of testing is to identify areas of the network that are either performing poorly or may require additional interventions to enable the respective growth strategy to be realised.

By using mean speed as a measure, areas that are classified as coming under stress can be determined as being either those which suffer low average speeds or those that experience a significant drop in the average speed when compared to the Reference Case conditions.

It should be noted that a reduction in mean speed does not always result in a worsening of conditions as vehicles may be slower moving but the management system may be such that throughput increases and correspondingly, queuing may be reduced. Similarly, a reduction in mean speed across a single band may not be as drastic as appears, it may imply a reduction from 20.1 mph to 19.9 mph rather than spanning the entire range of speed (i.e. 25mph to 15 mph).

The purpose of the mean speed analysis is to identify areas of the network where speeds are predicted to drop when compared to the 2028 Reference Conditions.

This analysis should be undertaken in unison with the analysis of changes in other network conditions (queuing, throughput, flow, etc) to allow a more thorough picture of the overall affects to be obtained.

Mean speed plots have been produced for all model scenarios and have been presented within **Appendix E** of this report.

6.5 Queue Lengths

A second, more detailed, level of analysis has been undertaken in the form of queue length analysis. Queue length analysis is intended to accompany the mean speed analysis as it provides a more detailed picture of the impacts at specific junctions within the model network.

At this stage the analysis of queue lengths has been based on the average hourly maximum queue length. Results presented for each junction are based on the worst performing single approach. The hourly maximum for each individual model run has been calculated and then the average of all runs has been calculated for each hour. The maximum of these values, across all hours, is reported as the maximum periodic average maximum queue length and is reported in vehicles.

The junctions for which average hourly maximum queue lengths have been calculated and compared are illustrated within Figure 14 on the following page. Junctions where queue differences have not been plotted on the maps simply represent junctions which did not trigger any of the assessment criteria across any one approach.

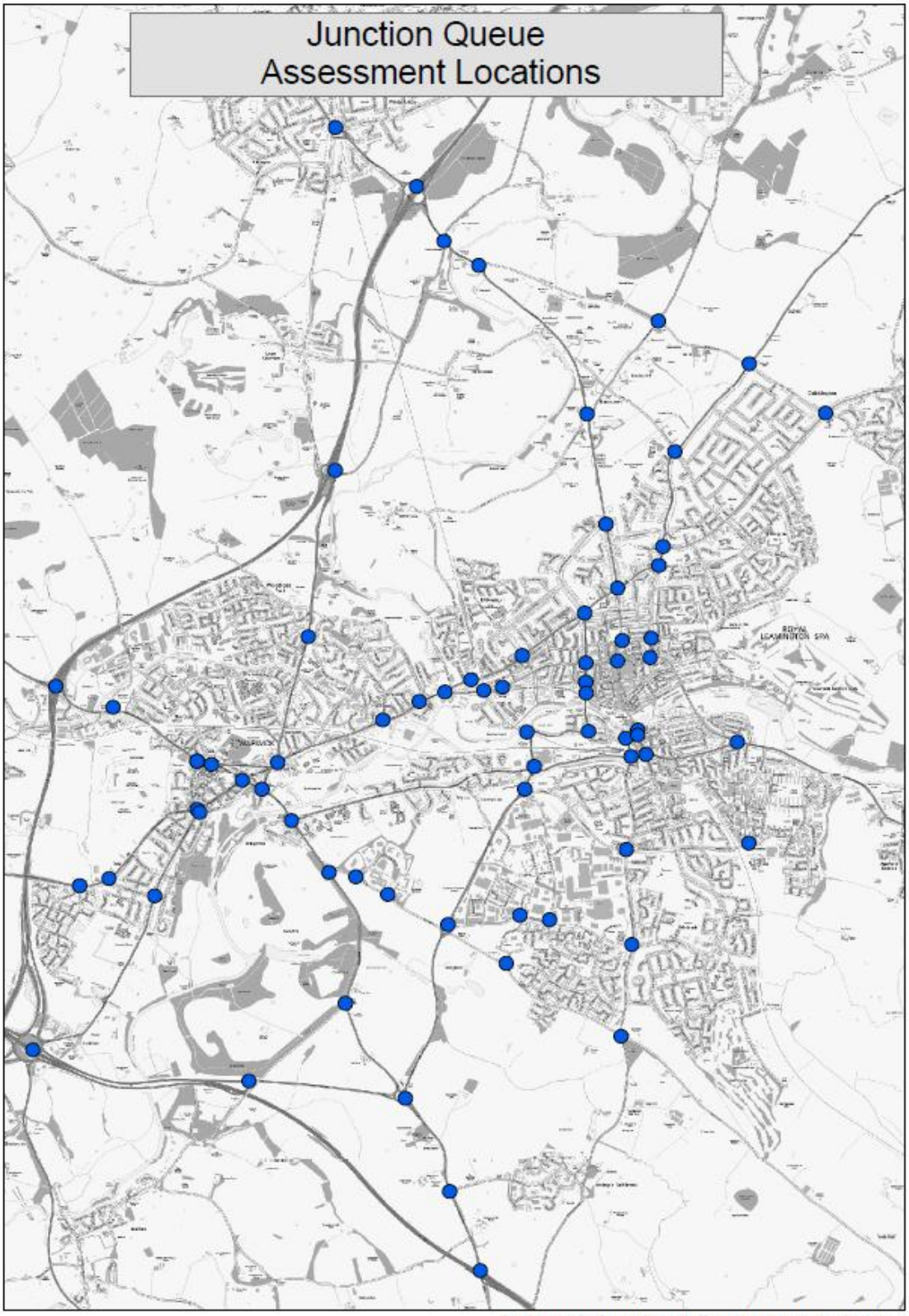
Queue difference plots have been produced for all model scenarios and have been presented within **Appendix F** of this report.

At this stage these results simply identify areas where further attention is required. A queue length increase of 50 vehicles does not necessarily mean that a scheme will not work, it may indicate that further optimisation of the layout or any signal times are required. Furthermore it may not account for improvements on other arms of the same junction which, when investigated further, may contain additional capacity which could be unlocked to reduce the queue length on the offending approach.

The classification of differences used within the queue length analysis is outlined as follows:

- **Queue Reduction** (a reduction in queue lengths of greater than 5 vehicles)
- **Moderate Increase** (an increase in queue lengths of between 15 and 30 vehicles)
- **Severe Increase** (an increase in queue lengths of between 30 and 50 vehicles)
- **Very Severe Increase** (an increase in queue length of over 50 vehicles)

Figure 14 - Queue Assessment, Junction Locations



7 Wide Area Testing Stage 1 Assessment

7.1 2028 SF & PO Results Analysis

The first stage of the assessment was to review the performance of the SF and PO in comparison to the existing 2028 Reference Network. The following section provides an overview of the relative impacts of each option.

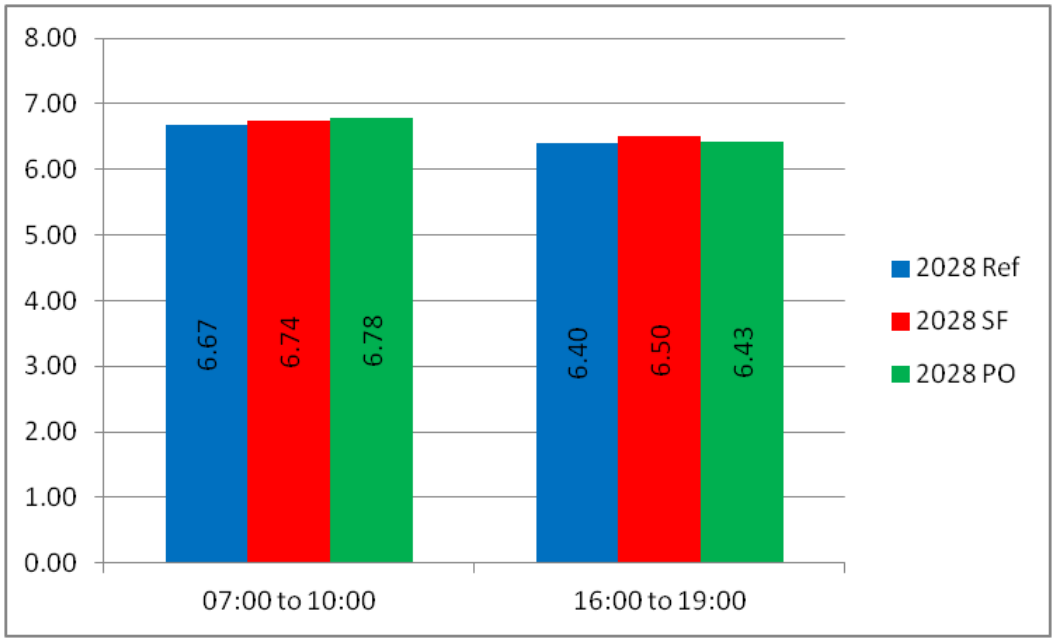
7.2 Network Wide Statistics

The following sets out the changes in network wide statistics between the 2028 Reference Case and SF and PO test models:

7.2.1 Average Journey distance

Analysis of the average journey distance within each scenario, across the entire AM and PM model periods, is presented within the following Figure 15:

Figure 15 - Average Journey Distance (2028 Ref vs. SF vs. PO), Km



Analysis of the Figure 15 indicates that there is very little difference between the three scenarios. An increase in the distance travelled may indicate an increase in the number of longer distance trips occurring within an option, or it may indicate an increased propensity for vehicles to reassign along longer routes in response to congestion.

A small increase in the distance travelled is always going to be likely due to the need to locate development on the periphery of the existing town network since that is where the available land is located.

7.2.2 Average Journey Speed

Analysis of the average journey speed (km/h) within each scenario, across the entire AM and PM model periods, is presented within the following Figure 16:

Figure 16 - Average Journey Speed (2028 Ref vs. SF vs. PO), Km/h

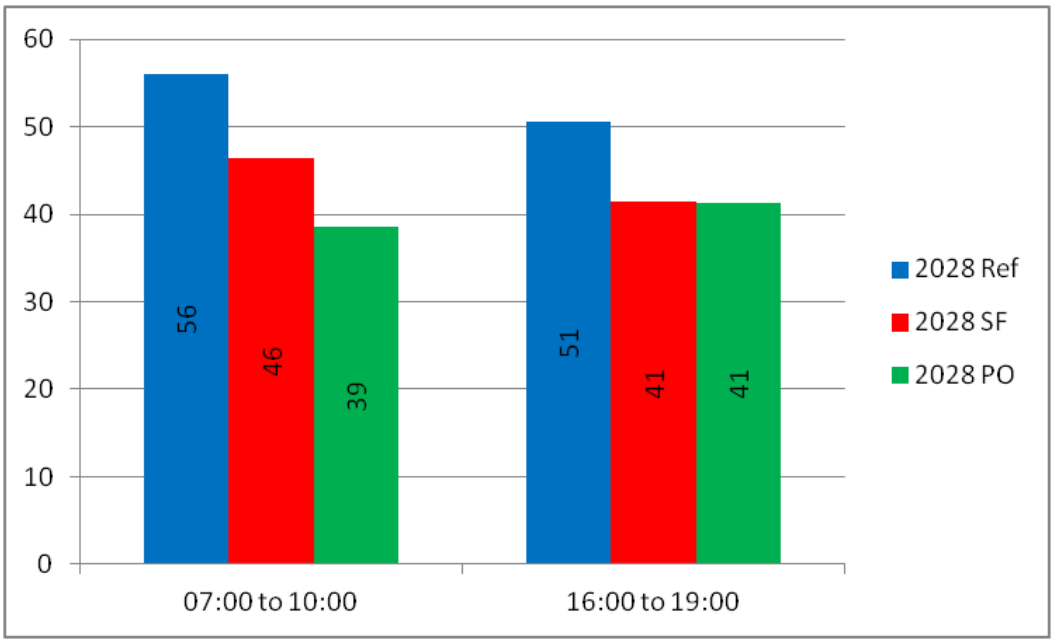


Figure 16 illustrates that there is likely to be a drop in overall speeds within the area when comparing either option to the Reference Case. With regards the relative performance of each option, analysis of the PM period indicates that there is little difference between either the SF or PO options during that period.

Within the AM model period, lower average speeds are experienced within the PO network when compared to the SF network. This is likely to indicate a greater level of congestion and queuing in the AM PO network when compared to the AM SF network. Further analysis is required to identify the possible reasons for this drop in average speed.

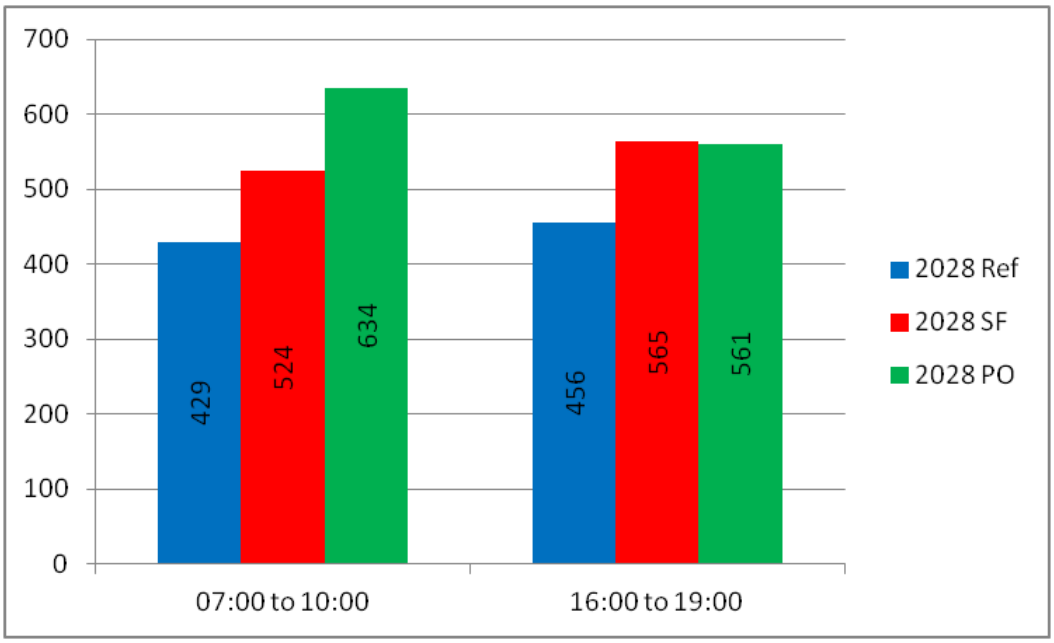
7.2.3 Average Journey Time (s)

Analysis of the average journey distance within each scenario, across the entire AM and PM model periods, is presented within Figure 17 on the following page.

Analysis of the difference in average journey time across the three scenarios indicates that both PO and SF scenarios will, experience an increase in the time it takes to complete a journey when compared to the 2028 Reference Case conditions. A significant amount of these increases will be incurred as a result of the additional demand that has been assigned across the network.

An incremental increase in delay is likely to be experienced as a result of these additional vehicles being added on to an already congested network. In some areas mitigation has been introduced to minimise these impacts and it is entirely possible that conditions in some areas will improve as a result.

Figure 17 - Average Journey Time (2028 Ref vs. SF vs. PO), Seconds



The overall picture is that the levels of delay experienced by vehicles on the network will increase across both SF and PO options. As with the average speed analysis, the fact that delay is higher within the PO AM network compared to the SF AM network indicates that the PO network is not performing as well as the SF network.

7.2.4 Completed Trips

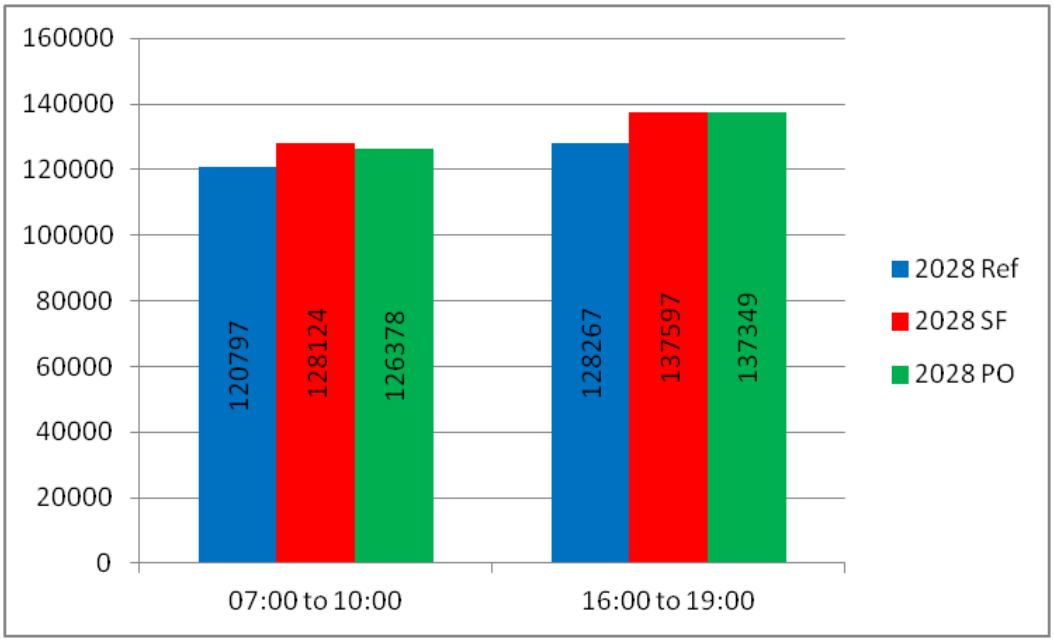
Analysis of the total number of completed trips within each scenario, across the entire AM and PM model periods, is presented within Figure 18 on the following page.

Analysis of Figure 18 indicates that there is an increase in completed trips of between 5 and 7%, in the AM and PM periods respectively, across both the SF and PO options when compared to the 2028 Reference Case.

Notably, the level of demand assigned across the demand within the SF and PO options is around 5% higher in the AM and 6% higher in the PM. This indicates that the SF and PO options, when the mitigation is assigned to the network, are able to accommodate the additional demand created by the respective allocations.

Because of the need for a cut off period it is never possible that 100% of the demand assigned within the model network will be a completed trip by the end of the model period. Some trips will have only just started when the model ends whilst some may be released onto the network later due to congestion effects.

Figure 18 - Completed Trips (2028 Ref vs. SF vs. PO), Vehicles



To understand how much demand is either unreleased or left on the network at the end of the simulation period the number of completed trips has been compared against the total demand levels assigned within the model. This information has been presented within the following Table 18:

Table 18 Completed Trips Analysis (2028 Ref vs. SF vs. PO)

	AM (07:00 to 10:00)			PM (16:00 to 19:00)		
	Demand	**Completed Trips**	**Completed %**	**Demand**	**Completed Trips**	**Completed %**
2028 Ref	127811	120797	94.5%	137249	128267	93.5%
2028 SF	134431	128124	95.3%	145856	137597	94.3%
2028 PO	134431	126378	94.0%	145857	137349	94.2%

Table 18 illustrates that, as a proportion of the demand assigned, the number of trips that are completed during the PM model period, increases across both the SF and PO options. During the AM model period there is an increase in the SF only.

This indicates that, despite the increase in demand, the number of trips that are completed compared to the total number of assigned trips within the model period, increases. This indicates that the mitigation measures are increasing the overall throughput of the network.

7.3 Mean Speed Analysis

The following sets out some initial observations of the mean speed plots for the three key model scenarios; 2028 Reference Case, 2028 Preferred Option and 2028 Southern Focus. The comments below are based on observations of the predicted changes in mean speed across links within the model area.

The maps which are referred to within the following analysis are presented within **Appendix E** of this report.

7.3.1 2028 Reference Conditions (MS001 to MS004)

Analysis of the AM network conditions within the reference case reveals that both Warwick and Leamington town centres suffer from increased congestion. Low speeds are observed along Park Drive, Princes Drive and Emscote Road, particularly in the vicinity of Greville Road. Low speeds are also present along the Harbury Lane and Heathcote Lane approaches to Europa Way Roundabout.

Within the PM period, conditions along Park Drive, Princes Drive and Emscote Road appear to worsen. The speeds along the Myton Road and Old Warwick Road approaches to the roundabout with Europa Way are low as are those on the links approaching the Bath Street/High Street area of south Leamington. The speeds on areas of Tachbrook Road and Banbury Road (south of Warwick) also appear to drop below 15 mph. Tachbrook Road is particularly effected in the regions near Harbury Lane and Shires Retail Park whilst Banbury Road speeds are lower on the section near St Nicholas Park.

7.3.2 2028 Preferred Option Conditions (MS005 to MS008)

Analysis of the AM period network conditions within the Preferred Option network reveals that, again, both Warwick and Leamington town centres suffer from the effects of congestion. The number of links within Leamington where speeds have dropped below 15 mph has increased significantly when compared to the 2028 Reference Case conditions. Low speeds are observed along Park Drive, Princes Drive and Emscote Road, in this instance the low speeds seem to propagate between the Emscote/Greville Road junction and the High Street Bath Street area of Leamington. Of particular concern, however, is the high numbers of links within Warwick town centre where speeds have dropped to as little as 5 mph. Low speeds appear to propagate back from the town centre along all arterial routes indicating that congestion within the town centre is likely to be severe and the impacts wide ranging. Low speeds are also present along the Harbury and Heathcote Lane approaches to Europa Way Roundabout. Speeds along the motorway have dropped to below 40mph on the sections of the M40 between J14 and J15.

Within the PM conditions along Park Drive and Princes Drive appear to have improved compared to the AM. NB speeds along Emscote Road appear to have worsened. The speeds along the Myton Road approaches to the roundabout with Europa Way are lower than those reported in the Reference Case but the speeds along Old Warwick Road have increased. Speeds travelling NB along Europa Way towards Shire's retail park are generally lower. Congestion around the area of Warwick town centre is not as severe as the AM PO and not too dissimilar from the Reference conditions, generally there appears to be reductions in speeds on links coming in from Banbury Road, Coventry Road, Coten end and Saltisford. Conditions on West Street and Hampton Road appear largely unchanged.

7.3.3 2028 Southern Focus Conditions (MS009 to MS012)

Analysis of the AM SF network conditions reveals that, again, both Warwick and Leamington town centres suffer from the effects of congestion. The number of links within Leamington where speeds have dropped below 15 mph has not increased to the same degree as has been observed when comparing the Preferred Option network to the 2028 Reference Conditions. The speeds along the Park

Drive, Princes Drive and Emscote Road corridor have dropped but the numbers of instances were speeds drop below 5 mph are limited. Notably, low speeds appear to be present in the areas of the Emscote Road/Charles St and Emscote Road/All Saints Road junctions. Speeds have also dropped considerably on links approaching Warwick from the South although speeds are not as low and do not propagate as far south as was observed within the Preferred Option network. Speeds along the M40 do not appear to have dropped within the Southern Focus scenario; this illustrates the effect of the "Managed Motorways" in operation.

Within the PM period, conditions along Princes Drive appear to have improved. NB speeds along Emscote Road appear to have worsened on the approach to Greville Road. Speeds within the Bath Street/High Street area of Leamington are lower than those present within the Reference Case. Speeds along Europa Way NB, particularly on the approach to Shires Roundabout have dropped to between 0-5 mph on the approach to the new signals. Speeds around Europa Way roundabout have dropped when compared to the Reference Case conditions. Speeds along the Europa Way Corridor SB between Europa Way roundabout and the M40 appear relatively unchanged. The speeds along the M40 are also unaffected although speeds on some approaches of Longbride Roundabout have dropped; optimisation of the signals would reduce these impacts.

7.3.4 Mean Speed Analysis - Summary

Analysis of the reference network plots reveals that, during the AM, Warwick town centre is already likely to suffer from low average speeds. The same situation is likely to occur within the PM, low speeds are also present, during the PM peak, around the Myton Road, Princes Drive to Warwick New Road, Emscote Road corridor. In Leamington, low speeds are also present around the Bath Street/High Street area.

Analysis of the PO mean speeds indicates a general worsening of conditions across the wider area. The low speeds around the Myton Road, Princes Drive to Warwick New Road, Emscote Road corridor and the Bath Street/High Street area of Leamington Spa are now present in both AM and PM periods. In the AM the area to the South East of Warwick town centre suffers from a drop in average speeds, when compared to the reference case from between 25 to 40 mph to as little as less than 5mph. Problems have materialised around Longbridge Island (M40 Junction 15) and Europa Way roundabout. During the PM the network operation appears to improve when compared to the AM conditions. The low speeds around Warwick town centre still propagate back further than they do within the Reference Case and although the speeds on Princess Drive and Warwick New Road appear to have improved, speeds have dropped on Europa Way NB through the junctions with Myton Road and Shires Retail Park. Speeds have also dropped on the approach to Warwick from the south west propagating back from Castle Hill to the Gallows Hill Banbury Road junction. Speeds on the M40 WB mainline have dropped considerably in the PO PM network assessment and, at certain points, the average speed drops below 15 mph which is indicative of problems on the motorway and indicates the need for managed motorways or some other as yet undetermined mitigation strategy for this area of the network

Analysis of the SF mean speed plots indicates a general worsening of conditions across the network. Speeds around Warwick town centre have lowered when compared to the Reference Case but, when compared to the PO the speeds are not

as low on as many links and the lower speeds do not propagate back to the same extent. The low speeds around the Myton Road, Princes Drive to Warwick New Road, Emscote Road corridor and the Bath Street/High Street area of Leamington are present in both AM and PM periods although they do not appear to propagate as far south as in the PO. The A429 NB approach to Longbridge Island is also affected within the AM period. Within the PM there is little difference in the SF network performance when compared to the PO network. The speeds on Europa Way NB appear to have dropped for longer sections in the SF option when compared to the PO and there also appears to be problems in the Heathcote Lane, Tachbrook Road, and Harbury Lane area of the SF network when compared to the PO.

In summary:

- Both options result in a general lowering of speeds in certain areas when compared to the 2028 Reference Case.
- Speeds approaching Warwick town centre from the South East are lower in the PO than the SF option during the AM peak hour.
- Low speeds along the Europa Way NB corridor between Europa Way roundabout and Princes Drive are present in both options, particularly during the PM peak.
- The speeds along the M40 WB mainline drop during the PO assessment.
- Speeds on the approaches to Longbridge Island drop in the SF option.
- The most significant difference between the two options is the network performance around Warwick town centre and on the arterial approaches into Warwick town centre, during the AM peak hour. In particular speeds appear considerably lower during the AM peak hour when reviewing the PO network operation in comparison to the SF network operation.

It is most likely that the final point above is indicating that, to achieve higher average speeds and lower overall congestion, there is a need to implement the town centre mitigation strategy and possibly “managed motorways” a regardless of whether the PO or SF options are progressed.

7.4 Maximum Queue Length Analysis

The following sets out some initial observations based on the maximum queue length analysis and the differences in queue lengths between the 2028 Reference Case and the 2028 Preferred Option and 2028 Southern Focus.

The maps which are referred to within the following analysis are presented within **Appendix F** of this report.

7.4.1 2028 Preferred Option vs. 2028 Reference Case

AM Analysis (MQ001)

Analysis of the difference in queuing between the 2028 Reference and 2028 PO model networks, during the AM period, reveals the following:

- There are only a few instances of queue reduction and these tend to occur around the Leamington and A452 areas;

- A large proportion of impacts to the East and South East of Warwick town centre are very severe;
- Very severe increases manifest at the following junctions for which mitigation has already been proposed:
    - Blackdown Road Roundabout.
    - Shires Retail Park Roundabout.
    - Myton Road/Banbury Road roundabout.
- Moderate increases have appeared at the junctions along Gallows Hill.
- Effects along the Emscote Road corridor are mixed, some areas have improved (Emscote/Greville Road) whilst others have worsened significantly (A445/A442).

PM Analysis (MQ002)

Analysis of the difference in queuing between the 2028 Reference and 2028 PO model networks, during the PM period, reveals the following:

- The number of instances of very severe increases occurring, when compared to the AM network conditions, has reduced.
- There are consistent reductions in queuing around the junctions adjacent to Thickthorn Roundabout as well as in the Bath Street High Street area of Leamington Spa.
- The majority of junctions achieve either reductions or moderate increases in queuing levels when compared to the 2028 Reference Conditions.

Overall there are more instances of very severe increases occurring in the AM than the PM period. Junctions to the South and East of Warwick appear to suffer the greatest number of queue increases which corresponds with other analysis of this area.

Blackdown Roundabout suffers very severe increases across both time periods despite the inclusion of mitigation this indicates further investigation of the mitigation scheme in this area is required.

The Heathcote Lane/Tachbrook Road junction suffers very severe increases across both time periods indicating a likely need to focus mitigation in this area.

7.4.2 2028 Southern Focus vs. 2028 Reference Case

AM Analysis (MQ003)

Analysis of the difference in queuing between the 2028 Reference and 2028 SF model networks, during the AM period, reveals the following:

- There are a number queue reductions and these tend to be more widespread than the within the PO.
- Very Severe increases in queue lengths are experienced to the South East of Warwick although the number of instances has reduced when compared to the PO impacts.
- A large majority of the junctions experience either reductions or only moderate increases in queue levels when compared to the Reference Case.

- In almost all instances where junctions have been flagged to the North of Leamington Spa, around the A452, it is because of a reduction in queuing.

PM Analysis (MQ004)

Analysis of the difference in queuing between the 2028 Reference Case and 2028 SF model networks, during the PM period, reveals the following:

- Instances of very severe increases in queue lengths have reduced considerably during the PM period.
- The largest number of reductions in queue lengths is achieved within the SF PM network.
- There are only 5 instances of very severe increases in queue lengths:
  - 2 instances at M40 J15.
  - Heathcote Lane/Tachbrook Road
  - Shires Retail Park Roundabout
  - Emscote Road/Charles St.

Overall the number of instances of very severe increases reduces in the SF when compared to the PO network.

South east Warwick still suffers from very severe increases in queue lengths during the AM period and Longbridge also appears to consistently suffer very severe increases in queue lengths in both AM and PM model periods, when compared to the 2028 Reference network conditions.

Reductions in queue lengths are achieved across both the AM and PM model periods in a number of locations compared to the Reference Case. More reductions are achieved in the SF network than the PO network, when compared to the 2028 Reference Case.

7.4.3 Queue Analysis Summary

A summary of the findings obtained through comparing the changes in queuing between the 2028 Reference Case and the SF and PO model networks is provided as follows:

- Overall, during the AM period, when compared to the 2028 Reference Case conditions, the PO network suffers more very severe increase in queue lengths than the SF.
- The SF network also achieved a greater number of queue reductions than the PO network in both AM and PM model periods.
- Blackdown roundabout suffers severe or very severe increases in queue lengths across both scenarios and time periods indicating further investigation of the mitigation measures is required.
- Similarly, very severe increases in queue lengths are experienced at Heathcote Lane/Tachbrook Road junction across all but the SF AM scenario.
- Further work is required to mitigate the problems to the South and East of Warwick particularly when considering the impacts of the PO scenario.

- Shires Retail Park roundabout suffers very severe increases in all scenarios, indicating further investigation into the proposed mitigation measures is required for this junction.
- More reductions in queue lengths are achieved, compared to the 2028 Reference Case in the SF network than the PO network

7.5 Summary

Analysis of a series of measures has been undertaken in an attempt to understand the likely impacts of adopted either the SF or PO approach to the allocation of growth.

Analysis of the network wide statistics revealed that, compared to the 2028 Reference Case, delay is likely to increase and speeds are likely to reduce in both Options. Comparatively there is little difference between either option during the PM period but during the AM period delay is higher and speeds are lower within the PO network when compared to the SF network.

Analysis of the number of completed trips indicates that more trips, as a proportion of the total assigned demand, are completed in both PO and SF PM network conditions when compared to the Reference Case. More trips are completed in total across both scenarios and both time periods but the proportion of completed trips within the PO AM network, when compared to the reference case, actually reduces. With the exception of the PO AM conditions this demonstrates that the mitigation measures attributed to the respective options are able to accommodate increases in demand levels at a rate which is higher than the additional level of demand assigned within the PO and SF option. Thus, the networks are accommodating more trips than just those occurring as result of the PO and SF growth strategies.

Analysis of the mean speeds in the model networks reveals very few significant differences in the operation of the two networks. One of the more significant differences is the performance of the network to the South and East of Warwick. Whilst average speeds in this area, during the AM peak, appear to drop in the SF network, the extent to which they drop in the PO network is far more significant. Low speeds propagate back from Warwick town centre, during the AM peak hour, in all directions and these low speeds reach almost as far back as M40 J15 in the PO scenario.

Within the PO there are also problems on the M40 mainline which may indicate a need for the implementation of managed motorways in this area within the PO as well as the SF.

Within both options the average speeds along Europa Way NB in the vicinity of Shires Retail Park are considerably lower than in the Reference Case indicating a need to investigate the mitigation measures in this area further.

As with the Mean Speed analysis, the queuing analysis also indicates that the area to the South and East of Warwick Town centre suffers a greater number of very severe increases in queue length within the PO network than the SF network.

In general the SF network appears to unlock the greatest number of queue reductions across both the AM and PM periods. Furthermore the SF network, particularly the PM network, contains the least number of occasions where the queue increases can be categorised as very severe.

7.6 Conclusions

The initial comparisons between the 2028 SF and PO network performance reveals the following conclusions:

- Inclusion of either option will result in an increase in journey times and a reduction in average speeds experienced by all vehicles travelling within the network when compared to the 2028 Reference Conditions.

- There is little difference in performance of either network in the PM when considering the analysis of network wide statistics.

- That the SF network performs better than the PO network in the AM period.

- The areas where the PO performs poorly, in the AM analysis, are to the South and East of Warwick and around the M40, the SF option contains mitigation in both of these areas.

- That both options accommodated between 5 and 7% greater levels of demand than the reference case and, with the exception of the PO AM network performance, both options result in more trips being completed (as a ration of those released on the network) than is achieved within the 2028 Reference Case.

- Both options have the potential to improve queuing conditions in certain areas despite the additional demand being assigned to the network.

- Some areas consistently identified as requiring further attention irrespective of the option assessed (although the severity of the impacts can change). These are:
    - M40 Junction 15
    - Europa Way NB in the area of Shires Retail Park roundabout
    - South and East of Warwick Town Centre
    - A452/Stoneleigh Road roundabout
    - Heathcote Lane/Tachbrook Road junction

It is recommended that when Core Strategy sites are decided, the first stage of the additional testing should focus on either additional mitigation or revisions to existing mitigation, in the areas outlined above.

It is not possible, based on the aforementioned points, to conclude that one option performs significantly better than the other. There is a clear case for the Warwick Town Centre improvements to be included in the PO network and further investigation is required to ascertain the necessity of implementing managed motorways alongside the approach to growth allocation outlined within the PO.

8 Wide Area Stage 2 Assessment (C&WG)

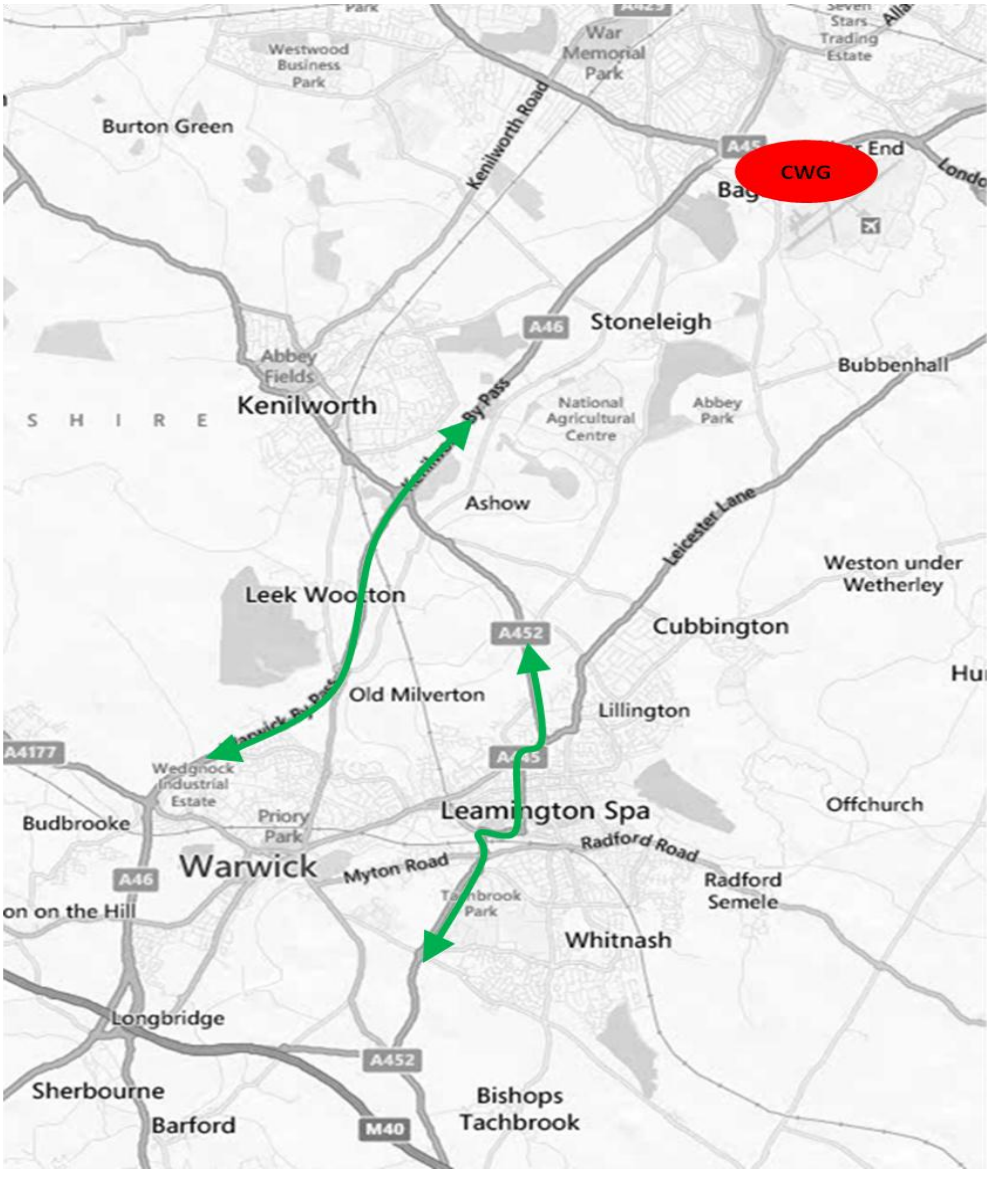
8.1 Coventry and Warwickshire Gateway

The second stage of the assessment reviewed the effects of allowing an additional draw of traffic towards the Coventry and Warwickshire Gateway (C&WG) on the performance of the respective options.

C&WG is a significant development to be located just south of Coventry near the Toll Bar End junction. It is estimated to be likely to create up to an additional 10,000 jobs for the area and so it was felt that the potential for this site to draw development traffic away from Warwick and Leamington should be tested.

The location of C&WG relative to Warwick and Leamington is presented within the following Figure 19:

Figure 19- C&WG Location



Within the SF and PO networks the trip generation remains relatively unchanged it is the distribution of the sites which changes in response to the new development to the north. The distribution was extracted from CITEware and the option test matrices reproduced to encapsulate this effect.

8.2 C&WG Impact Analysis

The following section provides an overview of the relative impacts of each option when C&WG is included within the network. It should be noted that the impacts that are reported as a result of this assessment relate to changes in the distribution of the trips associated with the allocated sites in response to the inclusion of C&WG. Additional trip generation for the C&WG site has not been included within the model scenarios to ensure that any impacts or changes in these scenarios, when compared to the original PO and SF test scenarios, are directly attributable to the SF & PO allocations and not affected by the inclusion of additional trip generation over and above the original demand levels assigned within the model.

8.3 Model Stability

Initial analysis of the model runs indicated that the inclusion of the C&WG into the model network resulted in a substantial drop in the stability of the model during the AM period. Of the initial 10 runs collected 7 failed, this is likely indicative of more serious problems than just model error.

The overall model stability outputs obtained from the initial set of 10 runs is presented within the following Table 19:

Table 19 Model Stability Outputs

Scenario	2028 Ref	2028 PO	2028 PO + CWG	2028 SF	2028 SF + CWG
AM (07:00 to 10:00)					
Number of Runs	10	10	10	10	10
Number of Failed Runs	0	3	7	3	1
Success Rate	100.00%	70.00%	**30.00%**	70.00%	90.00%
PM (16:00 to 19:00)					
Number of Runs	10	10	10	10	10
Number of Failed Runs	0	4	4	1	3
Success Rate	100.00%	60.00%	60.00%	90.00%	70.00%

The previous table demonstrates that in all but one case, model stability does not drop below 60% in any one option, the exception is the 2028 PO + CWG AM network. this should be considered as an early indicator that further work is likely to be required to ensure network operation is maintained at a satisfactory level within this scenario.

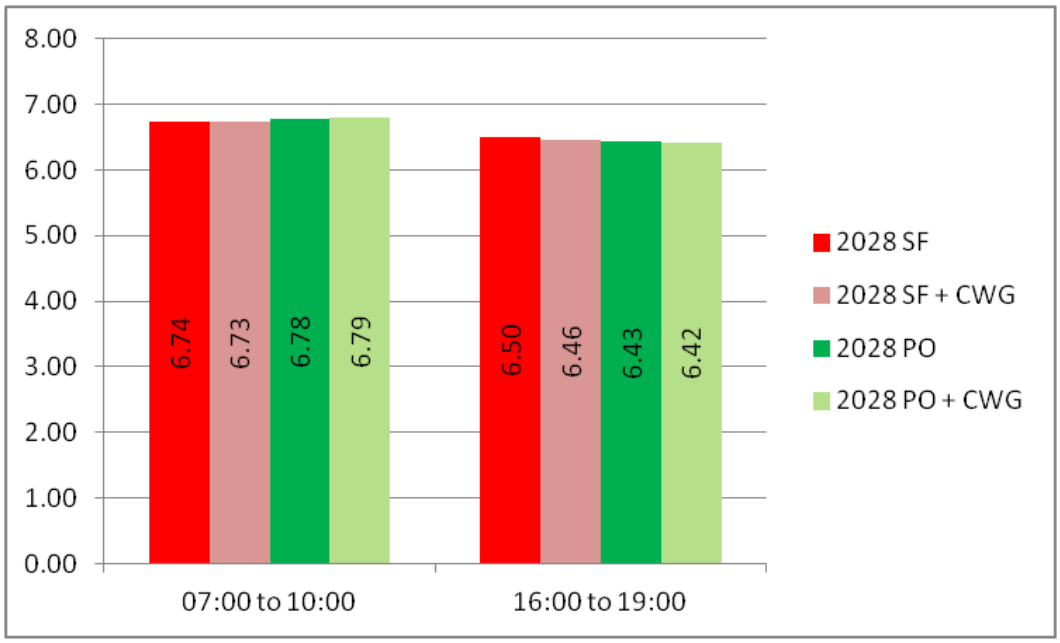
8.4 Network Wide Statistics

The following sets out the changes in network wide statistics between the 2028 SF and PO option test models with and without C&WG included.

8.4.1 Average Journey distance

Analysis of the average journey distance within each scenario, across the entire AM and PM model periods, is presented within the following Figure 20:

Figure 20 - Average Journey Distance (2028 SF vs. SF+CWG vs. PO vs. PO+CWG), Km



Analysis of the previous figure indicates that the inclusion of the C&WG development is unlikely to have any impact on the distance vehicles travel within the model network.

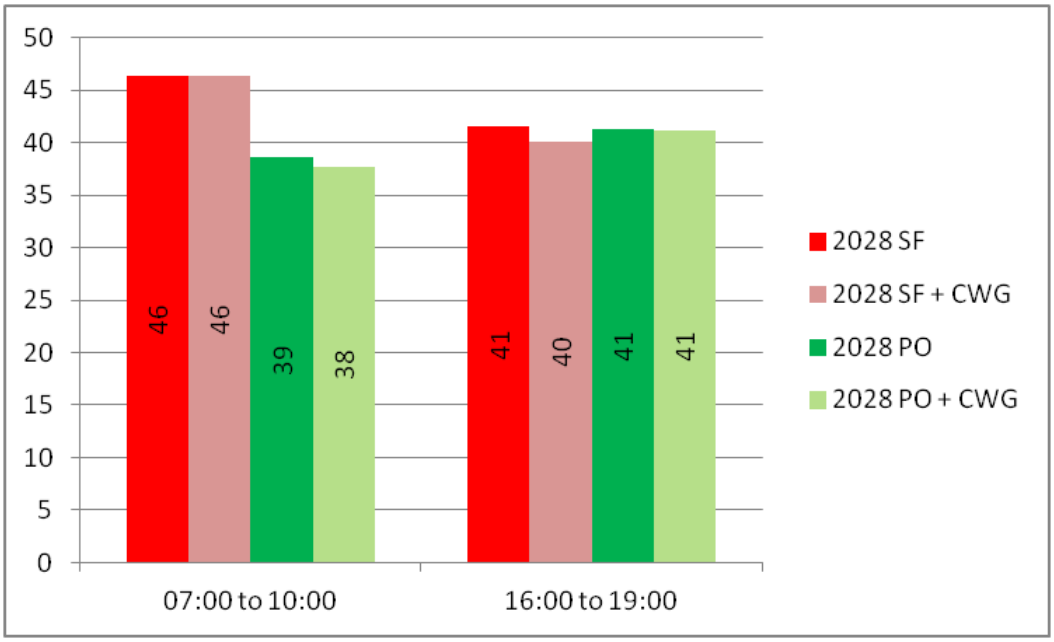
It should be noted that the network extent is only to Thickthorn roundabout and so the distance a vehicle travels is only measured to this point, it is possible that, if the wider Warwickshire transport network were included within the assessment, there would be a minor increase in journey distance due to the draw of traffic north.

However, without this additional network it is impossible to quantify the additional distances that are likely to be travelled. It can however, be concluded, based on the previous figure, that the inclusion of C&WG does not materially affect the wider assignment of route choice within the network.

8.4.2 Average Journey Speed

Analysis of the average journey speed (km/h) within each scenario, across the entire AM and PM model periods, is presented within the following Figure 21:

Figure 21 - Average Journey Speed (2028 SF vs. SF+CWG vs. PO vs. PO+CWG), Km/h

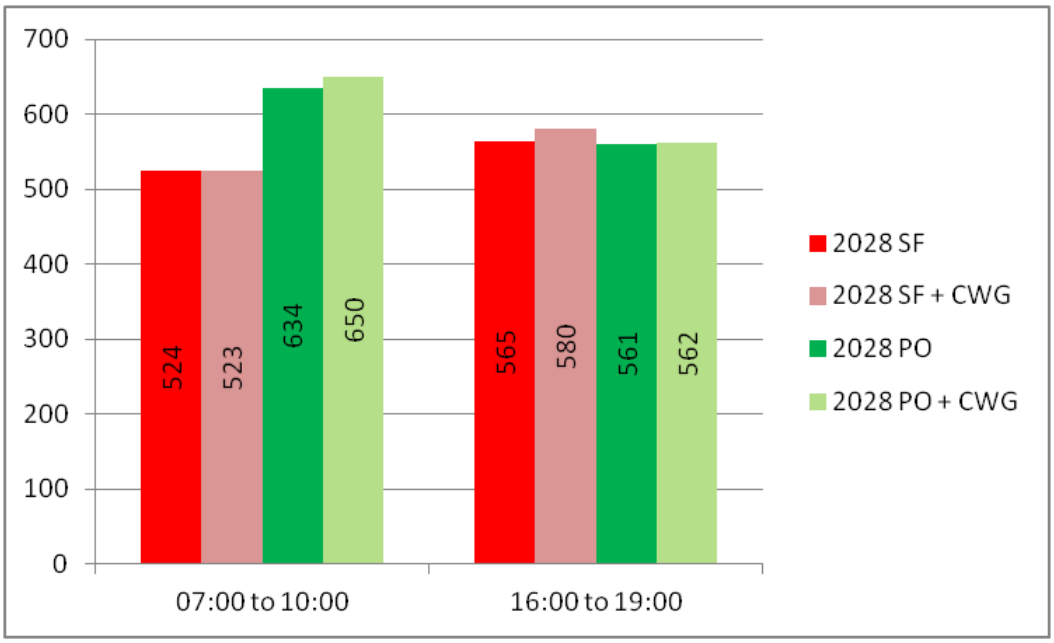


Analysis of Figure 21 indicates that there is little difference in the average speeds between the respective scenarios when C&WG is included. Within the PO network, indications are that the average speed will drop slightly in the AM and there will be little or no change in the PM. Within the SF network indications are that the average speed will remain unchanged during the AM model period but within the PM model period there is potential for a slight drop in speeds when C&WG is added to the network.

8.4.3 Average Journey Time (s)

Analysis of the average journey distance within each scenario, across the entire AM and PM model periods, is presented within Figure 22 on the following page. Analysis of Figure 22 reveals that there is an increase in the delay experienced within the PO network when C&WG is added in the AM model period whilst the SF network suffers an increase in delay across the PM period under the same conditions.

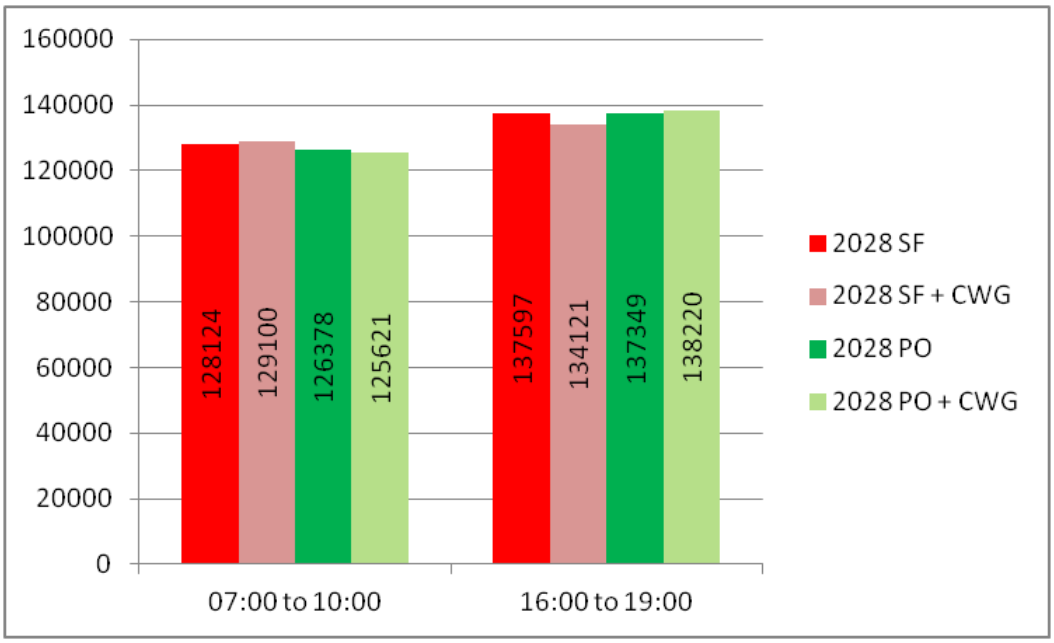
Figure 22 - Average Journey Time (2028 SF vs. SF+CWG vs. PO vs. PO+CWG), Seconds



8.4.4 Completed Trips

Analysis of the total number of completed trips within each scenario, across the entire AM and PM model periods, is presented within the following Figure 23:

Figure 23 - Completed Trips (2028 SF vs. SF+CWG vs. PO vs. PO+CWG), Vehicles



A comparison of the number of completed trips against the total assigned demand has also been undertaken and the outcome from this comparison is presented within Table 20:

Table 20 Completed Trip Analysis (2028 SF + CWG vs. 2028 PO + CWG)

	AM (07:00 to 10:00)			PM (16:00 to 19:00)		
	Demand	**Completed Trips**	**Completed %**	**Demand**	**Completed Trips**	**Completed %**
2028 SF + CWG	134431	129100	96.0%	145856	134121	92.0%
2028 PO + CWG	134431	125621	93.5%	145857	137349	94.2%

Overall, when considering the AM network performance, the number of completed trips, as a proportion of demand, increases in the SF network when C&WG is included but reduces in the PO network. The drop in the PO represents a reduction in the rate of completion of around 0.5% when C&WG is included. In the SF network there is an increase in the completion rate of a similar magnitude. This indicates that the SF network, with its current mitigation, is better placed in the AM to accommodate the revised distribution and changes in trip patterns that occur as a result of the inclusion of C&WG.

During the PM, however, the rate of trip completion stays the same in the PO with C&WG as without C&WG. The SF network suffers a drop in the rate of completion of 1.5% when compared to the SF scenario without C&WG.

Issues with model stability indicate that the 2028 PO network, within the AM, is likely to require further mitigation to ensure a satisfactory level of network operation. When the network does operate satisfactorily there are smaller impacts on overall delay and the proportion of completed trips within the AM PO network performance, when C&WG is considered, than there are in the PM SF network under the same circumstances.

This could be indicative of the need to include one or two additional critical schemes in the PO network, when C&WG comes forward whilst there may be a need for a more general, further, optimisation of the SF network schemes.

8.4.5 Mean Speed Analysis

The following sets out some initial observations of the mean speed plots for the PO and SF model scenarios inclusive of C&WG. The comments below are based on observations in the predicted changes in mean speed across links within the model area.

The maps which are referred to within the following analysis are presented within **Appendix E** of this report.

8.4.6 2028 PO + C&WG Conditions (MS013 to MS016)

Analysis of the AM network performance, within the 2028 PO + C&WG model scenario reveals that there are very few changes in the north of the area when C&WG is considered within the assessment. Within the South, the propensity for the propagation of low average speeds back from the town centre to the South and East has increased further. Speeds along the Banbury Rd NB approach to Warwick town centre have also reduced. There also appears to be some additional pressure on Longbridge Island.

Analysis of the PM network performance reveals very little difference between the PO or the PO + C&WG network performance within the northern areas. Within the South, however, the low speeds along Europa Way NB appear to further reduce for longer sections of network in the PO + C&WG scenario when compared to the original PO scenario. A similar situation has also occurred along the Banbury Rd NB approach to Warwick town centre. It is likely that focussing mitigation in this area would further reduce the impact of the draw between C&WG and the allocated sites on the overall network performance.

8.4.7 2028 SF + C&WG Conditions (MS017to MS020)

Analysis of the AM network performance, within the 2028 SF + C&WG model scenario reveals that, when compared to the 2028 SF network performance, there are no obvious substantial changes in network operation when C&WG is included within the assessment.

When considering the changes in the PM it appears that the only notable difference between the two scenarios, 2028 SF vs. 2028 SF + C&WG is that speed drop along the Europa Way NB stretch between the Europa Way roundabout and the junction with Myton Road.

This further demonstrates that the impacts of the changes in distribution as a result of including the potential draw of C&WG within the assessment is more likely to be overcome by a more general optimisation of the proposed mitigation schemes rather than focussing in a number of specific locations. The exception to this is the Europa Way/Myton Road roundabout which demonstrates a worsening of condition when C&WG is included within both the PO and SF assessments. This particular junction is one that has already been highlighted as requiring further mitigation.

8.4.8 Mean Speed Analysis – Summary

Comparing the network mean speed plots between scenarios with and without C&WG reveals that in most cases there are very few additional impacts incurred as a result of the inclusion of the C&WG. The inclusion of C&WG in the PO assessment indicates that the low speeds on links to the South and East of Warwick town centre are likely to lower further or extend back for longer sections when compared to the performance of the network without C&WG. The initial indication is that, when C&WG is included within the PO assessment the draw of trips northwards increases. Without the inclusion of managed motorways the M40 routes is not attractive to all vehicles and so, as a result, additional pressure is placed on the links into Warwick Town Centre from the South.

During the SF assessment it would be expected that the same situation would occur, especially when considering the focus of growth is located to the south, it would be reasonable to assume that the problems demonstrated within the PO + C&WG would reoccur within the SF + C&WG assessment.

When reviewing the mean speed plots, however, this problem does not appear in the SF + C&WG assessment which could be indicate that the Warwick town centre mitigation and also the implementation of managed motorways is likely to ensure the network is better placed to accommodate the draw of traffic from the allocated sites towards C&WG.

The SF + C&WG network performance during the PM, however, appears to perform slightly worse than the original SF network. With the exception of the Europa Way NB stretch between the Europa Way roundabout and the junction with Myton Road there are no obvious reductions in mean speeds which indicates that the mitigation measures in this area would benefit from further optimisation within this option when considering the SF allocation in conjunction with C&WG.

In both options the inclusion of C&WG results in a lowering of the average speeds along the Europa Way NB stretch between the Europa Way roundabout and the junction with Myton Road. This further demonstrates a need to look in more detail at the mitigation proposed for this area.

8.5 Maximum Queue Length Analysis

The following sets out some initial observations based on the maximum queue length analysis and the differences in queue lengths between the 2028 Reference Case and the 2028 Preferred Option and 2028 Southern Focus plus C&WG.

The maps which are referred to within the following analysis are presented within **Appendix F** of this report.

8.5.1 2028 Preferred Option + CWG vs. 2028 Reference Case

AM Analysis (MQ005)

Analysis of the difference in queuing between the PO + C&WG vs. Reference Case, during the AM period, reveals the following:

- The number of instances of queue reduction, when compared to the original PO queue assessment, has further reduced.
- There are no reductions in queuing achieved along Emscote Road.
- A large proportion of impacts to the east and south east of Warwick town centre are very severe.
- Queue increases at Gaveston roundabout are now very severe.

PM Analysis (MQ006)

Analysis of the difference in queuing between the PO + C&WG vs. Reference Case, during the PM period, reveals very little change when compared to the original PO queue impact analysis, with the following exceptions:

- The increases at the A452/Stoneleigh Rd and the Stoneleigh Rd/Bericote Rd junctions are no longer very severe
- The instances where queue reductions are achieved in the area to the south east of Warwick have increased.

Overall the results indicate a general worsening of conditions in the AM, particularly to the East and South East of Warwick, as well as the A46 Gaveston roundabout. During the PM there is no significant change in conditions when C&WG is introduced compared to the scenario without C&WG.

8.5.2 2028 Southern Focus + CWG vs. 2028 Reference Case

AM Analysis (MQ007)

Analysis of the difference in queuing between the SF + C&WG vs. Reference Case, during the AM period, reveals very little change in conditions is likely to occur as a result of the inclusion of C&WG when compared to the original SF assessment.

PM Analysis (MQ004)

Analysis of the difference in queuing between the SF + C&WG vs. Reference Case, during the PM period, reveals very little change when compared to the original SF queue impact analysis, with the following exceptions:

- The number of instances where queue increases are experienced along Emscote Road has risen.
- Europa Way roundabout experiences an increase in queuing conditions, previously this was a reduction.
- A large proportion of impacts to the East and South East of Warwick town centre are very severe.

8.5.3 Queue Analysis Summary

A summary of the findings obtained through comparing the changes in queuing between the 2028 Reference Case and the SF and PO model networks, with and without C&WG, is provided as follows:

- Very little change in queuing conditions is experienced within the SF AM and PO PM networks.
- During the AM conditions to the South and East of Warwick appear to worsen when C&WG is included, this could indicate a need for mitigation in this area.
- During the PM SF analysis it has become clear that further amendments to or optimisation of the schemes along the Europa way corridor is likely to be required.

8.6 Summary

Analysis of a series of measures has been undertaken in an attempt to understand the potential impact that the draw between C&WG and the development sites will have on the network.

When considering the network performance of both scenarios, the PO network appears to suffer increases in delay and a reduction in speed during the AM period when C&WG is included but there are no changes in the network conditions in the PM period. Within the SF network the opposite effect occurs in so far as the AM remains relatively unchanged but, within the PM the number of completed trips, as a proportion of the overall demand assigned, reduces. Furthermore, delay increases and speed drop.

This indicates that the SF network, with its current mitigation, is better placed in the AM to accommodate the revised distribution and changes in trip patterns that occur as a result of the inclusion of C&WG. Further work is required with regards

the SF mitigation to minimise the impacts of the change in distribution in the PM period.

Analysis of the mean speed plots indicates a lowering of speeds, during the AM peak hour, on the approaches to Warwick town centre from the south and east within the PO test scenario but the same does not occur within the SF network.

Analysis of the PM network mean speed plots indicates that the inclusion of C&WG has very little impact in the PO scenario but does cause some additional issues in the SF scenario. Notably, in the SF scenario, the inclusion of C&WG results in a reduction in the average speeds in the area around Shires Retail Park Roundabout and the junctions to the South and North.

The queuing analysis appears to mirror the mean speed analysis in so far as the fact that the AM network queuing does not appear to change, when C&WG is added, in the SF test scenario but queuing appears to worsen in the AM PO network when C&WG is included. In the PM the PO network remains relatively unchanged when C&WG is included but in the SF testing some areas suffer increased queuing levels when C&WG is considered within the testing.

8.7 Conclusions

Based on the analysis of the outputs from this stage of testing, the following conclusions have been drawn:

- The SF AM network is more able to accommodate the additional pressures incurred as a result of the C&WG inclusion than the PO
- There is a potential need for the Warwick Town Centre and managed motorway improvements to be considered in both PO and SF options.
- During the AM conditions to the South and East of Warwick appear to worsen when C&WG is included, this could indicate a need for further mitigation in this area.
- The area of Shires Retail Park has again been identified as requiring further attention.
- During the PM the network operation will require further optimisation within the SF + C&WG scenario.

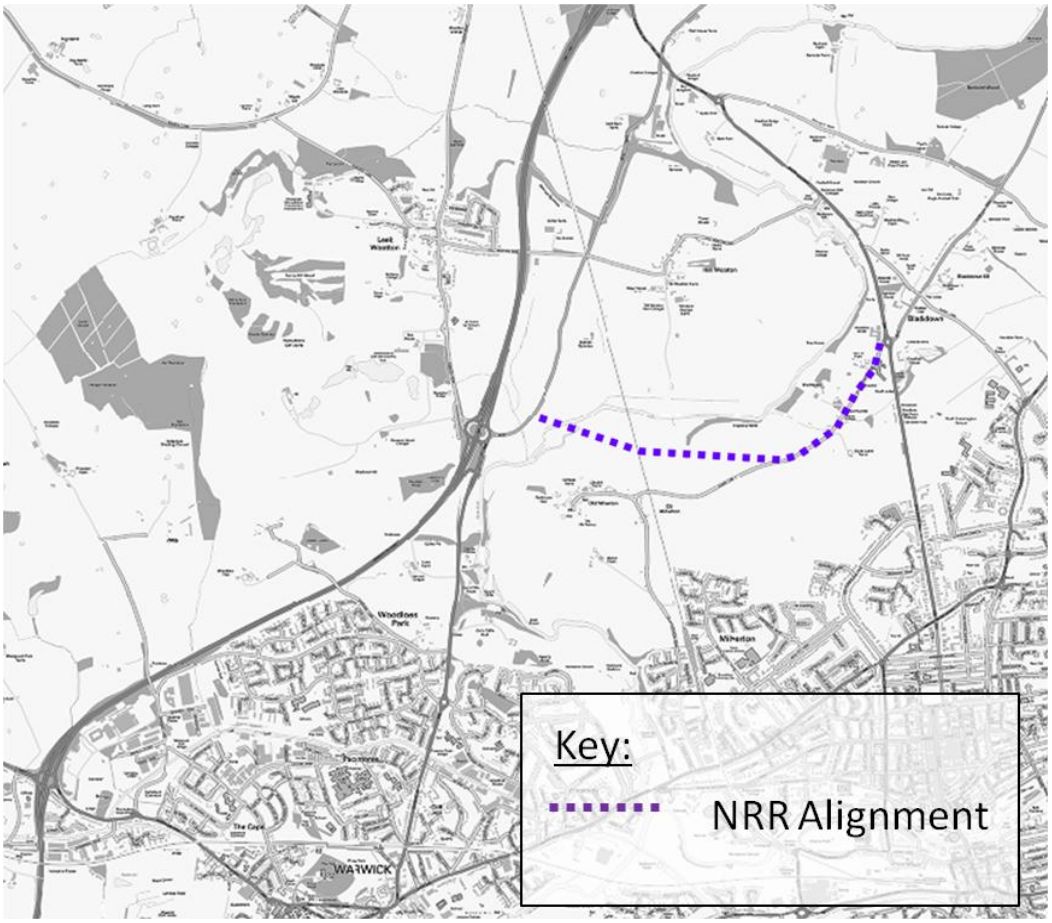
9 Wide Area Stage 3 Northern Relief Road (NRR) Testing

9.1 Northern Relief Road Overview

The third stage of this study was intended to assess whether there was potential for the PO allocation to come forward without the need to deliver the Northern Relief Road (NRR).

The original Strategic Transport Assessment identified a need for a new road between the A452 and the B4115 that provides a new connection between North Leamington and the A46 via Gaveston roundabout. The alignment of the road is outlined within the following Figure 24:

Figure 24 - NRR Alignment



Initially the No NRR scenario was built by simply removing the road from the model network but it quickly became clear that further mitigation would be required in order for the scenario to perform satisfactorily.

The primary requirements to improve the network performance was increased capacity along the A452, this seems sensible given that additional development is being located to the north of Leamington which will, in turn, create additional demand for the route between the north of Leamington and the A46. To achieve the capacity improvements it was initially assumed that the A452 would be upgraded to 2 lanes in both directions, along the section just north of

Northumberland Avenue to the A46. An additional merge lane was included to allow two lanes of traffic to merge from Thickthorn roundabout to the A46 SB.

Analysis of this scenario running revealed that it appeared to work but an imbalance of flow on the major movements across the A452 junctions made it difficult for traffic to join the A452 from the minor arms. A second option was therefore derived with the A452/Stoneleigh Road and the A452/Bericote Road roundabouts reconfigured to signalised crossroads. As a result, two scenarios were initially tested:

- PO NRR01 – NRR removed and A452 upgraded to two lanes from just north of Northumberland Avenue to the A46. Additional SB merge provided so vehicles can merge onto the A46 SB from two lanes.
- PO NRR02 – As above but with two critical junctions along the A452 (Blackdown & Bericote) reconfigured to signalised crossroads.

9.2 Results Analysis

The following section sets out the results analysis obtained from the assessment of the two additional scenarios, whereby the NRR is removed from the PO network and additional infrastructure included.

9.2.1 Model Stability

As with the C&WG assessment it was found that removing the NRR from the model had an adverse effect on overall model stability. The outputs of the model stability analysis have been presented, alongside the original PO option network and the PO + C&WG scenario within the following Table 21:

Table 21 Model Stability Outputs

Scenario	2028 PO	2028 PO + CWG	2028 PO & No NRR01	2028 PO & No NRR02
AM (07:00 to 10:00)				
Number of Runs	10	10	10	10
Number of Failed Runs	3	7	9	7
Success Rate	70.00%	**30.00%**	**10.00%**	**30.00%**
PM (16:00 to 19:00)				
Number of Runs	10	10	10	10
Number of Failed Runs	4	4	4	2
Success Rate	60.00%	60.00%	60.00%	80.00%

The previous table demonstrates that the removal of the road brings model stability down to a similar level to the PO + C&WG scenario test.

Furthermore, when the primary junction configuration, along the A452, is adopted as roundabouts, the AM model suffers from severe instability indicating that further work is required to improve this option. The same conclusion can generally be drawn regarding the second NRR option although the level of instability experienced is consistent with the earlier PO + C&WG scenario test.

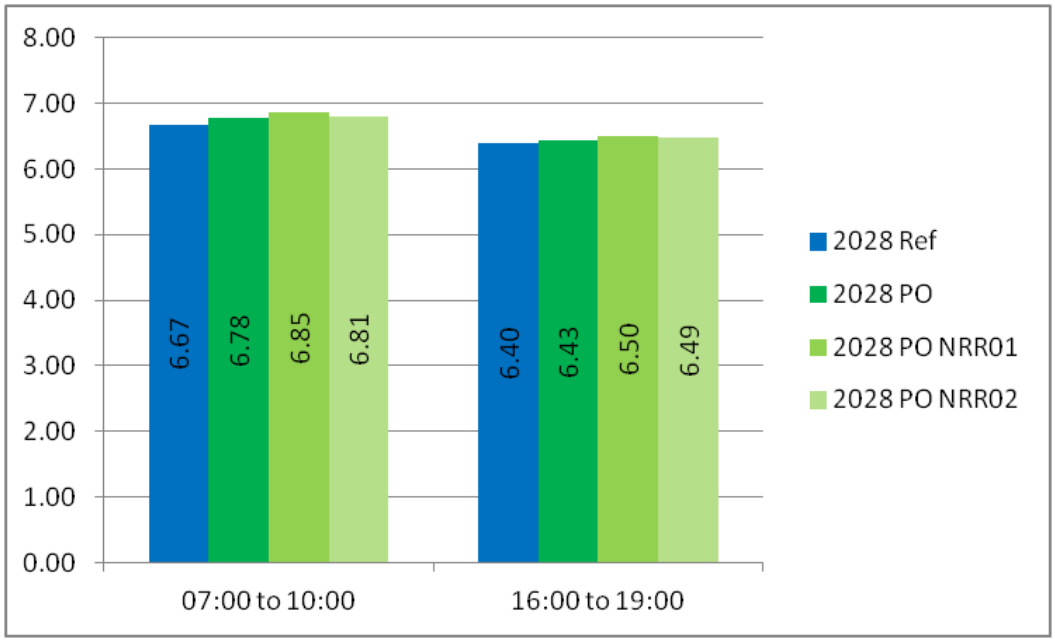
9.2.2 Network wide Statistics

The following sets out the changes in network wide statistics between the 2028 PO option test models with and without NRR.

9.2.3 Average Journey distance

Analysis of the average journey distance within each scenario, across the entire AM and PM model periods, is presented within the following Figure 25:

Figure 25 - Average Journey Distance (2028 Ref vs. PO. Vs PO NRR01 vs. PO NRR02), Km

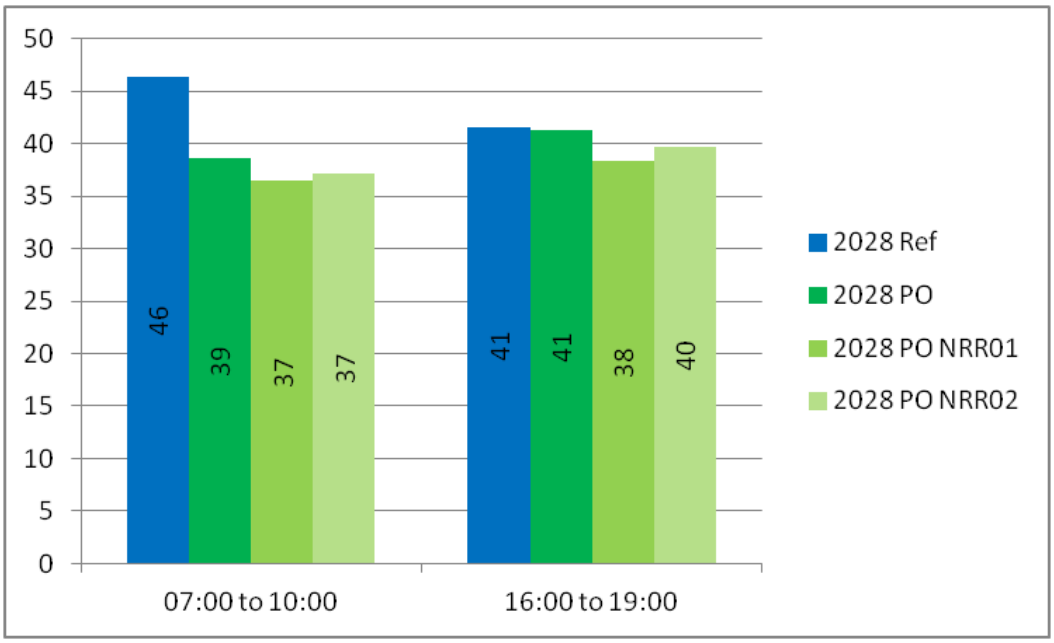


Analysis of Figure 25 reveals that there is an increase in the distance vehicles have to travel when the Relief Road is removed. The greatest increases from the Reference Case, when considering the original PO scenario outputs, have been experienced within the AM period. This indicates that the NRR provides a more direct route for vehicles to take on certain journeys. Furthermore the greater increase between scenarios within the AM period indicates that the effects of congestion will cause vehicles to reassign across longer distances in the NRR01 scenario when compared to the NRR02 scenarios.

9.2.4 Average Journey Speed

Analysis of the average journey speed (km/h) within each scenario, across the entire AM and PM model periods, is presented within Figure 26 on the following page.

Figure 26 - Average Journey Speed (2028 Ref vs. PO. Vs PO NRR01 vs. PO NRR02), Km/h



Analysis of Figure 26 reveals that, when considering the speeds achieved within the original PO option, removal of the NRR in either option results in further drop in average speed, when compared to the Reference Case.

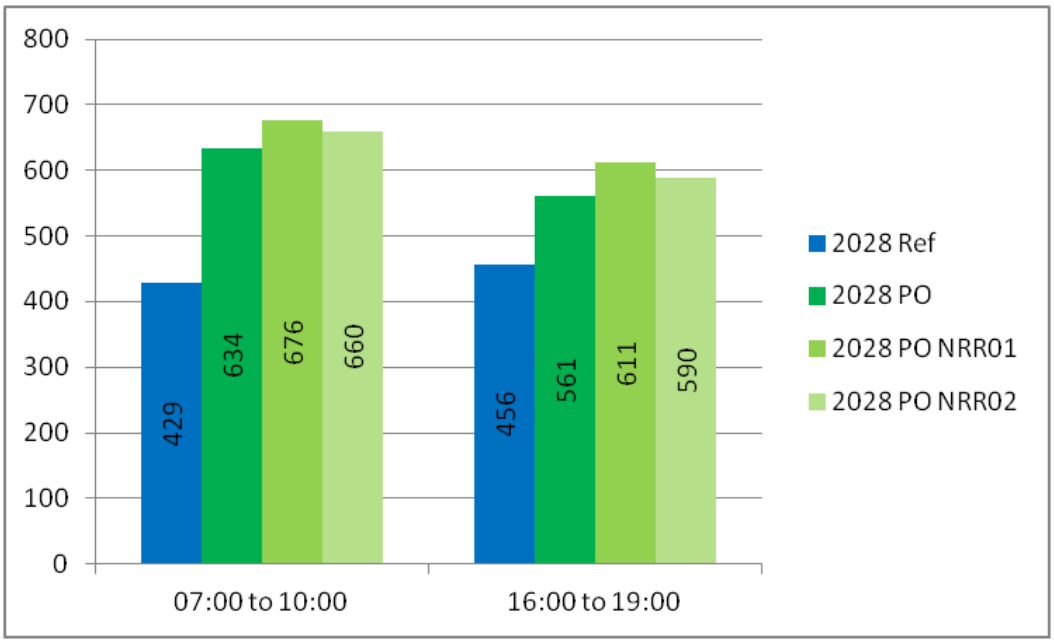
Between the two options the inclusion of roundabouts results in a greater drop in average speed across the entire network, than the option which includes signals.

9.2.5 Average Journey Time (s)

Analysis of the average journey speed (km/h) within each scenario, across the entire AM and PM model periods, is presented within Figure 27 on the following page. Analysis of Figure 27 reveals that delay in both options will increase beyond the levels experienced within the original PO option.

Greater increases are likely in the AM than the PM indicating that the NRR is more critical to network operation in the AM than the PM. Furthermore, the implementation of roundabouts along the A452 results in greater increases in delay, when compared to the signalised option.

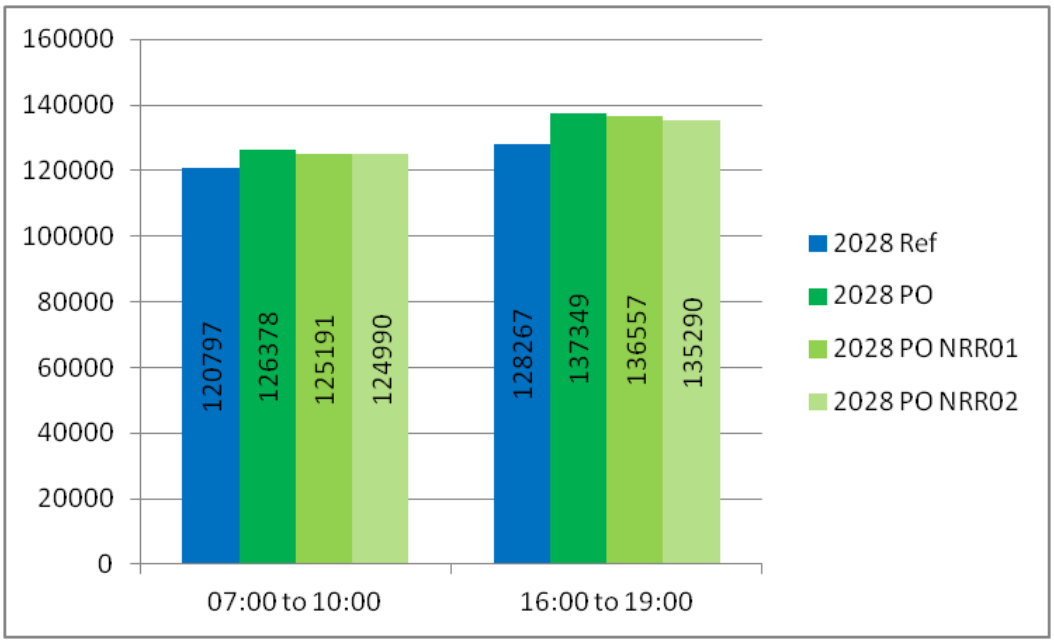
Figure 27 - Average Journey Time (2028 Ref vs. PO. Vs PO NRR01 vs. PO NRR02), Seconds



9.2.6 Completed Trips

Analysis of the total number of completed trips within each scenario, across the entire AM and PM model periods, is presented within the following Figure 28:

Figure 28 - Completed Trips (2028 Ref vs. PO. Vs PO NRR01 vs. PO NRR02), Vehicles



Analysis of the previous figure reveals that there is a slight reduction in the number of completed trips in either option when compared to the original PO model scenario. More detailed analysis of this data has been undertaken to ascertain the proportion of assigned trips within the network that complete their

journeys, within the respective period. This analysis has been presented within the following Table 22:

Table 22 Completed Trip Analysis (2028 Ref vs. PO. Vs PO NRR01 vs. PO NRR02)

	AM (07:00 to 10:00)			PM (16:00 to 19:00)		
	Demand	**Completed Trips**	**Completed %**	**Demand**	**Completed Trips**	**Completed %**
2028 Ref	127811	120797	94.5%	137249	128267	93.5%
2028 PO	134431	126378	94.0%	145857	137349	94.2%
2028 PO NRR01	134431	125191	93.13%	145857	136557	93.62%
2028 PO NRR02	134431	124990	92.98%	145857	135290	92.76%

It is notable that in both NRR test scenarios, when compared to the original PO model scenario; suffer a reduction in the rate of trip completion.

The reductions in the AM appear to be more severe than those experienced within the PM. The PO option contains around an additional 5% of demand when compared to the Reference Case within the AM period. Previously, when the NRR was included, the number of completed trips was 4.6% higher than the Reference Case indicating that the additional demand was almost all accommodated within the model network. When the NRR is removed, this value drops to around 3.5% which means there is a shortfall in the number of additional trips assigned to the network that complete their journey within the model period.

It is also interesting to note that the rate of trip completion, within the signalised option, is lower than the rate of trip completion within the roundabout option. The level of delay is higher in the roundabout option and the average speed is lower. Thus, it is anticipated that this may indicate that towards the end of the simulation period the roundabout configuration is more able to accommodate trips travelling through the network than the Signalised option. This cannot be a significant issue, however, as the traditional network wide measures indicate that the signals consistently outperform the roundabout across all of the key measures. It is likely that, towards the end of the model period, when the network is least congested; the current signal configuration does not provide the optimum solution for enabling more trips to be completed. Hourly optimisation of the signal timings would be likely to overcome such an issue and may also improve the overall ratio of trip completion.

9.2.7 Mean Speed Analysis

The previous analysis appears to indicate that, in almost every instance including a signal configuration along the A452, when the NRR is removed, results in a better level of network performance than the roundabout configuration. Thus, it has been decided that more detailed analysis of mean speed and queuing impacts should focus solely on the difference between the PO + NRR02 option (signals) and the original 2028 PO and 2028 Reference Case network.

The following comments are based on observations in the predicted changes in mean speed across links within the PO + NRR02 model area.

The maps which are referred to within the following analysis are presented within **Appendix E** of this report.

9.2.8 2028 PO + NRR02 Conditions (MS021 to MS024)

Analysis of the AM network performance indicates that there are some areas of the network where the average speeds drop further and for longer sections than was experienced within the original 2028 PO model network.

Notably, the average speeds appear to have dropped on the A429 Coventry Road approach to Warwick, as have speeds on the links to the south and east of Warwick. Low speeds now propagate back from Warwick town centre as far south as the point where the A4189 crosses the A46. The area around the A46/Birmingham Road 'Stanks Island' also appears to have come under increased pressure with speeds lowering even further than those contained within the 2028 PO model network.

Within the PM there appears to be very few differences between the 2028 PO and 2028 PO + NRR02 networks.

9.2.9 Mean Speed Analysis – Summary

Analysis of the mean speed plots appears to indicate that, during the AM, there are further reductions in the average speeds on the approaches to Warwick town centre from the south and east of Warwick as well as from the A425 Birmingham Road and A429 Coventry Road approaches. It is apparent that the removal of the NRR increases congestion within the area of Warwick town centre. This indicates that the NRR is likely to provide relief to the Town Centre and alleviate some demand that may otherwise occur should the alternative route not exist.

The number of east-west corridors between both Leamington and Warwick is limited with Emscote Road and Myton Road providing the two most viable options. The NRR appears to perform a similar role, as well as providing a more direct route to the A46 from North Leamington; it provides a 'release valve' that traffic can utilise when congestion within Warwick town centre causes the routes through the town to become unattractive. Without the NRR congestion and lower speeds propagate back further from Warwick town centre than in the original 2028 PO options.

9.3 Maximum Queue Length Analysis

The following sets out some initial observations based on the maximum queue length analysis and the differences in queue lengths between the 2028 Reference Case and the 2028 Preferred Option without the NRR. As with the mean speed analysis, the focus of analysis is on the second NRR scenario where key A452 junctions have been upgraded from roundabout to signal configuration.

The maps which are referred to within the following analysis are presented within **Appendix F** of this report.

9.3.1 2028 Preferred Option + CWG vs. 2028 Reference Case

AM Analysis (MQ009)

Analysis of the difference in queuing between the PO + no NRR vs. Reference Case, during the AM period, reveals the following:

- Compared to the original PO queue assessment, there are now no instances of queue reduction along Emscote Road.
- In general, compared to the original PO network, the number of instances of very severe increases in queuing has increased on all roads leading into Warwick town centre.
- The majority of impacts that have been recorded are either severe or very severe increases in queue lengths.
- The queue increases at Grey's Mallory are now very severe.

PM Analysis (MQ010)

Analysis of the difference in queuing between the PO + no NRR vs. Reference Case, during the PM period, reveals the following:

- Compared to the original PO queue assessment, the number of instances where severe or very severe increases are experienced has increased.
- The number of instances of very severe increases in queuing along Europa Way has increased.
- The majority of impacts that have been recorded are either severe or very severe increases in queue lengths.
- The queue increases at Grey's Mallory are now very severe.

9.3.2 Queue Analysis Summary

A summary of the findings obtained through comparing the changes in queuing between the 2028 Reference Case and the 2028 PO network without the NRR, compared to the 2028 PO scenario with the NRR is provided as follows:

- During both AM and PM periods the number of instances where there is a very severe increase in the average maximum queue length, compared to the original 2028 PO network conditions, increases.
- The AM network comparisons return a large proportion of severe or very severe increases in queue lengths compared to the 2028 Reference Conditions.
- In general during the AM, compared to the original PO network, the number of instances of very severe increases in queuing has increased on all roads leading into Warwick town centre.
- Neither AM nor PM period performs particularly well in terms of overall impacts on queuing but the number of occasions where a severe or very severe increase in queue lengths is experienced is highest during the AM.

9.4 Summary

Analysis of a series of measures has been undertaken to understand the impact of the removal of the NRR on the performance of the 2028 PO model network. Two options were initially tested:

- PO NRR01 – NRR removed and A452 upgraded to two lanes from just north of Northumberland Avenue to the A46. Additional SB merge provided so vehicles can merge onto the A46 SB from two lanes.
- PO NRR02 – As above but with two critical junctions along the A452 (Stoneleigh Rd & Bericote Rd) reconfigured to signalised crossroads.

Initial analysis indicated that the second of the two options performed better than the first indicating that reconfiguration of the A452/Blackdown roundabout and the A452/Bericote Road roundabout to signalised was a necessity in light of the removal of the NRR.

Furthermore, analysis of the network wide statistics indicates that removal of the NRR will lead to further increases in the average delay experienced by all vehicles within the network, as well as an accompanying reduction in average speeds. These impacts are likely to be experienced over and above those which occur simply as a result of the inclusion of the PO growth allocation strategy indicating that the network conditions will worsen as a result of the removal of the NRR.

By removing the NRR the rate of trip completion, as a proportion of the overall demand assigned within the model, also reduces. The level of demand assigned within the model during the AM period increases by around 5% but the number of completed trips, when compared to the Reference Case, only increases by around 3.5% indicating more vehicles left on the network at the end of the test period.

Analysis of the mean speed plots indicates that, during the AM, there are further reductions in the average speeds on the approaches to Warwick town centre from the south and east of Warwick as well as from the A425 Birmingham Road and A429 Coventry Road approaches. Without the NRR congestion and lower speeds propagate back further from Warwick town centre than in the original 2028 PO scenario.

The number of east-west corridors between both Leamington and Warwick is limited with Emscote Road and Myton Road providing the two most viable options, the NRR appears to perform a similar role, and provides a more direct route to the A46 from North Leamington. The NRR provides a ‘release valve’ that traffic can utilise when congestion within Warwick town centre causes the routes through the town to become unattractive. Removal of the NRR prevents this situation from occurring and results in higher levels of congestion within Warwick town centre.

Analysis of the queuing impacts reveals that both AM and PM periods experience an increase in the number of severe and very severe increases in queue lengths, particularly when compared to the original 2028 PO network. Furthermore, during the AM, compared to the original PO network, the number of instances of very severe increases in queuing has increased on all roads leading into Warwick town centre.

9.5 Conclusions

Based on the analysis of the outputs from this stage of testing, the following conclusions have been drawn:

- That the network is likely to become more unstable as a result of the removal of the NRR and that these effects are most obvious within the AM model period. Furthermore, the level of instability exemplified within the scenario models is comparable to that which is contained within the PO + C&WG assessment. It is reasonable to conclude that the cumulative effects of both scenarios in unison (i.e. PO + C&WG and PO + no NRR combined) will be further amplified and will require additional mitigation to accommodate the demand on the network.

- Removal of the NRR will result in a general increase in the delay experienced by all vehicles travelling along the network and a lowering of average speeds.

- The overall improvements in network performance, as a result of the inclusion of the signal scheme on the A452 north of Leamington, when compared to the roundabout option, indicates that signals may provide the optimum control strategy irrespective of whether the NRR is included or not.

- Mean speed analysis indicates that routes into Warwick town centre area likely to suffer more from the effects of congestion, during the AM period, when the NRR is removed compared to when it is included. Indicating that town centre works are likely to become essential if the PO allocation strategy is progressed without the NRR.

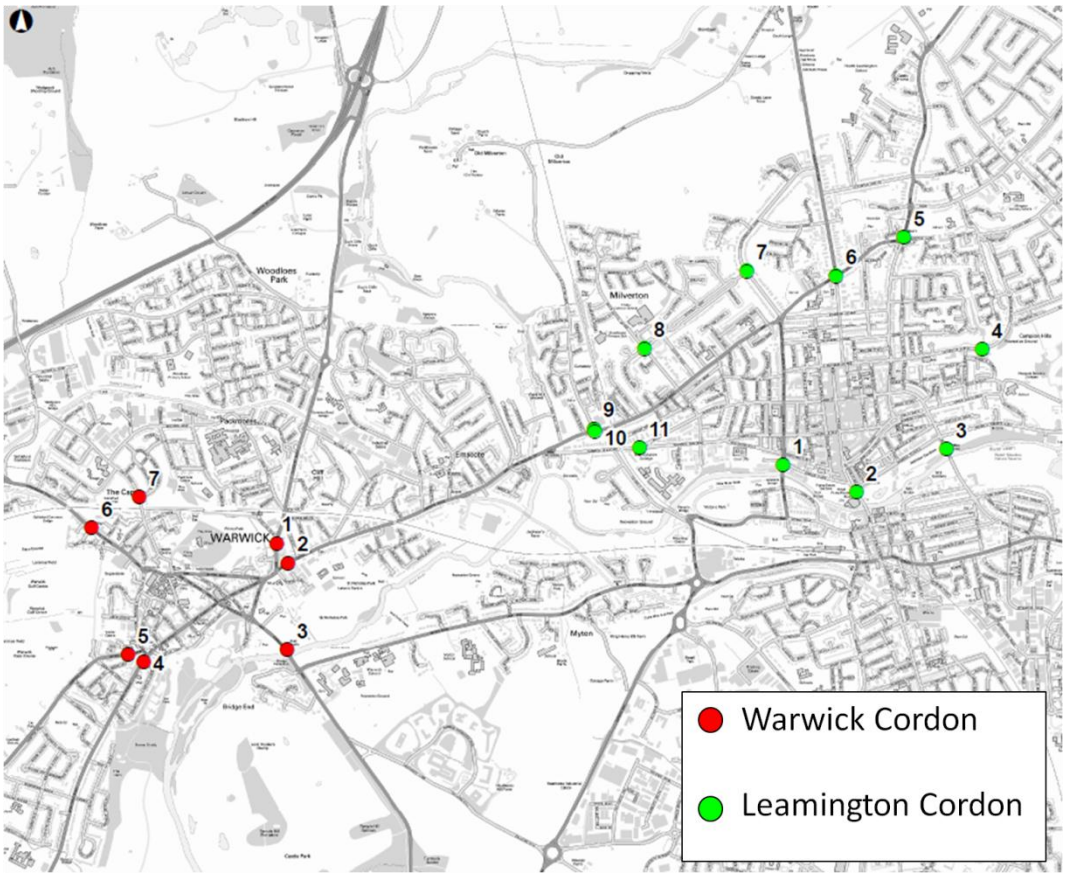
10 Detailed Link Analysis

In order to better understand the differences between the various options, more detailed analysis of the changes in two-way vehicular flow across various locations has also been undertaken. Two stages of analysis have been undertaken; firstly, cordon flows have been extracted and analysed to assess town centre traffic movements around both Warwick and Leamington towns. Subsequent analysis has then been undertaken which looks at the potential impacts in and around the AQMA areas of both Warwick and Leamington.

10.1 Cordon Analysis

Cordon analysis has been undertaken for two cordons around Warwick and Leamington town centres. Analysis of these inner cordons enables a picture of the traffic movements around critical parts of the network, under the various test scenarios, to be better understood. An overview of the cordon locations is provided within the following Figure 29:

Figure 29 - Warwick and Leamington Cordon Locations



10.1.1 Warwick Town Centre Cordon Analysis

Analysis of the changes in two way flows, across all of the Warwick cordon points has been undertaken for the 2028 Reference, 2028 PO and 2028 SF networks. The results of the analysis for the AM and PM model periods are presented within Table 23 and Table 24 on the following page.

Table 23 - AM (07:00 to 10:00) Warwick Cordon Analysis (2028 Ref vs. 2028 PO vs. 2028 SF)

Locations	2028 Ref	2028 PO	Diff from Ref	2028 SF	Diff from Ref
WIC-1 - Coventry Road	2525	2120	-405	2310	-215
WIC-2 - Coten End	2575	2287	-288	2994	419
WIC-3 - Banbury Road	5880	6312	432	7027	1147
WIC-4 - West Street	3659	2786	-873	3379	-280
WIC-5 - Friars Street	1851	1661	-190	1687	-164
WIC-6 - Saltisford Road	3358	3002	-357	3378	20
WIC-7 - Cape Road	1430	1504	74	1843	413
Total			-1607		1340

Table 24 - PM (16:00 to 19:00) Warwick Cordon Analysis (2028 Ref vs. 2028 PO vs. 2028 SF)

Locations	2028 Ref	2028 PO	Diff from Ref	2028 SF	Diff from Ref
WIC-1 - Coventry Road	2633	2140	-492	2757	124
WIC-2 - Coten End	2822	2807	-15	3414	592
WIC-3 - Banbury Road	5307	5552	246	7179	1872
WIC-4 - West Street	3409	3372	-37	3465	57
WIC-5 - Friars Street	1837	2093	256	2200	363
WIC-6 - Saltisford Road	3245	3228	-17	3652	407
WIC-7 - Cape Road	2703	3254	551	2943	240
Total			491		3655

Within the AM period analysis it is apparent from decrease flow through the town centre that the capacity of the town centre is compromised within the 2028 PO option. All but two locations experience a reduction the number of vehicles crossing the cordon points reduces. There is an increase of 7% on the Banbury Road and an increase of 5% on Cape Road. Some of the biggest reductions in the AM PO network comparisons are experienced along West Street and this ties in with earlier analysis which indicated problems along the approaches to Warwick town centre from the South and East. Given that there is an increase in traffic crossing the Banbury Road cordon this could indicate that traffic entering the town centre from this location could have a disproportionate effect on the overall network performance if left unmanaged.

Analysis of the AM SF network reveals there is a general increase in vehicles crossing the cordon points. The largest magnitude increase is experienced along the Banbury Road (19.5%) followed by Cape Road (22%). Overall, in the SF AM option, there are increases in the counts across all cordon points to the Northeast, Northwest and southwest but there is a reduction in the count across the southeast cordon points (4 and 5).

PM period analysis highlights a reduction in the volume of vehicles crossing a number of the cordon locations within the PO network but overall there is a small increase in the number of vehicles crossing the cordon points when compared to the 2028 Reference Case. In general, when assessing vehicle numbers accessing

the town from each location there is an increase in the number of vehicles crossing the cordon points from all directions except the northwest (1 and 2).

Within the SF network there are increases in the number of vehicles crossing all of the cordon points. The most substantial increase is again across the Banbury Road Cordon.

10.1.2 Summary

Initial analysis of the impact of the two options on the cordon points across Warwick Town centre indicates that, during the AM, the level of traffic is reduced within the PO scenario whilst it increases within the SF scenario. During the PM there are increases in both scenarios although the magnitude of increase is larger within the SF option than the PO option.

In the SF option the largest increase is consistently across the Banbury Road with large increases also experienced across Coten End and Cape Road. Banbury Road and Coten End are both directly controlled by the town centre mitigation scheme and the increases in flow occur as a result of this.

The increases across Cape Road may partly be as a result of the town centre improvement scheme but also are likely to be affected by the reassignment of vehicles away from Cape road due to congestion in that area of the network and the impact that it has on the route cost calculations.

In general there are likely to be reductions in flow across the network in the PO scenario if the town centre improvements are not progressed but this reduction will occur as a result of the adverse conditions that are created within the town centre, low speeds and poor accessibility, rather than the availability of alternative routes.

Across the PM period of the PO network there is still a general pattern of increasing vehicles crossing the cordon points although the increases within the SF scenario network are much higher.

Within the SF network the number of vehicles crossing the cordon points increases across every cordon point within the PM and almost all cordon points in the AM, the exception are the two locations within the southeast (4 & 5) which has already been identified as an area of the network likely to require further attention irrespective of the allocation strategy that is being progressed.

10.1.3 Leamington Town Centre Cordon Analysis

Analysis of the changes in two way flows, across all of the Warwick cordon points has been undertaken for the 2028 Reference, 2028 PO and 2028 SF networks. The results of the analysis for the AM and PM model periods are presented within the Table 25 and Table 26 on the following page.

Table 25 - AM (07:00 to 10:00) Leamington Cordon Analysis (2028 Ref vs. 2028 PO vs. 2028 SF)

Locations	2028 Ref	2028 PO	Diff from Ref	2028 SF	Diff from Ref
LIC-1 - Adelaide Rd	2041	2100	59	1245	-796
LIC-2 - Parade (B4087)	1476	1831	354	2054	578
LIC-3 - Wiles Road	2480	2951	471	2923	443
LIC-4 - Leicester St	620	848	228	618	-2
LIC-5 - Lillington Rd	3151	3289	139	3205	54
LIC-6 - Kenilworth Road	2012	2442	431	2319	307
LIC-7 – Northumberland Ave.	877	653	-224	1130	253
LIC-8 - Guy's Cliffe Avenue	573	988	415	600	27
LIC-9 - Old Milverton Road	497	594	97	598	101
LIC-10 - Rugby Road (A445)	1188	1379	191	1032	-156
LIC-11 - Warwick New Road	1731	1897	166	1939	208
Total			2327		1018

Table 26 - PM (16:00 to 19:00) Leamington Cordon Analysis (2028 Ref vs. 2028 PO vs. 2028 SF)

Locations	2028 Ref	2028 PO	Diff from Ref	2028 SF	Diff from Ref
LIC-1 - Adelaide Rd	2373	2128	-245	1654	-719
LIC-2 - Parade (B4087)	1448	1693	245	1739	291
LIC-3 - Wiles Road	2394	2749	355	2646	252
LIC-4 - Leicester St	321	426	105	448	127
LIC-5 - Lillington Rd	2277	2947	670	2460	183
LIC-6 - Kenilworth Road	1912	2338	427	2358	446
LIC-7 – Northumberland Ave.	540	453	-87	709	169
LIC-8 - Guy's Cliffe Avenue	393	1223	829	388	-6
LIC-9 - Old Milverton Road	237	308	70	348	111
LIC-10 - Rugby Road (A445)	1701	2146	445	1607	-94
LIC-11 - Warwick New Road	1808	1778	-30	2050	242
Total			2784		1000

Analysis of the previous tables indicates that, within the PO scenario, there are increases in the number of vehicles crossing all but one cordon point in both the AM and PM periods. The only cordon point which experiences a reduction in the AM is Northumberland Avenue which could be as a result of increases in demand elsewhere on the network making it difficult to enter and exit Northumberland Avenue and, thus, it becomes a less attractive route. In the PM the biggest reduction is across Adelaide Road but there are small reductions across Northumberland Avenue and Warwick New Road.

The magnitude of the increase across all cordon points, within both AM and PM periods of the PO scenario is over twice the level of increase experienced within the SF scenario.

Within the SF scenario there are increases across almost every location across both the AM and PM periods. A small reduction in the number of vehicles crossing the Rugby Road (10) appears to have occurred but this may be as a result of the Warwick New Road attracting more trips as, in both AM and PM model periods, the increase across Warwick New Road outweighs the reduction along the Rugby Road. The most substantial reduction is in the number of vehicles crossing the Adelaide road cordon point with reductions of between 30 and 40% across the AM and PM model periods. This reduction may occur partly as a result of difficulty exiting Adelaide Road onto Avenue Road which in turn, makes alternative routes more attractive. The increases in the adjacent cordon points 2, 3 and 11 are of a similar magnitude to the reduction along Adelaide Road which may also indicate the reassignment of vehicles away from Adelaide Road. The cordon analysis does not include the Princes Drive/Warwick New Road corridor which has been subject to improvements that may also draw traffic away from the Adelaide Road.

10.1.4 Summary

Overall the results indicate that, during both PO and SF scenarios the number of vehicles crossing the cordon points surrounding Leamington Town centre will increase in either scenario across both time periods. The increases in the PO scenario are, however over twice the size of the increases in the SF option. This is largely due to the improved Europa Way and "managed motorways" making the strategic road network a much more attractive option for route choice to the north of Warwick and Leamington

10.1.5 Northern Relief Road impacts

In light of the outcome of the initial cordon analysis it was felt that further analysis was required to ascertain the impact, on the cordon flows, likely to be experienced as a result of the removal of the NRR.

The analysis was undertaken using the same cordon point locations as identified within the earlier Figure 29.

10.1.6 Warwick Town Centre Analysis

Analysis of the changes in two-way flows across the Warwick town centre cordon points has been undertaken for the 2028 PO without NRR scenario and has been presented, alongside the 2028 Ref and 2028 PO results, within the following Table 27 and Table 28, on the following page, for the AM and PM respectively:

Table 27 - AM (07:00 to 10:00) Warwick Cordon Analysis (2028 Ref vs. 2028 PO vs. 2028 SF)

Locations	2028 Ref	2028 PO	Diff from Ref	2028 SF	Diff from Ref
WIC-1 - Coventry Road	2525	2120	-405	2119	-405
WIC-2 - Coten End	2575	2287	-288	2409	-166
WIC-3 - Banbury Road	5880	6312	432	6390	510
WIC-4 - West Street	3659	2786	-873	2774	-884
WIC-5 - Friars Street	1851	1661	-190	1632	-219
WIC-6 - Saltisford Road	3358	3002	-357	2807	-551
WIC-7 - Cape Road	1430	1504	74	1363	-67
Total			-1607		-1783

Table 28 - PM (16:00 to 19:00) Warwick Cordon Analysis (2028 Ref vs. 2028 PO vs. 2028 SF)

Locations	2028 Ref	2028 PO	Diff from Ref	2028 SF	Diff from Ref
WIC-1 - Coventry Road	2633	2140	-492	2202	-430
WIC-2 - Coten End	2822	2807	-15	2934	112
WIC-3 - Banbury Road	5307	5552	246	5737	430
WIC-4 - West Street	3409	3372	-37	3494	85
WIC-5 - Friars Street	1837	2093	256	2116	279
WIC-6 - Saltisford Road	3245	3228	-17	3367	122
WIC-7 - Cape Road	2703	3254	551	3479	776
Total			491		1374

Analysis of the above tables reveals that when the NRR is removed, within the AM period, the number of trips crossing the Warwick town centre cordon points actually reduces further despite the removal of an alternative route around the town centre. This indicates that the conditions in the town centre worsens as a result of the removal of the NRR to such an extent that the network accommodates significantly fewer trips.

In the PM period, however, when the effects of congestion within Warwick town centre are less severe there is a substantial increase in vehicles crossing the cordon points when the NRR is removed compared to the numbers presented with the NRR in place. This is in line with what would be expected in so far as it would be expected that removing additional infrastructure to the north would result in more traffic crossing the cordon points within the town. It is interesting to note that the largest increase, in the PM, is across the Cape road cordon which could indicate that the NRR will provide additional relief to this route into and out of Warwick town.

10.1.7 Leamington town Centre Cordon Analysis

Analysis of the changes in two-way flows across the Leamington town centre cordon points has been undertaken for the 2028 PO without NRR scenario and has been presented, alongside the 2028 Ref and 2028 PO results, within the following Table 29 and Table 30, on the following page, for the AM and PM respectively:

Table 29 - AM (07:00 to 10:00) Leamington Cordon Analysis (2028 Ref vs. 2028 PO vs. 2028 SF)

Locations	2028 Ref	2028 PO	Diff from Ref	2028 SF	Diff from Ref
LIC-1 - Adelaide Rd	2041	2100	59	2135	94
LIC-2 - Parade (B4087)	1476	1831	354	1929	453
LIC-3 - Wiles Road	2480	2951	471	2907	427
LIC-4 - Leicester St	620	848	228	753	133
LIC-5 - Lillington Rd	3151	3289	139	3255	105
LIC-6 - Kenilworth Road	2012	2442	431	2453	441
LIC-7 – Northumberland Ave.	877	653	-224	808	-68
LIC-8 - Guy's Cliffe Avenue	573	988	415	732	159
LIC-9 - Old Milverton Road	497	594	97	559	63
LIC-10 - Rugby Road (A445)	1188	1379	191	1691	503
LIC-11 - Warwick New Road	1731	1897	166	1982	251
Total			2327		2560

Table 30 - PM (16:00 to 19:00) Leamington Cordon Analysis (2028 Ref vs. 2028 PO vs. 2028 SF)

Locations	2028 Ref	2028 PO	Diff from Ref	2028 SF	Diff from Ref
LIC-1 - Adelaide Rd	2373	2128	-245	2161	-213
LIC-2 - Parade (B4087)	1448	1693	245	1759	311
LIC-3 - Wiles Road	2394	2749	355	2729	335
LIC-4 - Leicester St	321	426	105	432	111
LIC-5 - Lillington Rd	2277	2947	670	2854	577
LIC-6 - Kenilworth Road	1912	2338	427	2408	496
LIC-7 – Northumberland Ave.	540	453	-87	449	-91
LIC-8 - Guy's Cliffe Avenue	393	1223	829	768	375
LIC-9 - Old Milverton Road	237	308	70	272	34
LIC-10 - Rugby Road (A445)	1701	2146	445	2433	732
LIC-11 - Warwick New Road	1808	1778	-30	1609	-199
Total			2784		2468

Table 29 indicates that the number of trips crossing the Leamington town centre cordon points increases in the AM period when the NRR is removed. This is in line with earlier analysis indicating that the NRR is alleviating pressure around Warwick town centre which, when the NRR is removed, becomes more congested and pushes traffic further out onto the wider Warwick network. This traffic, in turn, pushes more traffic into Leamington which is reflected in the increased two way flows across the Warwick cordon points.

Table 30 indicates that, in the PM, there is a reduction in the number of vehicles crossing the cordon points when the NRR is removed compared to the original PO

scenario. This appears to be largely affected by the two way flow across Guy's Cliff Avenue which more than halves in response to the removal of the NRR. This indicates that there is potential for the NRR to draw traffic across Guy's Cliff Avenue. Aside from this reduction there are very few other significant differences within the PM with the exception of the flow crossing the Rugby Road Cordon. This has increased by almost double the flow difference as a result of the removal of the NRR which is indicative of an increase in movements between Warwick and Leamington as a result of the removal of the NRR.

10.2 AQMA sites

In addition to analysing the impact on the cordon locations within Warwick and Leamington, analysis of the potential impact on the AQMA sites within Warwick and Leamington has also been undertaken.

There are two AQMA locations within Warwick and Leamington. The AQMA area within Warwick covers the majority of the town centre and includes Saltisford, The Butts, Jury Street, Smith Street and Bowling Green Street. The AQMA location within Leamington includes Spencer Street, Bath Street, Tachbrook Road and Clement Street. The locations of the Warwick and Leamington AQMA areas are illustrated within the following Figure 30 and Figure 31 respectively:

Figure 30 - Warwick Town AQMA sites

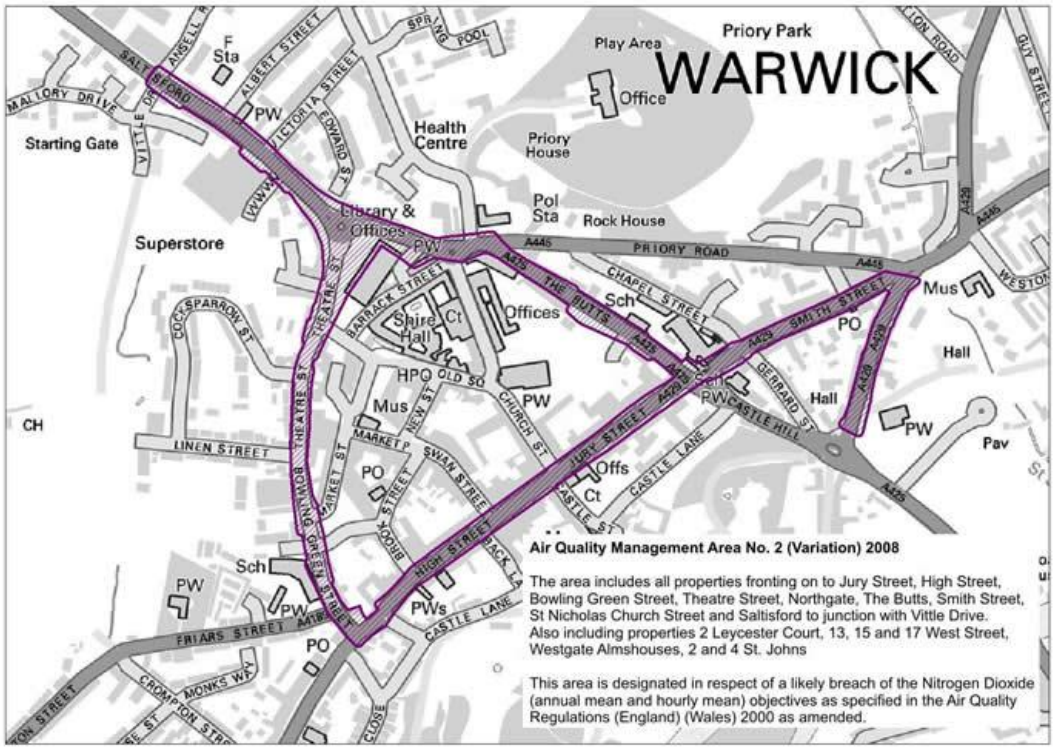
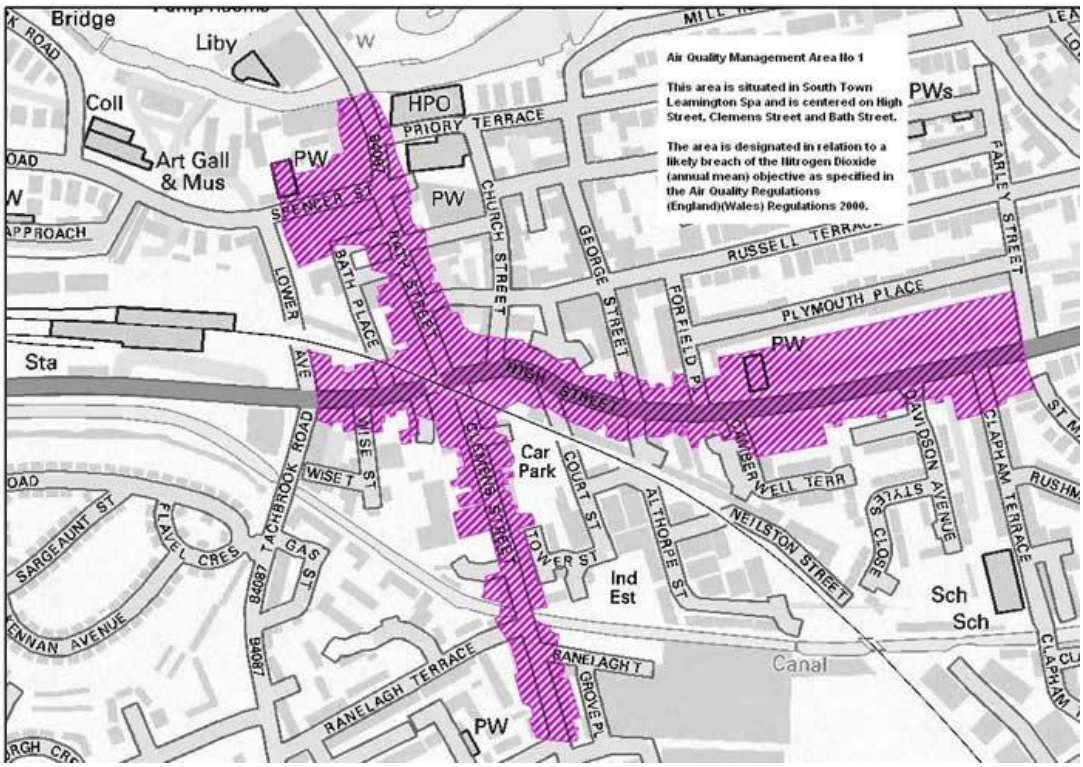


Figure 31 - Leamington AQMA Area



10.3 Warwick AQMA Analysis

Analysis of the changes in flow at key locations within the Warwick AQMA site, during the AM and PM peak hour, is presented within the following Table 31 and Table 32 respectively:

Table 31 - AM (08:00 to 09:00) Warwick AQMA Movement Analysis (2028 Ref vs. 2028 PO vs. 2028 SF)

Location	Dir.	2028 Ref	2028 PO	Diff	2028 SF	Diff
Saltisford	SB	654	473	-182	589	-66
	NB	635	516	-118	606	-29
The Butts	SB	385	375	-10	424	39
	NB	455	447	-8	563	108
Bowling Green Street	SB	333	268	-65	321	-12
	NB	913	602	-311	697	-216
Jury Street	WB	375	330	-45	249	-126
	EB	435	336	-99	339	-96
Smith Street	WB	473	469	-5	523	50
S Nicholas Church Street	SB	850	632	-218	1016	165
Total				-1060		-181

Table 32 - PM (17:00 to 18:00) Warwick AQMA Movement Analysis (2028 Ref vs. 2028 PO vs. 2028 SF)

Location	Dir.	2028 Ref	2028 PO	Diff	2028 SF	Diff
Saltisford	SB	673	728	55	688	15
	NB	666	664	-3	625	-41
The Butts	SB	337	378	41	417	80
	NB	411	367	-44	471	60
Bowling Green Street	SB	474	530	56	456	-18
	NB	631	601	-29	629	-2
Jury Street	WB	452	457	5	340	-113
	EB	464	468	4	430	-34
Smith Street	WB	740	672	-68	530	-210
S Nicholas Church Street	SB	865	742	-123	1074	210
Total				-106		-52

It should be noted that the analysis in the previous tables has been extracted for the peak hours only and presents the impact on a particular section of each road rather than the entire length. Thus the results would not correlate directly with the earlier cordon analysis as links such as Castle Hill and Priory Road are excluded from the analysis as are the internal town centre links such as Northgate Street and Barrack St.

Initial analysis of the previous Tables indicates that, within the AM and PM peak hours, the flows within the AQMA areas are likely to drop when compared to the Reference Case. The largest reductions are within the 2028 PO network where there are over 1000 movements less captured in the 2028 PO results when compared to the 2028 PO locations. The results are described as movements rather than flows as there is significant potential for vehicles to be captured in more than 1 location as they travel through the town centre. This means that any reductions reported as a result of the aforementioned analysis will not correlate directly to a reduction in total vehicles.

In general every location within the 2028 PO AM network suffers a reduction which ties in to earlier results analysis. Within the 2028 PO PM network there are still reductions although these are of a smaller magnitude.

Within the 2028 SF network, within both AM and PM model periods, there are increases in the movements captured along The Butts and St Nicholas Church Street. The indication is that the improvements proposed within Warwick town centre are likely to result in greater numbers of movements being recorded coming into the town via Coten End and Cape Road, this results in increases along the Butts and also substantial increases along St Nicholas Church St. St Nicholas Church Street is likely to be the area within Warwick town that suffers the greatest increase in traffic flows within the SF option as the town centre mitigation strategy appears to make the Cape Road, Priory Road and St Nicholas Church St route an attractive route through the centre of Warwick. Similarly Coten End to Banbury Road SB via St Nicholas Church street also becomes a more attractive route to vehicles.

Whilst the initial assumption may be that a reduction in vehicular movements will improve the conditions within the AQMA area it should be noted that a reduction in flow, when coupled with a reduction in average speed, can also have a detrimental effect.

In order to better understand the impacts of either CS option, on the selection of links within the AQMA area that are being assessed, analysis of the mean speed (MPH) that vehicles are travelling along the links at has also been undertaken. This analysis has been presented within the following Table 33 and Table 34 for the AM and PM periods respectively:

Table 33 - AM (08:00 to 09:00) Warwick AQMA Mean Speed (MPH) Analysis (2028 Ref vs. 2028 PO vs. 2028 SF)

Location	Dir.	2028 Ref	2028 PO	Diff	2028 SF	Diff
Saltisford	SB	9.9	4.9	-50%	5.9	-41%
	NB	25.9	21.8	-16%	22.6	-13%
The Butts	SB	5.1	3.6	-29%	4.0	-22%
	NB	18.4	14.3	-22%	22.8	24%
Bowling Green Street	SB	10.4	13.6	31%	12.8	23%
	NB	9.9	9.2	-7%	7.9	-21%
Jury Street	WB	4.0	2.0	-50%	2.7	-33%
	EB	19.1	14.1	-26%	11.6	-39%
Smith Street	WB	25.0	19.4	-22%	22.6	-9%
S Nicholas Church Street	SB	9.8	4.4	-55%	9.9	1%

Table 34 - PM (17:00 to 18:00) Warwick AQMA Mean Speed (MPH) Analysis (2028 Ref vs. 2028 PO vs. 2028 SF)

Location	Dir.	2028 Ref	2028 PO	Diff	2028 SF	Diff
Saltisford	SB	15.0	11.6	-23%	8.6	-43%
	NB	25.1	18.5	-26%	21.9	-13%
The Butts	SB	7.5	6.7	-10%	4.6	-39%
	NB	20.0	13.8	-31%	24.5	22%
Bowling Green Street	SB	15.5	12.5	-19%	15.7	1%
	NB	7.9	7.5	-6%	8.3	4%
Jury Street	WB	7.2	4.9	-31%	4.0	-45%
	EB	21.2	17.3	-18%	18.4	-13%
Smith Street	WB	17.0	7.2	-58%	10.1	-41%
S Nicholas Church Street	SB	19.4	21.2	9%	17.8	-8%

Analysis of the previous Tables reveals that in all but one location in the AM (Bowling Green St NB) and PM (St Nicholas Church Street), the average speed across the selection of links assessed within the Warwick town centre reduces in the PO network. The negative impacts of such a reduction in speeds are likely to outweigh any positive benefits experienced as a result of the reduction in traffic movements through the AQMA areas.

Across the 2028 SF network there are a number of locations where the average speed remains relatively constant or increases The Butts NB and Bowling Green St SB experience higher average speeds in the AM whilst, despite the heavy increase in movements, St Nicholas Church Street remains largely unaffected. Despites these impacts the average speeds on the rest of the links selected for analysis drop in the 2028 SF AM network. Within the PM there is again an increase in average speed along The Butts NB but the speeds across the rest of the areas tend to either stay the same or reduce.

It is interesting to note that during the 2028 AM SF assessment the number of vehicles travelling across ST Nicholas Church St increases but the average speed remains unaffected. Initial analysis appears to indicate that, when the town centre mitigation measures are put in place there is potential to draw more traffic through Cape Road, Priory Road and Coten End, these are areas which are not actually in the AQMA boundary.

10.4 Leamington AQMA Analysis

Analysis of the changes in flow at key locations within the Leamington AQMA site, during the AM and PM peak hour, is presented within the following Table 35 and Table 36 respectively.

Analysis of Tables 35 and 36 reveals that, in general, although movements captured at specific locations, and inevitably the movements through the area, vary between the scenarios and the Reference Case, the net effect of the changes is minimal, particularly during the AM. During the PM there is an increase in the number of movement captured within the 2028 SF AQMA analysis but this still represents an in movements increase of less than 4% when compared to the total movements captured through the AQMA area within the 2028 Reference Case.

Table 35 - AM (08:00 to 09:00) Leamington AQMA Movement Analysis (2028 Ref vs. 2028 PO vs. 2028 SF)

Location	Dir.	2028 Ref	2028 PO	Diff	2028 SF	Diff
Spencer Street	WB	603	931	328	989	386
	EB	136	0	-136	0	-136
Bath Street	SB	501	567	66	625	124
High Street (E of Bath Street)	WB	326	219	-107	195	-131
	EB	515	541	26	572	57
High Street (W of Bath Street)	WB	267	0	-267	0	-267
	EB	855	732	-123	887	32
Clement Street	SB	368	495	128	454	87
	NB	236	304	68	311	75
Tachbrook Road	SB	350	411	61	290	-60
	NB	727	752	24	577	-150
Total				68		16

Table 36 - PM (17:00 to 18:00) Leamington AQMA Movement Analysis (2028 Ref vs. 2028 PO vs. 2028 SF)

Location	Dir.	2028 Ref	2028 PO	Diff	2028 SF	Diff
Spencer Street	WB	818	1186	368	1248	430
	EB	111	0	-111	0	-111
Bath Street	SB	840	791	-50	858	18
High Street (E of Bath Street)	WB	451	306	-144	366	-85
	EB	466	596	131	686	221
High Street (W of Bath Street)	WB	379	0	-379	0	-379
	EB	888	998	110	1078	191
Clement Street	SB	517	452	-65	408	-109
	NB	218	362	144	365	147
Tachbrook Road	SB	502	493	-9	484	-18
	NB	683	608	-75	571	-112
Total				-80		192

As with the analysis of the impacts within the Warwick AQMA boundary, analysis of the mean speeds recorded on the links within the Leamington AQMA area, during the AM and PM peak hours has also been undertaken. This information is presented within the following Table 37 and Table 38 for the AM and PM respectively:

Analysis of the Tables 37 and 38 reveals that the average speed along the links selected within the AQMA areas is likely to drop, when compared to the 2028 Reference Case, in both the 2028 PO and 2028 SF scenarios.

Table 37 - AM (08:00 to 09:00) Leamington AQMA Mean Speed Analysis (2028 Ref vs. 2028 PO vs. 2028 SF)

Location	Dir.	2028 Ref	2028 PO	Diff	2028 SF	Diff
Spencer Street	WB	16.0	9.9	-38%	14.0	-13%
	EB	27.9	0.0		0.0	
Bath Street	SB	16.7	10.3	-38%	10.7	-36%
High Street (E of Bath Street)	WB	28.9	28.0	-3%	27.9	-3%
	EB	31.0	12.8	-59%	10.2	-67%
High Street (W of Bath Street)	WB	27.3	0.0		0.0	
	EB	14.7	5.8	-60%	4.7	-68%
Clement Street	SB	33.8	31.7	-6%	32.4	-4%
	NB	9.1	8.3	-8%	4.5	-51%
Tachbrook Road	SB	30.5	29.6	-3%	30.6	0%
	NB	8.4	10.1	20%	3.9	-53%

Table 38 - PM (17:00 to 18:00) Leamington AQMA Mean Speed Analysis (2028 Ref vs. 2028 PO vs. 2028 SF)

Location	Dir.	2028 Ref	2028 PO	Diff	2028 SF	Diff
Spencer Street	WB	14.5	11.7	-19%	13.7	-6%
	EB	29.3	0.0		0.0	
Bath Street	SB	14.1	13.8	-2%	9.8	-30%
High Street (E of Bath Street)	WB	28.8	28.4	-1%	28.1	-2%
	EB	27.0	21.7	-20%	10.7	-60%
High Street (W of Bath Street)	WB	20.9	0.0		0.0	
	EB	16.6	12.0	-28%	7.7	-54%
Clement Street	SB	33.0	30.7	-7%	32.4	-2%
	NB	4.2	3.8	-10%	3.3	-21%
Tachbrook Road	SB	29.4	30.5	4%	30.5	4%
	NB	5.9	5.4	-9%	4.2	-29%

During the AM analysis the reductions in average speeds in both 2028 PO and SF networks is of a similar magnitude whilst, during the PM analysis, the reductions appear smaller in the PO scenario than the SF scenario. Overall however, it is apparent that introducing signals in this area may have little effect on the overall movements through the area but, at this stage, there may still be impacts in terms of reduced average speeds through the area. There is potential for further optimisation of the scheme in this area to be further optimised to improve the situation and increase the average speeds over those currently presented within the model scenario.

10.5 Summary

10.5.1 Cordon Analysis

Analysis of the impacts on two-way vehicular flow across key cordons around Warwick and Leamington town centres, of the 2028 PO and 2028 SF scenarios when compared to the 2028 Reference Case conditions has been undertaken, as well as the cordon analysis, analysis of the impacts on the AQMA areas within Warwick and Leamington has also been undertaken.

Initial analysis of the impact of the two options on the cordon points across Warwick Town centre indicates that, during the AM, the level of traffic within the town centre is reduced within the PO scenario whilst it increases within the SF scenario. During the PM there are increases in both scenarios although the magnitude of increase is larger within the SF option than the PO option.

In the SF option the largest increase is consistently across the Banbury Road with large increases also experienced across Coten End and Cape Road. Banbury Road and Coten End are both directly controlled by the town centre mitigation scheme and the increases in flow occur as a result of this. The increases across Cape Road may partly be as a result of the town centre improvement scheme but also are likely to be affected by the reassignment of vehicles away from Cape road due to congestion in that area of the network and the impact that it has on the route cost calculations.

Overall the results indicate that, during both PO and SF scenarios the number of vehicles crossing the cordon points surrounding Leamington Town centre will increase in either scenario across both time periods. The increases in the PO scenario are, however over twice the size of the increases in the SF option. This is indicative of traffic avoiding the area around Warwick centre in the PO scenario which results in increased levels of traffic on the outer urban area of Warwick which, in turn, pushes more traffic into the Leamington area. Implementation of the Warwick town centre improvements minimises the potential for this to occur.

In light of the previous findings it was decided that analysis of the changes in two-way flows across the Warwick town centre cordon points should be undertaken for the 2028 PO without NRR scenario to understand the implications that the removal of the NRR may have on movements through the two town centres.

Initial analysis of the impacts on the Warwick cordon indicates that, when the NRR is removed, within the AM period, the number of trips crossing the Warwick town centre cordon points actually reduces further despite the removal of an alternative route around the town centre. Indicating that the conditions in the town centre must worsen, as a result of the removal of the NRR, to such an extent that the network is able to accommodate even less trips and be even less attractive without the NRR than when it is included.

In the PM, however, when the effects of congestion within Warwick town centre are less severe there is a substantial increase in vehicles crossing the cordon points when the NRR is removed compared to the numbers presented with the NRR in place. This is in line with what would be expected in so far as it would be expected that removing additional infrastructure to the north would result in more traffic crossing the cordon points within the town. It is interesting to note that the largest increase, in the PM, is across the Cape road cordon which could indicate that the NRR will provide additional relief to this route into and out of Warwick town.

The number of trips crossing the Leamington town centre cordon points, when the NRR is removed, increases. This is in line with earlier analysis indicating that the NRR is alleviating pressure around Warwick town centre which, when the NRR is removed, becomes more congested and pushes traffic further out onto the wider Warwick network. This traffic, in turn, pushes more traffic into Leamington which is reflected in the increased two way flows across the Warwick cordon points.

In the PM there is a reduction in the number of vehicles crossing the cordon points when the NRR is removed compared to the original PO scenario. This appears to be largely affected by the two way flow across Guy's Cliff Avenue which more than halves in response to the removal of the NRR. This indicates that there is potential for the NRR to draw traffic across Guy's Cliff Avenue. Aside from this reduction there are very few other significant differences within the PM with the exception of the flow crossing the Rugby Road Cordon. This has increased by almost double the flow difference as a result of the removal of the NRR which is indicative of an increase in movements between Warwick and Leamington as a result of the removal of the NRR.

10.5.2 AQMA Analysis

Initial analysis of the impacts on the Warwick AQMA area indicates that, within the AM and PM peak hours, the movements within the area are likely to drop when compared to the Reference Case. The largest reductions are within the 2028 PO network where there are over 1000 movements less captured in the 2028 PO results when compared to the 2028 PO locations. The results are described as movements rather than flows as there is significant potential for vehicles to be captured in more than 1 location as they travel through the town centre. This means that any reductions reported as a result of the aforementioned analysis will not correlate directly to a reduction in total vehicles.

In general every location within the 2028 PO AM network suffers a reduction which ties in to earlier results analysis. Within the 2028 PO PM network there are still reductions although these are of a smaller magnitude.

Within the 2028 SF network, within both AM and PM model periods, there are increases in the movements captured along The Butts and St Nicholas Church Street. The indication is that the improvements proposed within Warwick town centre are likely to result in greater numbers of movements being recorded coming into the town via Coten End and Cape Road, this results in increases along the Butts and also substantial increases along St Nicholas Church St. St Nicholas Church Street is likely to be the area within Warwick town that suffers the greatest increase in traffic flows within the SF option as the town centre mitigation strategy appears to make the Cape Road, Priory Road and St Nicholas Church St route an attractive route through the centre of Warwick. Similarly Coten End to Banbury Road SB via St Nicholas Church street also becomes a more attractive route to vehicles.

Analysis of the impacts on the Leamington AQMA area reveals that, in general, although movements captured at specific locations, and inevitably the movements through the area, vary between the scenarios and the Reference Case, the net effect of the changes is minimal, particularly during the AM. During the PM there is an increase in the number of movement captured within the 2028 SF AQMA analysis but this still represents an in movements increase of less than 4% when compared to the total movements captured through the AQMA area within the 2028 Reference Case.

As with the analysis of the impacts within the Warwick AQMA boundary, analysis of the mean speeds recorded on the links within the Leamington AQMA area, during the AM and PM peak hours has also been undertaken. This information is presented within the following Tables for the AM and PM respectively.

10.6 Conclusions

Based on the initial analysis of the changes in two-way flow across a number of town centre cordon points around both Warwick and Leamington, the following conclusions have been drawn:

- That the number of vehicles crossing the cordon points surrounding Warwick Town centre reduce in the AM PO scenario network when compared to the 2028 Reference case as the lack of mitigation in this area makes it less attractive to vehicles.

- Within the SF scenario there are more vehicles crossing the Warwick Town Centre Cordon points than the PO network as a result of the town centre mitigation but, in both options, during the AM, the area to the Southeast experiences a drop in the number of vehicles crossing the cordon points compared to the Reference Case.

- Within both PO and SF scenario networks the number of vehicles crossing the Leamington cordon point's increases but the increase is far greater within the PO scenario than the SF scenario indicating that when Warwick town centre is less attractive, greater vehicular movements are likely around Leamington town centre.

- Furthermore, the implementation of 'Managed Motorways' in the 2028 SF network is likely to influence the draw of traffic away from Leamington whilst the NRR could have the opposite effect.

The final point above does not necessarily indicate that the Warwick town centre mitigation will result in less vehicles travelling through Leamington, rather it is indicative of the fact that if traffic is more easily able to travel through the area around the Warwick town centre cordon then the number of vehicles using this area will increase. Those vehicles would otherwise reassign and use routes on the outer Warwick network which will, in turn push traffic off these routes and into the Leamington area, thus by including the Warwick town centre mitigation strategy a greater level of demand can be accommodated across the entire network due to the improved capacity within Warwick town centre. Notwithstanding the previous comments, there is also potential within the 2028 SF model network for the implementation of Managed Motorways to draw traffic away from Leamington as the Europa Way SB to M40 route towards the A46 becomes much more attractive when this system is in place.

When considering the effects of 'Managed Motorways' on the movements captured across the Leamington cordon it is not unreasonable to assume that the implementation of dissuasive factors such as congestion charging or gating of traffic through Warwick Town centre could achieve similar consequence for Warwick without severely compromising the operation of Warwick town centre network.

Assessing the impact of the removal of the NRR reveals the following:

- When the NRR is removed, within the AM period, the number of trips crossing the Warwick town centre cordon points actually reduces further despite the removal of an alternative route around the town centre. Indicating that the conditions in the town centre must worsen, as a result of the removal of the NRR, to such an extent that the network is able to accommodate even less trips and be even less attractive without the NRR than when it is included.

- In the PM, when the effects of congestion within Warwick town centre are less severe there is likely to be a substantial increase in vehicles crossing the cordon points when the NRR is removed compared to the numbers presented with the NRR in place.

Consideration has also been given to the impacts on the Warwick and Leamington AQMA area and this has revealed the following:

- That the movements across the Warwick AQMA area within both AM and PM peak hours are likely to reduce in both PO and SF scenarios.
- These reductions in movements are likely to be accompanied by a reduction in average speeds within the area indicating that the positive benefits accrued as a result of the reduction in vehicular movements may be outweighed by a reduction in average speeds within the area.
- The implementation of the Warwick Town Centre mitigation measures appears to have the potential to draw traffic away from the core AQMA area by making Cape Road, Priory Road and Coten End more attractive routes. Further investigation of this is required.
- There are less changes in the movements captured across the Leamington AQMA area but there are still reductions in average speeds on the links within the same area. There is potential for the signalised scheme that has been proposed within this area to be further optimised however meaning that these impacts could be reduced.
- Furthermore, when the signalised scheme was not in place there were significant reductions in the average speed vehicles could achieve within this area that indicates that the implementation of the scheme is still likely to be beneficial regardless of which allocation strategy is adopted.

11 Detailed SF Cordon Testing

11.1 Overview

Once the condition of the 2028 SF model network was deemed of a sufficient standard to inform the overall analysis a set of cordon demands were extracted from the 2028 SF model and transposed into origin-destination matrices which could be assigned within the M40 PARAMICS model and rerun. The purpose of this assessment is to review and refine, in more detail, the mitigation schemes proposed within the M40 and Europa Way areas.

The refined mitigation measures were then re-input into the M40 cordon model alongside a set of cordon demands representing all growth, committed development and CS demands. Background trips were left unadjusted.

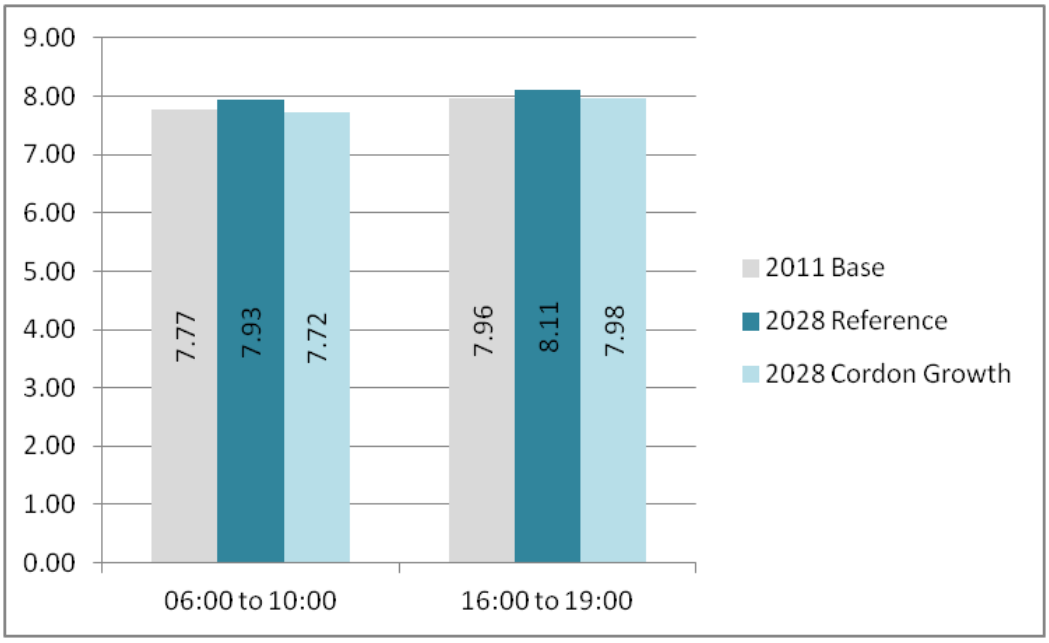
The models were then run to allow a more detailed assessment of the network performance within the Europa Way area to be undertaken inclusive of the effects of trip redistribution in response to the effects of congestion.

11.2 Network Wide Statistics

11.2.1 Average Journey distance

Analysis of the average journey distance within each scenario, across the entire AM and PM model periods, is presented within the following Figure 32:

Figure 32 - Average Journey Distance (2011 Base vs. 2028 Ref vs. 2028 SF Cordon), Km



Analysis of the changes in journey distance indicates that there are few differences in journey distance between the three scenarios. There is a small increase in the 2028 Reference Case scenario indicating some reassignment of route choice and then the distance vehicles travel reduces again indicating that the additional network included within the testing (link from Europa Way to Gallows Hill, extra link from Harbury Lane to Europa Way), alongside the proposed schemes will minimise reassignment and provide some shorter routes when compared to the Reference Case conditions.

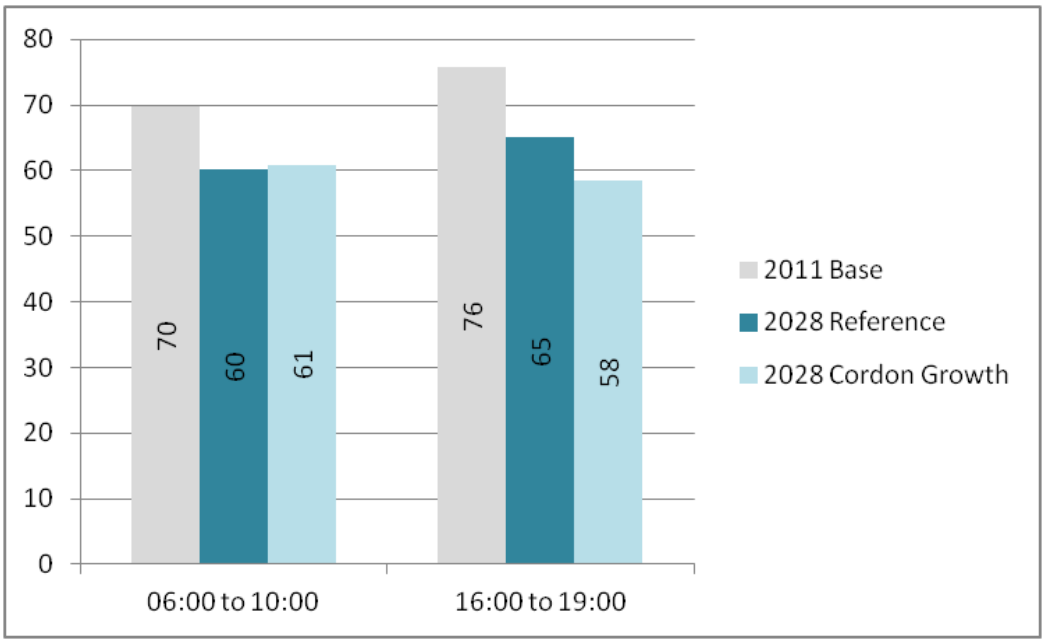
11.2.2 Average Journey Speed

Analysis of the average journey speed (km/h) within each scenario, across the entire AM and PM model periods, is presented within Figure 33 on the following page.

Analysis of Figure 33 indicates that, within the AM, there is little difference in the average speeds between the two 2028 test scenarios whilst, within the AM, the average speeds appear lower within the 2028 SF Cordon network than the 2028 Reference Case network.

This is indicative of the 2028 SF network mitigation implemented within this area is better able to facilitate the flow of traffic into Warwick from the M40 within the AM than the flow out of Warwick towards the M40 within the PM period.

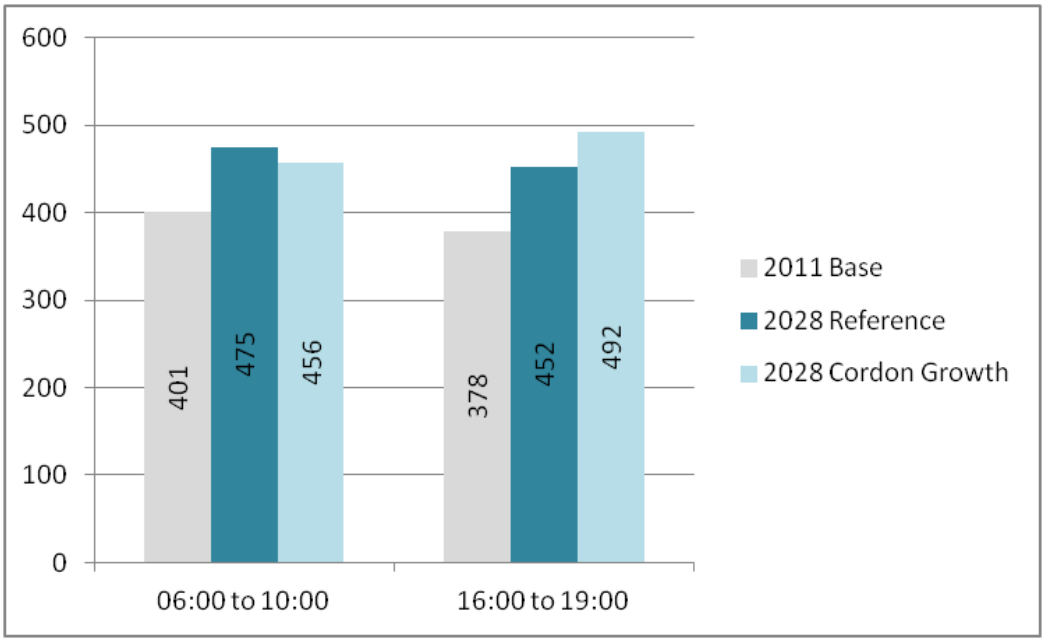
Figure 33 - Average Journey Speed (2011 Base vs. 2028 Ref vs. 2028 SF Cordon), Km/h



11.2.3 Average Journey Time (s)

Analysis of the average journey speed (km/h) within each scenario, across the entire AM and PM model periods, is presented within the following Figure 34:

Figure 34 - Average Journey Time (2011 Base vs. 2028 Ref vs. 2028 SF Cordon), Seconds



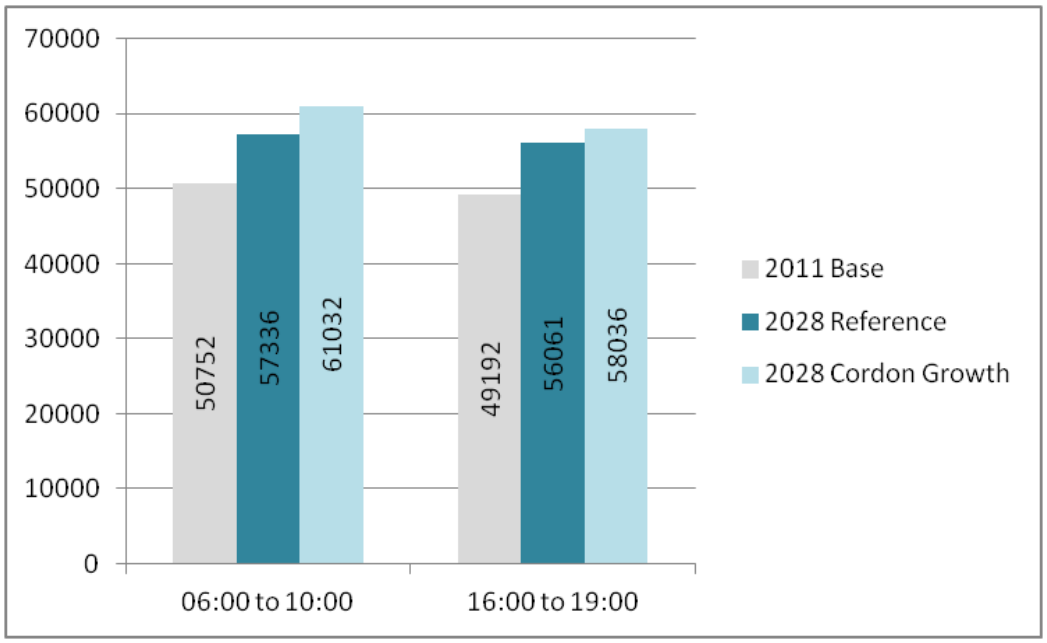
Analysis of the changes in delay between the scenarios corresponds to the mean speed analysis in so far as the fact that vehicles within the 2028 Cordon scenario are likely to experience reduced levels of delay when compared to the 2028

Reference Case but, within the PM, the opposite occurs and delay increases within the 2028 SF Cordon Scenario when compared to the Reference Case.

11.2.4 Completed Trips

Analysis of the total number of completed trips within each scenario, across the entire AM and PM model periods, is presented within the following Figure 35.

Figure 35 - Completed Trips (2011 Base vs. 2028 Ref vs. 2028 SF Cordon), Vehicles



Analysis of Figure 35 reveals that there are a larger number of completed trips within the 2028 SF cordon scenario when compared to the 2028 Reference Case. This is to be expected as the overall level of demand assigned to the 2028 SF Cordon Network is high

Additional analysis of the rate of trip completion has also been undertaken to understand how much of the additional demand is accommodated within the 2028 SF Cordon model period when compared to the 2028 Reference Case. This analysis is presented within the following Table 39:

Table 39 Completed Trip Analysis (2011 Base vs. 2028 Ref vs. 2028 SF Cordon)

	AM (07:00 to 10:00)			PM (16:00 to 19:00)		
	Demand	**Completed Trips**	**Completed %**	**Demand**	**Completed Trips**	**Completed %**
2011 Base	51497	50752	98.6%	49878	49192	99%
2028 Reference (TEMPRO)	59065	57336	97.1%	57750	56061	97%
2028 WLWA Cordon	62788	61032	97.2%	61098	58036	95%

Analysis of the rate of trip completion reveals that, during the AM, the number of trips that are completed, as a proportion of the overall assigned demand increases

within the AM and decreases within the PM. The evidence from the AM analysis is that there is potential for the schemes proposed within this area to accommodate demand levels over and above those predicted

11.3 Mean Speed Analysis

The following sets out some initial observations of the mean speed plots of the various M40 corridor model scenarios. The comments are based on observations in the changes in predicted mean speeds across links within the model area.

11.3.1 2011 M40 Corridor Conditions (MS025 & MS026)

The baseline plots have been included within this analysis as they provide a useful indication of current network conditions within the area. Problems travelling NB into Warwick from the M40 are frequently observed to result in queue propagation back from the Europa Way roundabout onto the M40 mainline. These queues are a regular occurrence and are indicated within the mean speed plots by the low average speeds along the section of network between the M40 and Europa Way roundabout. Low speeds on the Banbury Rd (S) and Myton Road approaches to the Myton Road/Banbury Road roundabout are also apparent within the AM network.

During the PM the mean speed analysis demonstrates a shift in the direction in which the low speeds are experienced. Low average speeds are now present along the SB section of the network between Europa Way roundabout and the M40 J14.

11.3.2 2028 Reference Case Conditions (MS027 & MS028)

When analysing the AM network conditions within the 2028 Reference Case network it is apparent that the low average speeds experienced by vehicles travelling NB through the network has shifted northwards, this is as a result of the inclusion of the J14 proposals and, specifically, amendments at Grey's Mallory and Europa Way roundabouts. Issues at the Banbury Road/Myton Road roundabout result in the propagation of low speeds back from the junction along both Myton Road and Banbury Road. The low speeds on Banbury Road can be observed to extend back through the junction with Gallows Hill as well as along Gallows Hill Itself.

When analysing the PM network conditions there is a clear general, lowering of speeds along the Europa Way corridor travelling SB. The low speeds appear to originate at the entry point to the J14 slip demonstrating that this location is likely to act as a 'pinch point' on the network constraining the amount of demand that can be released onto the M40. Furthermore, lower speeds on the Myton Road WB approach to the roundabout with Banbury Road indicate that this location is likely to act as a constraint to growth in both AM and PM model periods by the time 2028 growth levels are realised.

11.3.3 2028 Cordon SF Growth Conditions (MS031 to MS032)

Analysis of the AM network conditions reveals that the mitigation implemented along Europa Way corridor and Gallows Hill is likely to improve the average speeds that vehicles travel through this section of network when compared to the

2028 Reference Case despite the additional demand assigned to the network. Low speeds on the Harbury and Heathcote Lane approaches to Europa way roundabout indicate that further attention may be required in this area but the higher average speeds on the other approaches to the roundabout could indicate that further benefits could be unlocked through further optimisation of the signals proposed in this area. Speeds along the Banbury Rd NB approach to the junction with Myton Rd have also improved, when compared to the Reference Case, as a result of the implementation of the signalised scheme in this area. Low speeds on the Myton Rd EB approach to this junction indicate that the signals proposed within this area would benefit from further optimisation.

When analysing the PM network performance it is clear that further optimisation of the scheme proposed at the Ford Foundry roundabout is required. Low speeds on the links approaching this junction from the south propagate back as far as the Europa Way roundabout. This has a significant impact on the performance of the Shires Retail Park roundabout as well. Similarly low speeds on the Myton Road and Banbury Road NB approaches to the Myton Road/Banbury Road junction indicate that further optimisation of the scheme in this area is required when considering the implementation within the PM period.

11.4 Summary

Once the condition of the 2028 SF model network was deemed of a sufficient standard to inform the overall analysis a set of cordon demands were extracted from the 2028 SF model and transposed into origin-destination matrices which could be assigned within the M40 PARAMICS model and rerun. The purpose of this assessment is to review, in more detail, the mitigation schemes proposed within the M40 and Europa Way areas. In particular a review was undertaken of the performance of these schemes when the reassignment of routes away from the area was accounted for.

Analysis of the network wide statistics has been undertaken and this has revealed that there is potential for the implementation of the proposed schemes to improve network conditions beyond those experienced within the 2028 Reference Case, in particular, vehicles are able to travel shorter distances at quicker speeds and spend less time within the model network when the schemes and developments are included within the assessment. This situation does not manifest within the PM assessment as analysis of the network wide statistics reveals a general worsening of conditions when the schemes and the development are included within the assessment. When the impact on network wide statistics is reviewed in the context of the changes in the mean speeds it is apparent that further optimisation of the schemes proposed at the Ford Foundry and Myton Road/Banbury Road junctions is required.

11.5 Conclusion

Based on the initial analysis of the changes in network conditions, within the M40 model, between the 2028 Reference Case and 2028 Cordon SF Demand scenarios, the following conclusions have been drawn:

- That, in general, network wide statistics improve in the scenario containing the developments and schemes during the AM and

- Assessment of the changes in AM network conditions between the two scenarios indicates that conditions are likely to improve along Europa way between the M40 and Europa Way roundabout as well as along Gallows Hill. The schemes either side of Myton road will require further attention to minimise impacts of congestion in those areas.

- Differences in the PM network performance between the two 2028 scenarios reveals that low speeds experienced by vehicles travelling SB along the Europa Way corridor towards the M40 increase when the schemes and developments are included. The problems within the PM network appear to manifest at the Ford Foundry roundabout indicating that further optimisation of this scheme is required to improve conditions in this area. Similarly low speeds on the Myton Road and Banbury Road approaches to the Myton Road/Banbury Road junction indicates that further optimisation of this scheme is required within the PM period.

12 Summary & Conclusions

12.1 Summary

Arup have been commissioned by Warwickshire County Council (WCC) to undertake additional testing of the Warwick District Council (WDC) Core Strategy allocations, identify the potential impacts and investigate mitigation schemes. The impacts of two different allocation strategies have been assessed, namely:

- WDC Southern Focus (SF) – whereby the growth associated with the Core Strategy has been focussed in sites to the South of Warwick
- WDC Preferred Option (PO) – whereby growth has been focussed within the areas of Warwick and Leamington in line with the preferred approach outlined by WDC.

12.2 Scenario Demand

The two scenarios that have been tested both contain consistent assumptions regarding dwellings and employment rates, the primary change between the two options is the allocation of development. Both scenarios have been subjected to mode shift, internalisation and peak spreading procedures. Growth within both scenarios has been capped so as not to exceed the levels of growth predicted by the TEMPRO database, after adjustments for national trends (NTEM Adjusted TEMPRO).

12.3 Stages of Assessment

A number of objectives have been addressed within this study through a staged approach to the assessment. The initial assessment stage gives an understanding of whether the growth proposed within the Southern Focus option could actually be accommodated within the existing network and what mitigation would be required to facilitate the delivery of such a growth option. The conclusion of this initial stage of the assessment was that the full extent of the SF growth allocation could be accommodated within the local network but wider effects such as redistribution and impacts in areas further away from the Europa Way corridor need to be considered in more detail.

Following on from this the following stages of assessment were undertaken:

- Stage 1 – Assess the impacts of the 2028 PO and SF allocation strategies, against the 2028 Reference conditions.
- Stage 2 – Identifies any changes, to the previous scenarios, which occur as a result of the additional draw between the sites and the Coventry and Warwickshire Gateway development.
- Stage 3 – Assesses the need for the Northern Relief Road and provides analysis of potential alternatives.
- Stage 4 – Looks at the impact of the various options on vehicle flows into and out of the towns as well as around key AQMA locations.
- Stage 5 – looks in detail at the impact of the SF allocation on the Europa Way corridor and immediate surrounding area.

The methodology for establishing the Reference Case conditions used in the aforementioned stages of assessment are outlined within Section 3 of this report.

A summary of the findings obtained through each of the key stages of the assessment is provided at the end of every section of the report through which they have been detailed.

12.4 Conclusions

The key conclusions drawn from each stage of the assessment are summarised as follows:

12.4.1 2028 PO vs. 2028 SF Testing

The first stage of the assessment was to review the performance of the SF and PO options in comparison to the existing 2028 Reference Network.

The initial comparisons between the 2028 SF and PO network performance reveals the following conclusions:

- Inclusion of either option will result in an increase in journey times and a reduction in average speeds experienced by all vehicles travelling within the network when compared to the 2028 Reference Conditions.
- There is little difference between either network in the PM when considering the analysis of network wide statistics.
- That the SF network performs better than the PO network in the AM period.
- The areas where the PO performs poorly, in the AM analysis, are to the south and east of Warwick and around the M40. The SF option contains mitigation in both of these areas, some of which would also be beneficial if provided as part of the PO mitigation package
- That both options accommodated between 5 and 7% greater levels of demand than the reference case and, with the exception of the PO AM network performance, both options result in more trips being completed (as a ration of those released on the network) than is achieved within the 2028 Reference Case.
- Both options have the potential to improve queuing conditions compared to the Reference Case in certain areas despite the additional demand being assigned to the network.
- Some areas are consistently identified as requiring further attention irrespective of the option assessed (although the severity of the impacts can differ). These are:
    - M40 Junction 15
    - Europa Way NB in the area of Shires Retail Park roundabout
    - South and East of Warwick Town Centre
    - A452/Stoneleigh Road roundabout
    - Heathcote Lane/Tachbrook Road signalised junction

12.4.2 C&WG Assessment

The second stage of the assessment was to look into the effects of Coventry and Warwickshire Gateway (C&WG) on the performance of the respective options. It is estimated to create up to 10,000 jobs for the area. The potential for this site to draw development traffic away from Warwick and Leamington and the likely associated impacts should be assessed.

The initial comparisons of the model network performance both with and without C&WG reveal the following conclusions.

- The SF AM period mitigated network is more able to accommodate the additional pressures incurred as a result of the C&WG inclusion than the PO
- There is a potential need for the Warwick Town Centre improvements and managed motorway schemes to be considered in both PO and SF options should the C&WG be included.
- During the AM period, conditions to the south and east of Warwick appear to worsen when C&WG is included, this could indicate a need for further mitigation in this area.
- The area of Shires Retail Park has again been identified as requiring further attention.

12.4.3 Northern Relief Road Assessment

The next stage of this study was intended to assess whether there was potential for the PO allocation to come forward without the need to deliver the Northern Relief Road (NRR).

Two scenarios were initially tested:

- PO NRR01 – NRR removed and A452 upgraded to two lanes from just north of Northumberland Avenue to the A46. Additional SB merge provided so vehicles can merge onto the A46 SB from two lanes.
- PO NRR02 – As above but with two critical junctions along the A452 (Blackdown & Bericote) reconfigured to signalised crossroads.

Initial analysis indicated that the reconfiguration of roundabouts along the A452 to signalised junctions provided improved network performance. Meaning the more detailed stages of analysis focussed only on the PO NRR2 described previously.

Based on the analysis of the outputs from this stage of testing, the following conclusions were drawn:

- That the network is likely to become more unstable as a result of the removal of the NRR and that these effects are most obvious within the AM model period. Furthermore, the level of instability exemplified within the scenario models is comparable to that which is contained within the PO + C&WG assessment. It is reasonable to conclude that the cumulative effects of both scenarios in unison (i.e. PO + C&WG and PO + no NRR combined) will be further amplified and may require significant additional mitigation to facilitate.

- Removal of the NRR will result in a general increase in delay experienced by all vehicles travelling along the network and a lowering of average speeds. Furthermore the impacts appear larger in the AM than the PM period.

- The overall improvements in network performance as a result of the inclusion of the A452 signal schemes, when compared to the A452 roundabout option, indicates that signals may provide the optimum control strategy for the A452 irrespective of whether the NRR is included or not.

- Mean speed analysis indicates that routes into Warwick town centre area likely to suffer more from the effects of congestion, during the AM period, when the NRR is removed compared to when it is included. Coupled with the poor AM performance of the PO network in this area, this indicates that town centre works are likely to become essential if the PO allocation strategy is progressed without the NRR.

12.4.4 AQMA and Cordon Assessment

More detailed analysis of the changes in two-way vehicular flow across various locations was also undertaken during the final stage of the strategic level assessment. Two stages of analysis were undertaken; firstly,

- Cordon flows have been extracted and analysed to assess town centre traffic movements around both Warwick and Leamington towns.
- Analysis was then undertaken to look at the potential impacts in and around the AQMA areas of both Warwick and Leamington.

Based on the initial analysis of the changes in two-way flow across a number of town centre cordon points around both Warwick and Leamington, the following conclusions have been drawn:

- That the number of vehicles crossing the cordon points surrounding Warwick Town centre reduce in the AM PO scenario network when compared to the 2028 Reference case as the lack of mitigation in this area makes it less attractive to vehicles.

- Within the SF scenario there are more vehicles crossing the Warwick Town Centre Cordon points than the PO network as a result of the town centre mitigation but, in both options, during the AM, the area to the Southeast experiences a drop in the number of vehicles crossing the cordon points compared to the Reference Case.

- Within both PO and SF scenario networks the number of vehicles crossing the Leamington cordon points increases but the increase is far greater within the PO scenario than the SF scenario indicating that when Warwick town centre is less attractive, greater vehicular movements are likely around Leamington town centre

The final point above does not necessarily indicate that the Warwick town centre mitigation will result in less vehicles travelling through Leamington, rather it is indicative of the fact that if traffic is more easily able to travel through the area around the Warwick town centre cordon then the number of vehicles using this

area will increase. Those vehicles would otherwise reassign and use routes on the outer Warwick network which will, in turn push traffic off these routes and into the Leamington area, thus by including the Warwick town centre mitigation strategy a greater level of demand can be accommodated across the entire network due to the improved capacity within Warwick town centre.

Assessing the impact of the removal of the NRR reveals the following:

- When the NRR is removed, within the AM period, the number of trips crossing the Warwick town centre cordon points actually reduces further despite the removal of an alternative route around the town centre. Indicating that the conditions in the town centre must worsen, as a result of the removal of the NRR, to such an extent that the network is able to accommodate even less trips and be even less attractive without the NRR than when it is included.

- In the PM, when the effects of congestion within Warwick town centre are less severe there is likely to be a substantial increase in vehicles crossing the cordon points when the NRR is removed compared to the numbers presented with the NRR in place.

Consideration has also been given to the impacts on the Warwick and Leamington AQMA area and this has revealed the following:

- That the movements across the Warwick AQMA area within both AM and PM peak hours are likely to reduce in both PO and SF scenarios.

- These reductions in movements are likely to be accompanied by a reduction in average speeds within the area indicating that the positive benefits accrued as a result of the reduction in vehicular movements may be outweighed by a reduction in average speeds within the area.

- The implementation of the Warwick Town Centre mitigation measures appears to have the potential to draw traffic away from the core AQMA area by making Cape Road, Priory Road and Coten End more attractive routes. Further investigation of this is required.

- There are less changes in the movements captured across the Leamington AQMA area but there are still reductions in average speeds on the links within the same area. There is potential for the signalised scheme that has been proposed within this area to be further optimised however meaning that these impacts could be reduced.

- Furthermore, when the signalised scheme was not in place there were significant reductions in the average speed vehicles could achieve within this area that indicates that the implementation of the scheme is still likely to be beneficial regardless of which allocation strategy is adopted.

13 Recommendations

Once the preferred option to the allocation of growth has been determined there are number of recommendations that should be considered during a second, more detailed stage of testing:

13.1 Modelling Assumptions

A modal shift allowance was made for all sites of 15% whilst sites which contained an element of Residential and Employment were subject to a further 10% reduction to allow for internalisation. At this stage these factors have been applied on the basis that they are in line with what was adopted during the earlier STA work. ***It is recommended that, once the final option for the allocation of growth is determined, testing is undertaken both with and without these assumptions attributed to the developments.***

It is recommended that a sensitivity test be undertaken during the next stage of testing whereby unadjusted growth is assigned to the model network in order to identify further areas that may require additional mitigation. Such schemes would be difficult to secure in the short term as the growth levels required to trigger the need for these schemes is difficult to justify. The purpose of any sensitivity test would be to provide an indication of any further mitigation that may be required over and above that which can be attributed, and delivered, by the respective CS growth options.

The PM peak spreading proportions were readjusted within the PM period to ensure that demand in the 1600 to 1700 hour did not exceed the level of demand within the 17:00 to 18:00 peak hour. ***Whilst testing without any application of peak spreading assumptions is not likely to yield acceptable results due to the general bias towards the peak hour, it is recommended that, once the final option for the allocation of growth is determined, testing is undertaken both with and without the revised PM spreading assumptions attributed to the model demands.***

13.2 Mitigation Refinement

Any subsequent stage of testing should look to refine and improve the mitigation that has been tested within this phase of the assessment. Certain areas such as southeast Warwick and the Heathcote Lane/Tachbrook Road signalised junction have been identified as being areas that may benefit from the implementation of mitigation.

Other areas such as the Shires Retail Park and Ford Foundry Roundabouts are areas that have been identified as performing poorly despite the inclusion of mitigation within these areas, consideration should be given to the optimisation of these and other mitigation schemes proposed throughout the modelling.

13.3 Widening the Scope

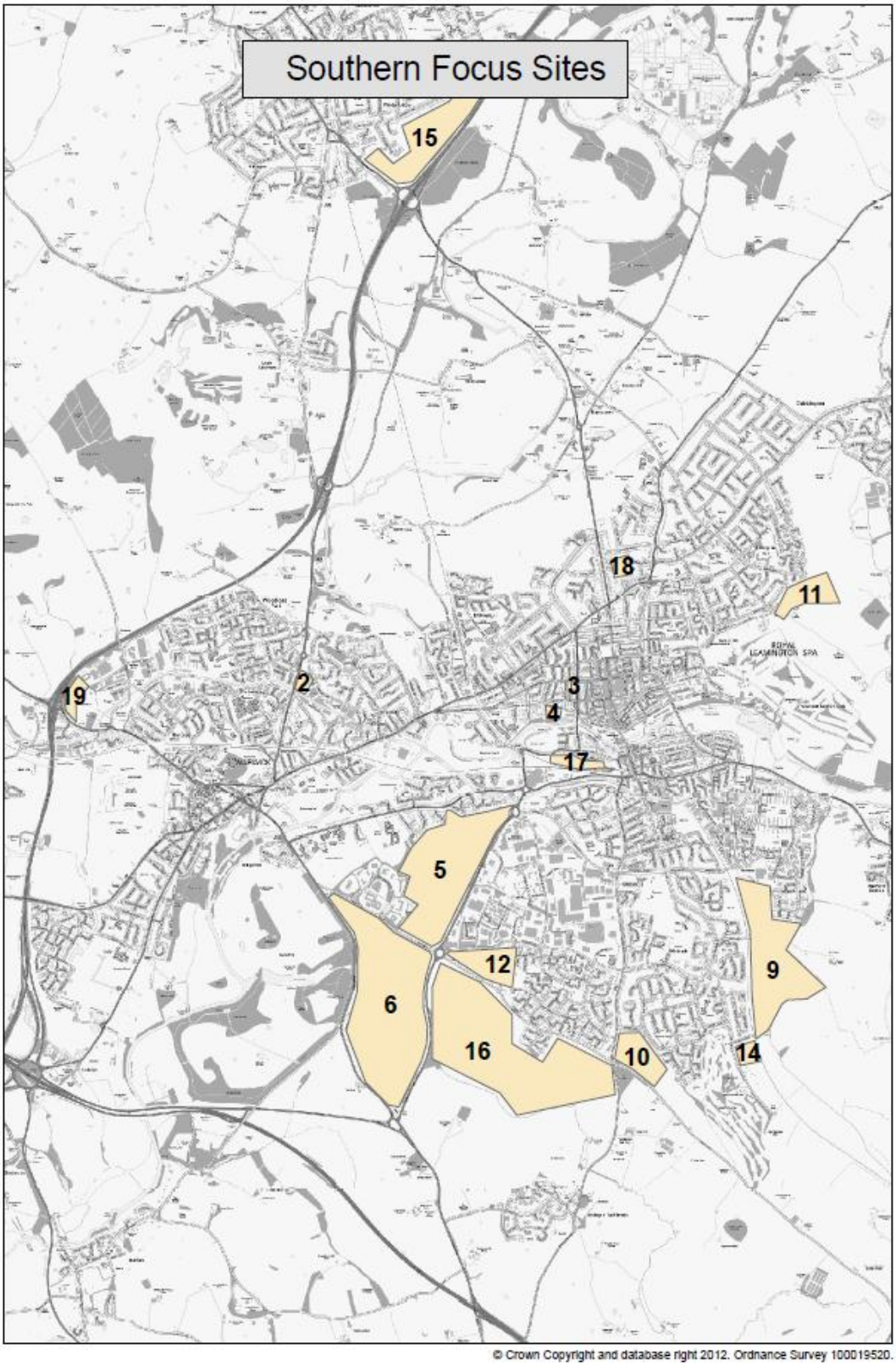
The focus of this stage of assessment has always used the existing Warwick and Leamington and the M40 Corridor PARAMICS models to inform the assessment. The strength of using the Corridor model is that is calibrated and validated to a

higher degree of accuracy within the corridor area. The problem is that the M40 corridor model does not take account of the wider effects if route choice and congestion across the wider area. Thus it is proposed that any future assessment should continue with the same hierarchical approach to the modelling of impacts as has already been adopted. Any further assessment scope should, however, be widened to include the Kenilworth and Stoneliegh and the A452 Corridor models in a manner consistent with the approach taken to date.

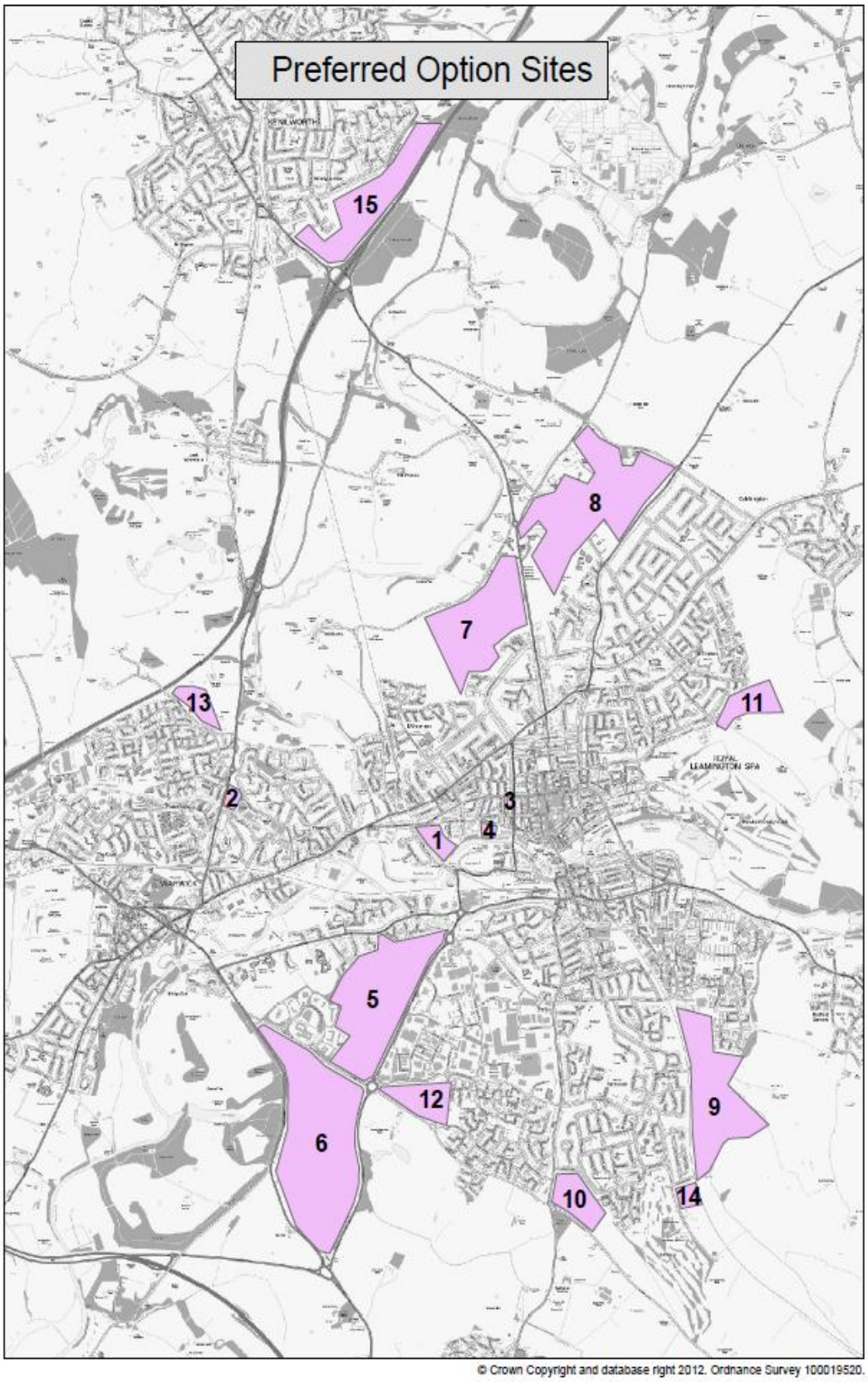
Appendix A

Core Strategy Option Testing - Site Locations

A1 Southern Focus Site Locations



A2 Preferred Option Site Locations



Appendix B

2028 Reference Network Amendments

B1 2028 Reference Network Amendments

Change	Description	Location
Clear Exit Adherence	Clear exit adherence factors of 100 have been applied to movements which suffer significantly from exit blocking. Applying factors to these movements reduces the number of times stationary and slow moving queues block back and prevent vehicles using links to adjacent junctions.	CEA factors of 100 have been applied to the appropriate movements at the junctions governed by the following nodes: 2425, 1705, 92, 95, 99, 1717, 168, 476, 1648, 2431, 2066, 2060, 2052, 3353y, 1820, 1822, 1827, 1973
Average Profile	The cumulative release profile across the entire model has been calculated and assigned to control the release of growth and CS specific demands	n/a
Headway & Urban Links	A particular failing of pre-2011.1 versions of PARAMICS is the failure of vehicles to perceive more than one hazard at a time on highway links. Coupled with this is the issue whereby as demand on highway links increases, the higher speed differential can often cause 'phantom' jam effects to occur on sections of highway. To overcome this, all highway links were switched to urban classification and headway factors of 0.5 were added to the links to which ramps are connected. A preceding HF of 0.75 and a following HF of 0.5 was adopted on adjacent links at the same time.	These changes were applied to all highway links along the A46 and M40 as well as all areas of the network where ramps have been adopted. As well as this the headway factor was applied to M40 J15 Longbridge Island to improve throughput, this is acceptable in light of the fact that, without the direct implementation of MOVA within the model, the throughput of this junction is probably being underestimated anyway.
Major/ Minor	Inconsistent application of link classification. Links through the IBM/Opus 40 site near Stanks Island had been set partly minor and partly major. The minor link classification was applied throughout this section of the network.	All links within the IBM/Opus 40 section of the network have been reclassified as minor.
Mini – Roundabout priorities	Two mini roundabouts exist in Leamington that have been included within the model by simply assigning all approaches with medium priority. The throughput at these junctions frequently causes extensive queuing even if there is no need for traffic to yield before entering the junctions. By switching a couple of priorities from medium to major it is possible to improve throughput without significantly altering the fundamental operation of the junction.	The northbound movement across node 3338y and the left turn at 3344y have both been set to major priority.
Closed links	Inclusion of unnecessary links, which do not present realistic or viable alternative routes, can cause unnecessary issues in the future year model as the increase in demands causes the link utilisation to increase disproportionately which can, in turn, increase the frequency of model lock ups.	Links 3230z:187 and 2428:2472z have been closed.

Appendix C

Core Strategy Developments - Modelled Trip Generation Tables

C1 Southern Focus Hourly Trip Generation Totals

SITE			07:00 to 08:00		08:00 to 09:00		09:00 to 10:00		16:00 to 17:00		17:00 to 18:00		18:00 to 19:00	
			Arr.	Dep.	Arr.	Dep.	Arr.	Dep.	Arr.	Dep.	Arr.	Dep.	Arr.	Dep.
Stoneleigh Park	0	0	421	72	757	111	439	98	109	383	91	670	46	238
Thickthorn	1	900	143	213	246	313	173	160	229	156	303	220	224	121
Red House Farm	4	54	13	56	20	82	21	38	59	20	82	20	62	20
Fieldgate Lane	6	94	6	27	10	39	10	18	28	9	39	10	29	9
Woodside Farm	7	901	17	70	26	102	26	47	74	25	102	26	78	25
South of Sydenham	8	80	43	182	66	265	68	122	193	64	265	66	202	65
Warwick Gates	9	904	23	52	38	76	30	37	55	28	75	35	56	24
Myton Garden	10	902	127	287	211	421	166	203	306	152	414	194	311	131
Castle Park	11	903	184	416	306	609	240	295	444	221	600	281	450	190
South of Harbury ln	12	904	270	611	449	894	353	433	652	324	881	413	661	279
Leam Fire Station	b	41	3	14	5	20	5	9	15	5	20	5	16	5
ibm Car Park	c	160	7	28	10	41	10	19	30	10	41	10	31	10
Montague Road	e	362	5	22	8	33	8	15	24	8	33	8	25	8
Riverside House	g	326	3	14	5	20	5	9	15	5	20	5	16	5
Lapworth	v1	520	7	28	10	41	10	19	30	10	41	10	31	10
Hampton Magna	v2	209	7	28	10	41	10	19	30	10	41	10	31	10
Barford	v3	208	7	28	10	41	10	19	30	10	41	10	31	10
Bishops Tachbrook	v4	206	7	28	10	41	10	19	30	10	41	10	31	10
Radford Semele	v5	533	7	28	10	41	10	19	30	10	41	10	31	10
Rowington	v6	520	4	15	6	22	6	10	16	5	22	6	17	5
Shrewly	v7	520	4	15	6	22	6	10	16	5	22	6	17	5
Hatton	v8	520	4	15	6	22	6	10	16	5	22	6	17	5
Norton Lindsey	v9	518	4	15	6	22	6	10	16	5	22	6	17	5
Cubbington	v10	532	4	15	6	22	6	10	16	5	22	6	17	5
Leek Wootton	v11	201	4	15	6	22	6	10	16	5	22	6	17	5
Burton Green	v12	502	4	15	6	22	6	10	16	5	22	6	17	5
TOTAL			3635		5635		3317		3992		5382		3699	

C2 Preferred Option Trip Generation Totals

SITE		07:00 to 08:00		08:00 to 09:00		09:00 to 10:00		16:00 to 17:00		17:00 to 18:00		18:00 to 19:00	
		Arr.	Dep.	Arr.	Dep.	Arr.	Dep.	Arr.	Dep.	Arr.	Dep.	Arr.	Dep.
stonely park	0	421	72	757	111	439	98	109	383	91	670	46	238
thickthorn	15	143	213	246	313	173	160	229	156	303	220	224	121
red house farm	11	13	56	20	82	21	38	59	20	82	20	62	20
fieldgate lane	14	3	14	5	20	5	9	15	5	20	5	16	5
woodside farm	10	17	70	26	102	26	47	74	25	102	26	78	25
south of sydenham	9	43	182	66	265	68	122	193	64	265	66	202	65
warwick gates	12	24	52	40	76	31	37	56	28	75	36	56	24
myton garden	5	131	287	219	420	170	204	306	156	414	201	310	133
castle park	6	191	417	318	611	248	297	446	227	602	292	451	194
leam fire station	3	3	14	5	20	5	9	15	5	20	5	16	5
montague road	2	5	22	8	33	8	15	24	8	33	8	25	8
riverside house	4	3	14	5	20	5	9	15	5	20	5	16	5
lapworth	v4	7	28	10	41	10	19	30	10	41	10	31	10
hampton magna	v3	7	28	10	41	10	19	30	10	41	10	31	10
barford	v1	7	28	10	41	10	19	30	10	41	10	31	10
bishops tachbrook	v2	7	28	10	41	10	19	30	10	41	10	31	10
radford semele	v5	7	28	10	41	10	19	30	10	41	10	31	10
rowington	v10	4	15	6	22	6	10	16	5	22	6	17	5
shrewly	v11	4	15	6	22	6	10	16	5	22	6	17	5
hatton	v7	4	15	6	22	6	10	16	5	22	6	17	5
norton lindsey	v9	4	15	6	22	6	10	16	5	22	6	17	5
cubbington	v6	4	15	6	22	6	10	16	5	22	6	17	5
leek wootton	v8	4	15	6	22	6	10	16	5	22	6	17	5
burton green	v12	4	15	6	22	6	10	16	5	22	6	17	5
warwickshire colleg	1	20	84	31	122	31	56	89	29	122	31	93	30
north of milverton	7	109	240	182	351	142	170	256	130	345	168	259	111
loes farm	13	12	50	18	73	19	34	53	18	73	18	56	18
blackdown	8	158	346	264	507	205	246	369	188	499	242	374	160
TOTAL		3737		5791		3408		4105		5532		3807	

Appendix D

Mitigation Schedule, Grading & Outline Costs

D1 Mitigation Overview

D1.1 Grading

- **GRADE 1 - Included Essential** – A scheme identified at an early stage of the assessment that has been included within the modelling and is likely to be essential in maintaining network operation and conditions should the respective CS option come forward
- **GRADE 2A - Included Desirable -** A scheme identified during the assessment that has been included within the modelling, implementation of the scheme is desirable to ensure maintenance of network operation and conditions should the respective CS option come forward. Further investigation may be required to determine whether the scheme is essential.
- **GRADE 2B – Desirable** – A scheme not included within the assessment but likely to have benefits should it be implemented alongside the respective CS option.
- **GRADE 3 -Not Determined** – A scheme not included within the assessment that may still have potential benefits, further investigation may be required before this scheme is ruled out for implementation alongside the respective CS option.

D2 Mitigation Schedule

Scheme	Status		Notes	Indicative Costs
	SF	PO		
Thickthorn Roundabout	Grade 1	Grade 1	Both Schemes are intrinsically linked to the Thickthorn CS Site	1,000,000
Kenilworth Gyratory	Grade 1	Grade 1		500,000
A452/Bericote Roundabout	Grade 2A	Grade 1	Signals adhere better to K2L Cycle aspirations. Growth in North more likely to trigger need for delivery.	500,000
A452/Blackdown Roundabout	Grade 2A	Grade 1	Signals adhere better to K2L Cycle aspirations. Growth in North more likely to trigger need for delivery.	500,000
A452 Spinney Hill Roundabout	Grade 2A	Grade 1	Requirement for junction in SF CS option is likely to be less provided the route into Warwick from the South (Europa Way Corridor) can be maintained (ATM implementation)	500,000
Emscote Road/Greville Road	Grade 1	Grade 1	Schemes need to be implemented in unison to maintain functionality of Emscote Road Corridor	400,000
Princes Drive/Warwick New Road	Grade 1	Grade 1		400,000
Bath Street/High Street	Grade 1	Grade 1	Potential to provide opportunity for PT interchange facilities along High Street	500,000
Adelaide Road/Avenue Road	Grade 1	Grade 2A		400,000
Dormer Place/Adelaide Road	Grade 1	Grade 2B		400,000
Myton Road Roundabout	Grade 1	Grade 2B	Potential for synchronisation of these signal schemes with between each scheme as well as with existing Coventry Road/Coten End signalised junction increases overall potential benefit of implementation substantially.	500,000
Priory Road/Smith Street/St Nicholas	Grade 1	Grade 2B		400,000
Castle Hill Gyratory Signals	Grade 1	Grade 2B		400,000
Europa Way/Myton Road Roundabout	Grade 1	Grade 2B	A set of smaller signalisation schemes may be desirable as a result of the PO allocation. Any such scheme would be likely to be best implemented in the form of signalised roundabouts in one or both locations.	500,000
Shires Retail Park	Grade 1	Grade 2B		500,000

Roundabout				
Europa Way Roundabout	Grade 1	Grade 1	A smaller version of the scheme could be required to facilitate PO allocations in comparison to SF	500,000
Grey's Mallory Roundabout	Grade 1	Grade 3	Signalisation may be required in the PO but further enhancements above recent J14 proposals, outside of signals, are unlikely if PO allocation is adopted.	500,000
Europa Way Corridor – Part 1	Grade 1	Grade 1	Sections of the route will require dualling. It is imperative that queuing onto the M40 mainline is avoided	5,000,000
Europa Way Corridor – Part 2	Grade 2A	Grade 3	Sections of this route may require dualling It is imperative that queuing onto the M40 mainline is avoided	5,000,000
Gallows Hill – 2 Lanes	Grade 1	Grade 3	Schemes should be implemented in unison to achieve maximum benefit	500,000
Banbury Road – 2 Lanes	Grade 1	Grade 3		500,000
ATM "Managed Motor Ways"	Grade 1	Grade 2B/3	ATM Gantries and hard shoulder running required between J15 and 14 in both directions. Would have to be part of a much wider "Managed Motorway" Strategy, perhaps down to J12. HA are receptive to such ideas. A appropriate contribution may be in the region of £10m, total costs would be far greater but could not be attributed to developments	10,000,000
Junction 13 improvements	Grade 2B	Grade 2B	Signalisation of slips	500,000
A46/Gaveston Roundabout Signalisation	Grade 2a	Grade 2a	MOVA on A46 approaches	500,000
Leamington Northern Relief Road (LNRR)	NA	Grade 2A	The route would link an upgraded Old Milverton Lane or would utilise Milverton development site distributor roads to link to the A429/A46 grade separated junction.	20,000,000
Further Capacity/PT Improvements on A452 between Kenilworth and Leamington	Grade 3/ NA	Grade 1/3	These schemes may involve dualling sections or widening to provide additional link capacity, bus lanes and bus priority schemes to encourage modal shift and should complement the K2L proposals and junction capacity improvements. Chesford bridge may require widening works.	5,000,000
Dalehouse Lane roundabout flare extensions, A46/C32 Signalisation and C32/B4115 Roundabout	Grade 2B	Grade 2B	Delivered by Stoneleigh Park and Coventry & Warwickshire Gateway.	Will be delivered as part of other developments

Kenilworth Station	Grade 2a	Grade 2a	WCC has a shovel ready scheme for this location, we are currently seeking funding, this may be achieve prior to adoption of the local plan and thus may not be required as part of the mitigation package. Included in terms of modal shift assumption (15%)	May already have funding, £1m if other funding streams fail
Town Centre Improvements	Grade 2B	Grade 2B	Leamington in particular has significant pressure on town routes. Careful consideration needs to be given as to whether additional capacity should provided where possible in order to alleviate these town routes, whether further improvements to sustainable infrastructure such as further cycle route provision, bus priority and crossing facilities with the aim of reducing demand or divert the funds for use on the wider highway network on order to provide realistic alternatives to using town centre through routes. The funding pool could be used for any of these options or combinations and may require involvement of stakeholder groups to decide the most appropriate way to use the fund.	2,000,000
Sustainable Travel Infrastructure	Grade 2a	Grade 2a	Extensive sustainable travel infrastructure should be constructed to encourage modal shift and thus alleviate pressure on the road network. It is likely that this contribution would be best spent on provision of K2L cycle route between Kenilworth and Leamington, completion of the existing cycle networks - this has been termed "Missing Links" and provision of new cycle infrastructure linking proposed developments to the existing cycle network. Provision of "Missing Links" may involve working closely with WDC in order to provide the shortest routes to key destinations (e.g. Use of Victoria Park to link the town centre with the proposed cycle infrastructure for Ford Foundry, linking Connect2 to Kenilworth town centre and linking Warwick town centre to the rail station). Provision should include toucan/pedestrian crossings to avoid severance. Provision of minor schemes has not been included in these costs but provision of bus shelters should also be included. Included in terms of modal shift assumption (15%)	2,000,000
Virtual P&Rs	Grade 2a	Grade 2a	Virtual Park and Rides accrue the benefits of standard park and ride facilities without incurring the costs of providing expensive infrastructure. Developers would be encouraged to provide additional parking at edge of town sites which could then be utilised for P&R facilities. Instead of providing a bespoke bus services to the P&R facilities, a two stage bus journey would be made where the first stage would provide a	1,500,000

			direct service to the town centres or employment sites with perhaps one or two stop on route thus avoiding. The second stage would distribute local trips around housing areas or employment areas This would maximise potential of new bus routes provided by developers which are necessary ensure sustainable access to their developments and to meet model share targets. Such facilities would be easier to deliver where there is a critical mass of development proposed in one area. Suitable sites may include developments along the A452 corridor to the south of Leamington or close to the sites next to the A46 proposed at Kenilworth. Included in terms of modal shift assumption (15%)	

D3 Indicative Costs

Scheme	SF	PO	PO No RR
Thickthorn Roundabout	£1,000,000	£1,000,000	£1,000,000
Kenilworth Gyratory	£500,000	£500,000	£500,000
A452/Bericote Roundabout	£500,000	£500,000	£500,000
A452/Blackdown Roundabout	£500,000	£500,000	£500,000
A452 Spinney Hill Roundabout	£500,000	£500,000	£500,000
Emscote Road/Greville Road	£400,000	£400,000	£400,000
Princes Drive/Warwick New Road	£400,000	£400,000	£400,000
Bath Street/High Street	£500,000	£500,000	£500,000
Adelaide Road/Avenue Road	£300,000	£400,000	£400,000
Dormer Place/Adelaide Road	£300,000	£400,000	£400,000
Myton Road Roundabout	£500,000	£500,000	£500,000
Priory Road/Smith Street/St Nicholas	£300,000	£300,000	£300,000
Castle Hill Gyratory Signals	£400,000	£400,000	£400,000
Europa Way/Myton Road Roundabout	£500,000	£300,000	£300,000
Shires Retail Park Roundabout	£500,000	£500,000	£500,000
Europa Way Roundabout	£500,000	£500,000	£500,000
Grey's Mallory Roundabout	£500,000	£0	£0
Europa Way Corridor – Part 1	£5,000,000	£5,000,000	£5,000,000
Europa Way Corridor – Part 2	£5,000,000	£0	£0
Gallows Hill – 2 Lanes	£500,000	£0	£0
Banbury Road – 2 Lanes	£500,000	£0	£0
ATM "Managed Motor Ways"	£10,000,000	£0	£0
Junction 13 improvements	£500,000	£500,000	£500,000
A46/Gaveston Roundabout Signalisation	£500,000	£500,000	£500,000
Leamington Northern Relief Road (LNRR)	£0	£20,000,000	£0
Further Capacity/PT Improvements on A452 between Kenilworth and Leamington	£0	£0	£5,000,000
Dalehouse Lane roundabout flare extensions, A46/C32 Signalisation and C32/B4115 Roundabout	£0	£0	£0
Kenilworth Station	£1,000,000	£1,000,000	£1,000,000
Town Centre Improvements	£2,000,000	£2,000,000	£2,000,000
Sustainable Travel Infrastructure	£2,000,000	£2,000,000	£2,000,000
Virtual P&Rs	£1,500,000	£1,500,000	£1,500,000
TOTAL	**£36,600,000**	**£40,100,000**	**£25,100,000**

Appendix E

Mean Speed Plots

E1

Appendix F

Queue Analysis Plots

F1