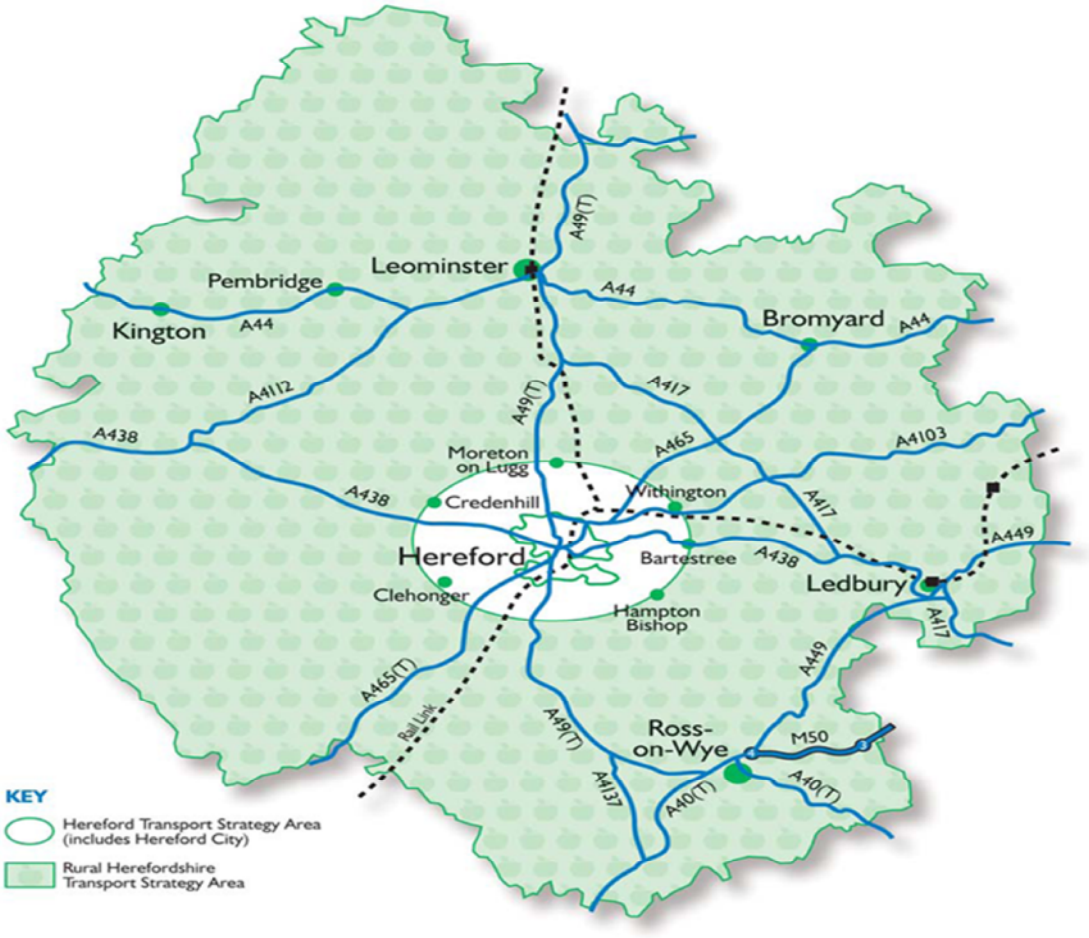
Hereford Relief Road

Interim Forecasting Report Addendum: Reduced Housing and Employment Option

Revision: Final

Issued: November 2012



Document Control Sheet

Project Name:	Hereford Relief Road
Project Number:	CO00551574
Document / Report Title:	Interim Forecasting Report Addendum: Reduced Housing and Employment Option
Document / Report Number:	

Issue Status/Amendment	Prepared	Reviewed	Approved
Draft	Name: John Rochester Signature: Date:	Name: Jeff Webb Signature: Date:	Name: Andrew Palmer Signature: Date:
Draft Rev 2	Name: John Rochester Signature: Date:	Name: Paula Jobson Signature: Date:	Name: Andrew Palmer Signature: Date:
Draft Rev 3	Name: Alan Feeney Signature: Date:	Name: Paula Jobson Signature: Date:	Name: Andrew Palmer Signature: Date:
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Executive Summary

This report, commissioned by Herefordshire Council (HC), examines a revised housing and employment allocation for the proposed Local Development Framework. This report is an addendum to the Hereford Relief Road Study of Options Report (Amey, September 2010) that assessed four housing and employment scenarios. The report recommended Housing Option 4 with a Western Relief Road and sustainable transport package 3.

Since the original report, there has been a revision to the Department for Transport National Trip End Model (NTEM) forecasts and TEMPRO software. This latest revision, called TEMPRO 6.2, has been incorporated into the modelling work presented in this report. Since the original report, there has also been a revision in projected timescales for housing development in Hereford with the time of delivery of housing options extended from 2026 to 2031.

Sustainable transport package 3 identified in the original Study of Options report is included in all future year scenarios. This is an assumption regarding the reduction of car trips due to sustainable transport measures to be introduced in the future. This methodology is explained further in Section 2 of this report.

The revised housing option 5 and housing option 4, favoured in the original report, are assessed using the Hereford SATURN model (Simulation and Assignment of Traffic to Urban Road Networks) to consider the effect on the local highway network, with and without a Western Relief Road.

The growth associated with Housing Options 4 and 5 is growth in the Hereford area which is assumed to be additional to the growth forecast in TEMPRO. This methodology has been used to provide consistency with previous assessments which have used the same methodology in updating the Hereford Model demand matrices.

This report assesses the effect of these revisions and re-evaluates the need for a Western Relief Road.

Transport Network Model Performance With No Relief Road: Impact Of New TEMPRO Version 6.2 Forecast And New Forecast Year Of 2031

The following tables 1 and 2 consider how the revised strategic housing commitment and the revised development year affect the number of predicted person trips on the network using the superseded growth rate of TEMPRO 5.4 and the current growth rate of TEMPRO 6.2; only the no relief road scenarios are considered for this comparison. Although TEMPRO 6.2 takes account of the latest slowdown in growth experienced in the UK, the long term growth predicted to 2031 remains relatively unaffected and has undergone only minor variations.

Table 1: AM peak period forecast of person trips on the network

Scheme	Mode	Base Year	Housing Option 4				Housing Option 5
		2008	2026		2031		2031
			TEMPRO 5.4	TEMPRO 6.2	TEMPRO 5.4	TEMPRO 6.2	TEMPRO 6.2
No Relief Road	Car	19,921	22,362	21,595	21,603	21,626	21,152
	PT	3,005	3,583	3,531	3,507	3,559	3,305
	Cycle	850	1,964	1,917	1,939	1,936	1,936
	Walk	6,043	10,578	10,341	10,403	10,461	10,674
	Total	**29,918**	**38,487**	**37,384**	**37,452**	**37,582**	**37,067**
Percentage Increase on Base Year Total Trips			**28.6%**	**25.0%**	**25.2%**	**25.6%**	**24.0%**

Table 2: PM peak period forecast of person trips on the network

Scheme	Mode	Base Year	Housing Option 4				Housing Option 5
		2008	2026		2031		2031
			TEMPRO 5.4	TEMPRO 6.2	TEMPRO 5.4	TEMPRO 6.2	TEMPRO 6.2
No Relief Road	Car	21,053	23,293	22,666	22,955	22,962	22,383
	PT	2,025	2,809	2,947	2,823	2,860	2,665
	Cycle	863	1,961	2,055	1,988	1,985	1,996
	Walk	8,365	13,173	13,605	13,316	13,481	13,789
	Total	**32,306**	**41,236**	**41,273**	**41,082**	**41,288**	**40,833**
Percentage Increase on Base Year Total Trips			**27.6%**	**27.8%**	**27.2%**	**27.8%**	**26.4%**

Comparing all the Future Year growth scenarios with the Base Year of 2008 there is an increase in the range of 24% - 28.6% of person trips through all scenarios. There is a marginal difference in number of trips on the network for Housing Option 4 when comparing TEMPRO 5.4 with TEMPRO 6.2. The Housing Option 5 scenario predicts less total trips on the network than Housing Option 4 in 2031 (TEMPRO 6.2), however there is an increase in walking and cycle trips in both the AM and PM peak hours.

For the forecast year of 2026 with Housing Option 4, there is a slight increase in car trips in both the AM and PM peak periods; however, for 2031 there is a slight reduction in car trips compared to 2026 combined with a slight increase in walk trips. This pattern suggests that the network is near its capacity by 2031 and so persons are more inclined to walk than to travel by car.

The transfer of trips from public transport (PT) to car, walk or cycle is due to increases in the economic costs to travel by PT as compared to other modes. Increases in network congestion, in particular affecting outbound PT trips, increases in fares and increases in values of time causes public transport costs to increase at a higher rate than that of the other modes leading to a transfer of trips from PT to other modes of travel.

Compared with Housing Option 4, with the reduced housing and employment allocations, Housing Option 5 has the overall lower number of forecast person trips.

In Chapter 5 of this report a comparison of the network statistics in the no relief road scenarios reveals how the model predicts conditions of the highway to change in future years. The results show that all scenarios without the Relief Road are predicted to operate considerably worse than the base year 2008 conditions.

Comparing all the future year scenarios, the results are very similar, with the reduced Housing Option 5 performing the best. This is to be expected given the lower number of trips assigned onto the network for Housing Option 5 as compared to the other scenarios.

A standard measure of determining how the network is performing is to consider the performance of the junctions within the network. In considering the effect on the network in future years, with no relief road, the SATURN models are interrogated in order to obtain the volume-to-capacity ratio at each modelled junction. Junctions operating at 85%+ of capacity are considered to be operating inefficiently and are divided into three bands:

- 85% to 100% - operating at or close to capacity, delays are to be expected;
- 100% to 120% - operating over-capacity, delays are likely to be considerable;
- 120% and over - operating significantly over-capacity, delays will be considerable and could lead to widespread queuing.

Table 3: Junctions Over Capacity Both Peaks						
Volume to Capacity Ratio	2008 Base	2026 H4 T54 S03	2026 H4 T62 SO3	2031 H4 T54 SO3	2031 H4 T62 SO3	2031 H5 T62 SO3
85% to 100%	34	35	38	36	38	39
100% to 120%	14	26	30	33	33	25
120% and over	0	0	0	0	0	0
Total	**48**	**61**	**68**	**69**	**71**	**64**

The modelling results between future years and different TEMPRO growth rates are broadly similar, with the number of over-capacity junctions increasing when using growth forecast by TEMPRO 6.2.

The above information gives confidence that when modelling Housing Options 4 and 5 with and without the Western Relief Road; the results given are implicitly due to the changes to the housing and employment numbers, and the changes to the network in the form of a Relief Road. Furthermore, we can be confident when drawing comparisons between previous modelled scenarios.

Transport Network Model Performance with a Western Relief Road

In Chapter 8 it can be seen that the addition of a Relief Road improves the overall total journey times across the network. For Housing Option 5 the AM peak predicts a journey-time saving of approximately 19 minutes and the PM peak a saving of almost 30 minutes as a direct result of the Relief Road.

The statistics for the trip length distribution on the network show that there are no significant changes of trip lengths and trip patterns between the No Relief Road and Western Relief Road scenario in both peak periods, with the distribution of short vehicle journeys and longer vehicle journeys remain relatively similar.

The modelling results for junctions at over capacity with and without a relief road show that with a relief road the network is performing significantly better than Base Year 2008.

Table 4: Junctions Over Capacity Both Peaks					
Volume to Capacity Ratio	Base Year	No Relief Road		Western Relief Road	
	2008	H4 2031 T62 SO3	H5 2031 T62 SO3	H4 2031 T62 SO3	H5 2031 T62 SO3
85% to 100%	34	38	39	26	24
100% to 120%	14	33	25	13	10
120% and over	0	0	0	0	0
Total	**48**	**71**	**64**	**39**	**34**
Percentage Difference on 2008	**-**	**+47.9%**	**+33.3%**	**-18.8%**	**-29.2%**

The report analyses the provision of a Western Relief Road on routes through the city, statistics identify that it provides congestion relief on key routes in the Hereford study area; further detail is available in Section 8. It is predicted that the provision of a Western Relief Road will result in a decrease in traffic flow volumes on 31 out of the 46 key routes with the Housing Option 4 scenario and 32 out of the 46 key routes with Housing Option 5 scenario.

The provision of a Western Relief Road is expected to provide a decrease in traffic flow volumes within Hereford city centre with predicted decreases of approximately 25% in both directions on Eign Street and Belmont Road. The drop in traffic volume is more pronounced in Housing Option 5 than Housing Option 4 on Victoria Street with an expected reduction of 23% northbound and 9% southbound.

The Greyfriars Bridge on the A49 and the Western Relief Road represent strategically important links between the north and south of the city. A series of select link analyses have been undertaken at several locations of which Greyfriars Bridge and the Western relief Road are two locations. The select link analysis demonstrates the distribution on the road network of trips which travel through this location. It enables a visual inspection of the origins and destinations of a particular distribution.

The select link analysis plots shown below for Greyfriars Bridge in 2031 for the AM peak show the traffic distribution for Housing Options 4 and 5. The plots demonstrate that the two Options have similar travel distribution patterns for traffic crossing the bridge and that there is no significant difference in the origins and destinations for traffic using the bridge between the two options.

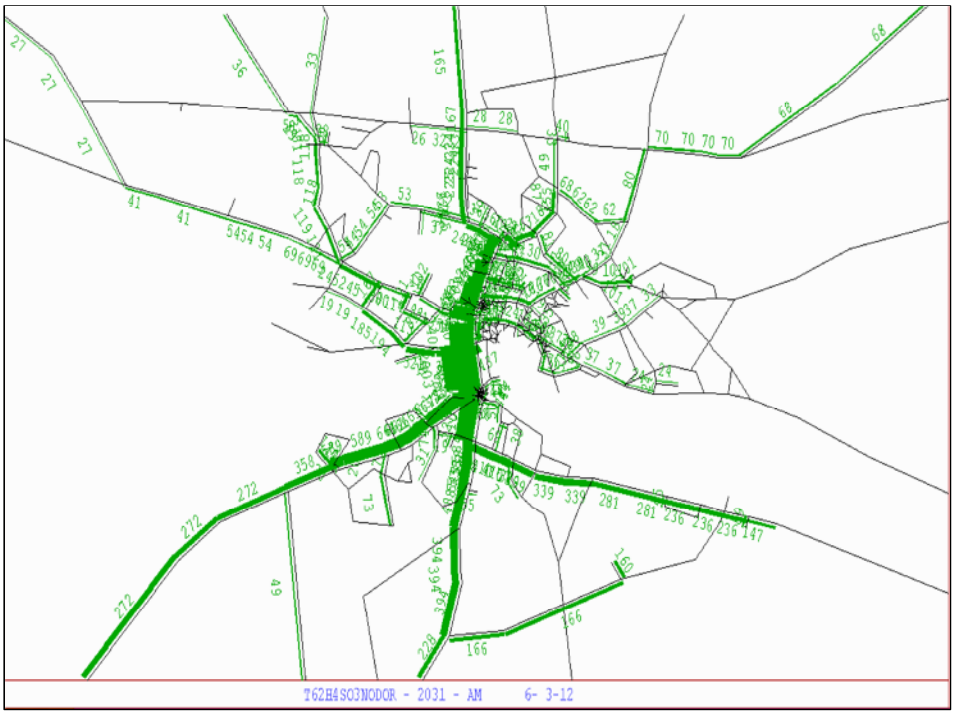

Figure 1: Housing Option 4, AM Period, A49 Greyfriars bridge (no relief road)

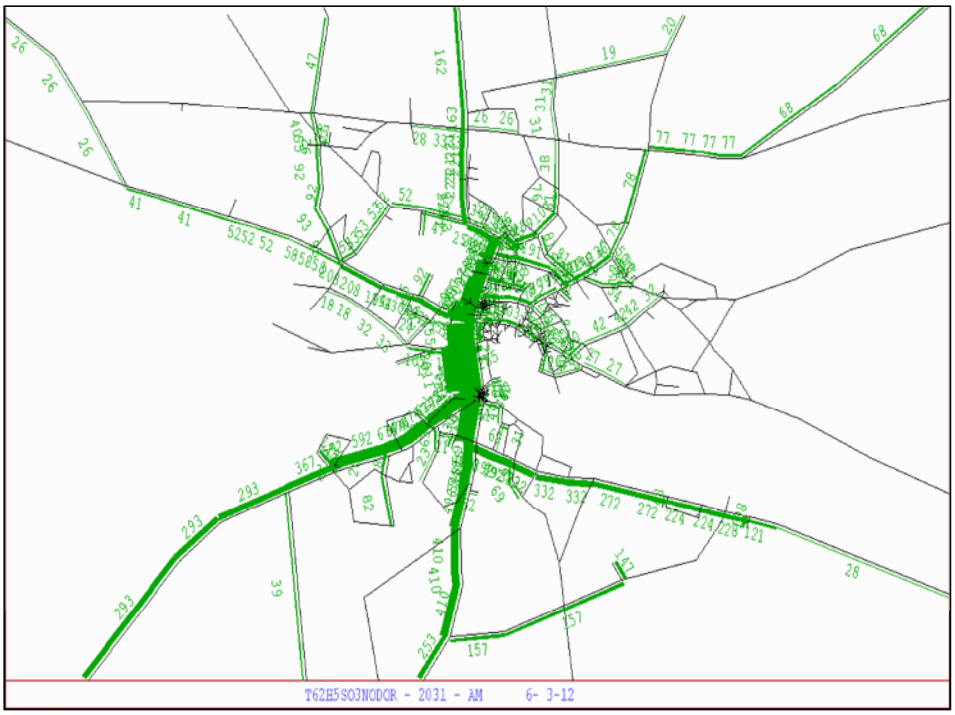

Figure 2: Housing Option 5, AM Period, A49 Greyfriars bridge (no relief road)

The select link analysis plots shown below in Figures 3 and 4 are for the Western Relief Road in 2031 for the PM peak. These plots also demonstrate the similarity in origins and destinations for the Western Relief Road for both housing Options.

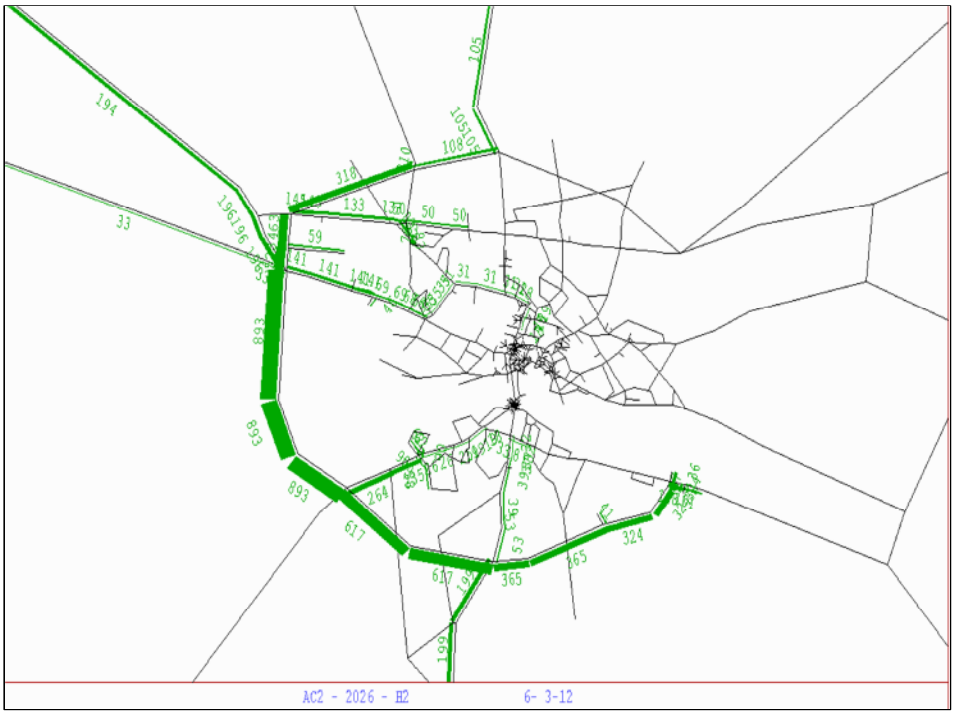

Figure 3: Housing Option 4, PM Period, Western Relief Road, NB

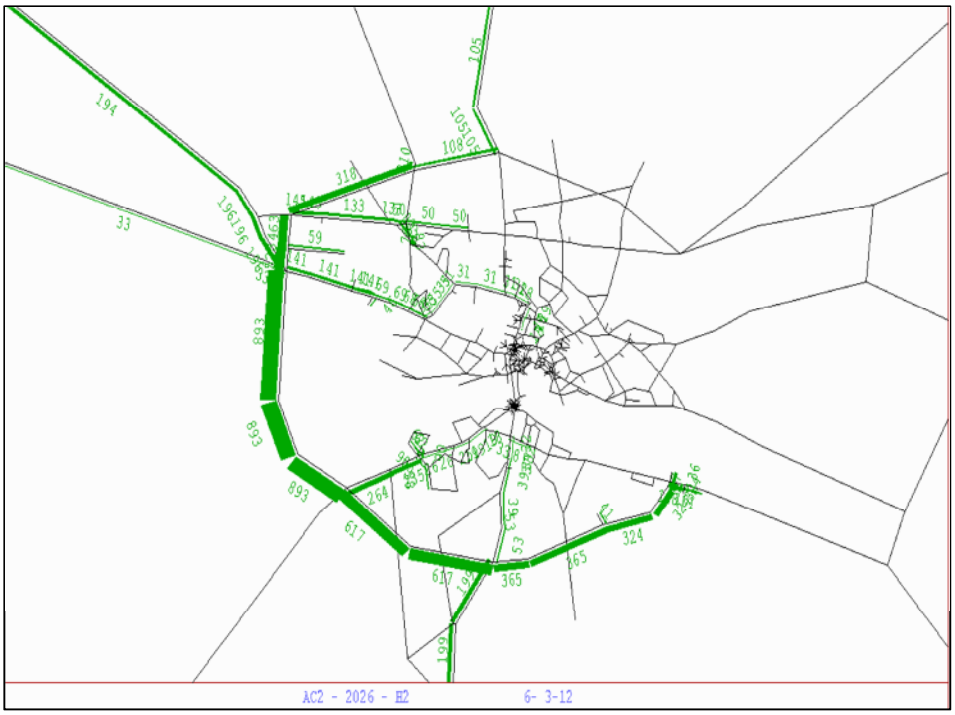

Figure 4: Housing Option 4, PM Period, Western Relief Road, NB

Overall, the results show that the revised forecast growth predicted by TEMPRO 6.2 does not introduce significant new volumes of travel demand, rather that the traffic growth associated with

TEMPRO 6.2 is broadly in line with growth predicted previously using TEMPRO 5.4 in the Hereford area.

Despite the reduction in the numbers of housing allocations and employment levels associated with Housing Option 5 and the inclusion of the traffic reduction assumptions associated with Sustainable Option Package 3, the problems of congestion within Hereford remain and results are comparable with previous growth point scenario options already tested in previous reports. Consequently, in combination with sustainable transport measures there is a need to provide congestion relief in the form of a Relief Road despite the reduction in the number of dwellings and employment sites in Housing Option 5 networks.

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1. Introduction and Background

1.1. Introduction

1.1.1. This report, commissioned by Herefordshire Council (HC), examines a revised housing and employment allocation for the proposed Local Development Framework. This report is an addendum to the Hereford Relief Road Study of Options Report (Amey, September 2010) that assessed four housing options. The revised allocation is referred to throughout this report as Housing Option 5 (HO5) and this option will be compared to the favoured housing option 4, with and without a Western Relief Road.

1.1.2. The original housing allocation numbers were generated from the now abolished Regional Spatial Strategy. The revised HO5 proposed for the LDF are lower thus, in conjunction with a revision in timescales and revised NTEM forecasts from the DfT, the comparison undertaken in this report has been made to see whether there is still a need for a Relief Road.

1.1.3. It should be noted that since the previous option reports and due to the LDF process more detailed information is becoming available. It has been identified that the current Hereford Transport Model has a number of shortcomings and in order to improve the accuracy and reliability of appraising future transport and land use initiatives including the LDF proposals, this model is currently being upgraded through liaison with the Highways Agency.

1.2. Background

1.2.1. In the Study of Options (September 2010), the interim Sustainable Options Report produced by TPi identified four future housing and employment development options and three sustainable transport options.

1.2.2. The preferred development option identified in the Study of Options Report is the Housing Growth Option 4 and Sustainable Option Package 3 with a Western Relief Road.

1.2.3. Sustainable Option Package 3, presenting the greatest level of sustainable measures, is assumed to consist of the elements listed in Table 1. This entire package of sustainable measures was never explicitly modelled as the current model lacks the facility and sensitivity to represent these packages in detail where they could have an impact on the mode choice in the model. It was reasoned that the package of measures in Table 1 would be capable of delivering a mode shift of 20% from car to non-car modes.

1.2.4. Therefore, in the modelling assessment carried out, this mode transfer of 20% from car to non-car modes was assumed to take place and 20% of the trips in the car matrix was removed from the highway assignments. This 20% reduction in the car matrix was targeted at the appropriate trips, i.e. a reduction in short distance trips to represent a mode shift to walk and cycle modes, etc.

Table 1: Sustainable Transport Options Package 3		
		Option 3
Smarter Choices	Developing travel plans	X
	Travel promotions	X
	Active travel information	X
	Localised branding	X
	Developing Rail Station travel plans	X
	Personalised Travel Planning	X
	Community lead travel plans	X
	Development of Park and Share and Park and Cycle Sites	X
Active Travel	Connect 2 scheme	X
	Promotion of active travel through enhancements of existing infrastructure	X
	Promotion of active travel through new infrastructure delivery	X
	Reduction in the number of school trips by car	X
	New access arrangements from strategic sites to existing highway network	X
	Substantial improvements in pedestrian facilities	X
	At grade crossings on A49 Victoria Street (Eign Street and Barton Road)	X
	Accelerated expansion of cycle routes and infrastructure	X
	City wide cycle hire scheme	X
	Maximum feasible improvements	X

		Option 3
Bus	Serving changing customer needs	X
	Promotion of bus use	X
	Improvements to passenger waiting facilities	X
	Easing modal interchange – Hereford Transport Hub	X
	Improved service coverage and frequency	X
	Expansion of concessionary travel (16 to 19 year olds)	X
	Real time information	X
Park and Ride	A49 North Park and Ride Site – 400 spaces – located north of Starting Gate roundabout	X
	A49 South Park and Ride Site – 500 spaces located at Rotherwas Access Road	
	A465 East Park and Ride Site – 500 spaces located at Aylestone Park	X
	A4103 West Park and Ride Site - 200 spaces located at Cattle Market site	X

1.3. Policy Update

1.3.1. The Regional Spatial Strategy was the main driving force for the original Study of Options, as it identified designated growth points and areas within the West Midlands Region. Herefordshire Council are now consulting on a more localised, reduced housing and employment strategy for the draft Local Development Framework (LDF).

1.4. Reduced Housing Option

1.4.1. In this report, the reduced housing allocations are compared with the preferred development option HO4 using Sustainable Option Package 3.

1.4.2. The reduced housing scenario option would have a revised opening year of 2031 rather than to an opening year of 2026, assessed in the earlier studies. As a result, revised forecasts are required for five years' growth from 2026 to 2031.

1.4.3. Since the Study of Options forecasts were undertaken, a revised National Trip End Model has become available and a new version of TEMPRO has been issued (V6.2) which is now the definitive version to be used for all future forecasts.

1.5. Impact of TEMPRO, Revised Future Year and Reduced Housing and Employment

1.5.1. The impact of the revised future year and revised TEMPRO growth rate is compared with the preferred option HO4 and revised option HO5 in order to assess the impact of the reduced housing allocations with reduced growth forecasts. All the assessments are on the No Relief Road networks with the car matrix reduced to account for Sustainable Option Package 3.

1.5.2. The impact of the change in TEMPRO, the revised future year and the reduced housing and employment are considered in two parts:

- Impacts of revised development option - using the new forecast year of 2031 and TEMPRO version 6.2;
- Sensitivity testing of the three modelling variables.

1.5.3. Modelling results are analysed through application of the following scenarios:

- Base year 2008;
- 2026 No Relief Road TEMPRO V5.4 Housing Option 4 Sustainable Option Package 3;
- 2026 No Relief Road TEMPRO V6.2 Housing Option 4 Sustainable Option Package 3;
- 2031 No Relief Road TEMPRO V5.4 Housing Option 4 Sustainable Option Package 3;
- 2031 No Relief Road TEMPRO V6.2 Housing Option 4 Sustainable Option Package 3;
- 2031 No Relief Road TEMPRO V6.2 Reduced Housing Scenario (Housing Option 5) Sustainable Option Package 3;
- 2031 Western Relief Road TEMPRO V6.2 Reduced Housing Scenario (Housing Option 5) Sustainable Option Package 3.

1.5.4. The remainder of the report is set out in the following format:

- Chapter 2 of the report discusses the modelling methodology used to model each of the scenarios;
- Chapter 3 to Chapter 5 of the report compares the housing and employment options, revised future years, and different TEMPRO growth rates;
- Chapters 6 through to Chapter 8 discuss the impacts of the reduced housing scenario for With / Without Relief Road scenarios;
- Chapter 9 sets out the conclusions.

2. Modelling Methodology

2.1. Introduction

2.1.1. The future year transport networks and demand matrices were directly taken from the previous forecasting work for the Housing Option 4 growth matrices, the networks for the No Relief Road & western alignment and the car mode reduction assumptions contained in Sustainable Option Package 3. Details have been provided in TPi / Amey's Hereford Relief Road Interim Forecasting Report for Sustainable Option Packages (September 2010) in Chapters 2 and 3. Figure 1 below summarises the modelling process.

2.1.2. The demand matrices are re-forecasted to allow for different future years and different TEMPRO growth rates before being re-assigned to the No Relief Road networks and or the Western Relief Road networks. These highway demand matrices have been reduced by a factor 20% in accordance with the methodology associated with the Sustainability Options explained in Section 1. These various options are tested using JMP's 2008 base year Hereford Multi Modal Model. The model contains a representation of the transport system within Herefordshire by all modes of transport. A SATURN-based highway model contains a representation of the main roads within Hereford together with the strategic road network of Herefordshire.

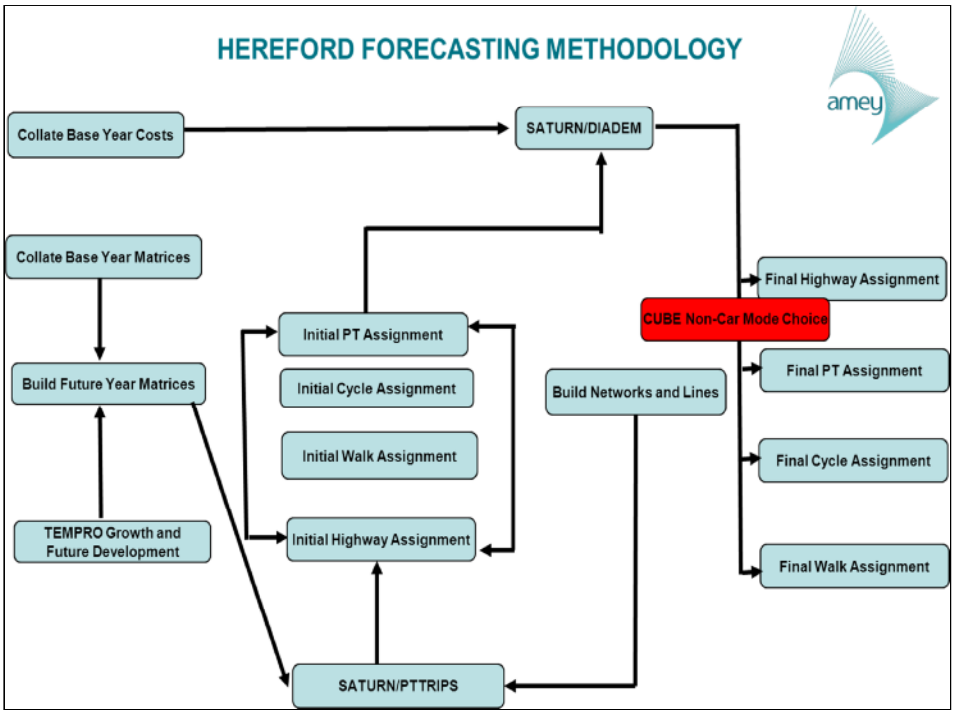

Figure 1: Hereford Forecasting Methodology

2.1.3. The methodology shown in Figure 1 to test the various options uses the principles outlined in WebTAG to estimate changes in demand for travel by all modes in response to changes in the costs of travel by all modes.

2.1.4. For the reduced housing and employment scenario, which for the purposes of this report is labelled Housing Option 5 (HO5), the Do Minimum 2031 TEMPRO V6.2 demand matrices are used. The Do Minimum commitments for housing assumptions in the TEMPRO scenario were left the same as Table 2.1 in the JMP Hereford Multi Modal Model Forecasting Report 02/09/2009, with the total equating to 2,480 dwellings.

2.1.5. The additional dwellings and employment options for the Housing Option 5 scenario, and the Housing Option 4 scenario, are shown in Table 2 and illustrated in Figure 2.

Table 2: Additional Dwellings Assumed for Growth Scenario

Housing Options		Demand Scenario Housing Option 4	Demand Scenario Housing Option 5
Hereford	Edgar Street Grid – Urban Village	1,000	800
	Whitecross	1,500	0
	Three Elms Road / Kings Acre	1,500	1,000
	Bullinghope	1,000	1,000
	Holmer West	500	500
	Other SHLAA citywide distribution	1,009	2,100
	TOTAL	**6,509**	**5,400**
Herefordshire	Other Urban Area Outer Hereford	1,714	1,714
	Rural Herefordshire	3,070	3,070
	Market Towns	3,625	3,625
	TOTAL	**8,409**	**8,409**
GRAND TOTAL		**14,918**	**13,809**
Employment Options			
Hereford	Retail Comparison – Edgar St Grid	60,000sqm	60,000sqm
	Office – Edgar St Grid	45,000sqm	45,000sqm
	Holmer East	150,000sqm	0
	Rotherwas	250,000sqm	250,000sqm
	Three Elms	100,000sqm	100,000sqm
GRAND TOTAL		**605,000sqm**	**455,000sqm**

2.1.6. From Table 2 it is evident that Housing Option 5 has a larger number of housing blocks of a smaller size, with an overall reduced housing and employment allocation. The Housing Option 5 scenario has deleted Whitecross housing block, and Holmer East employment block.

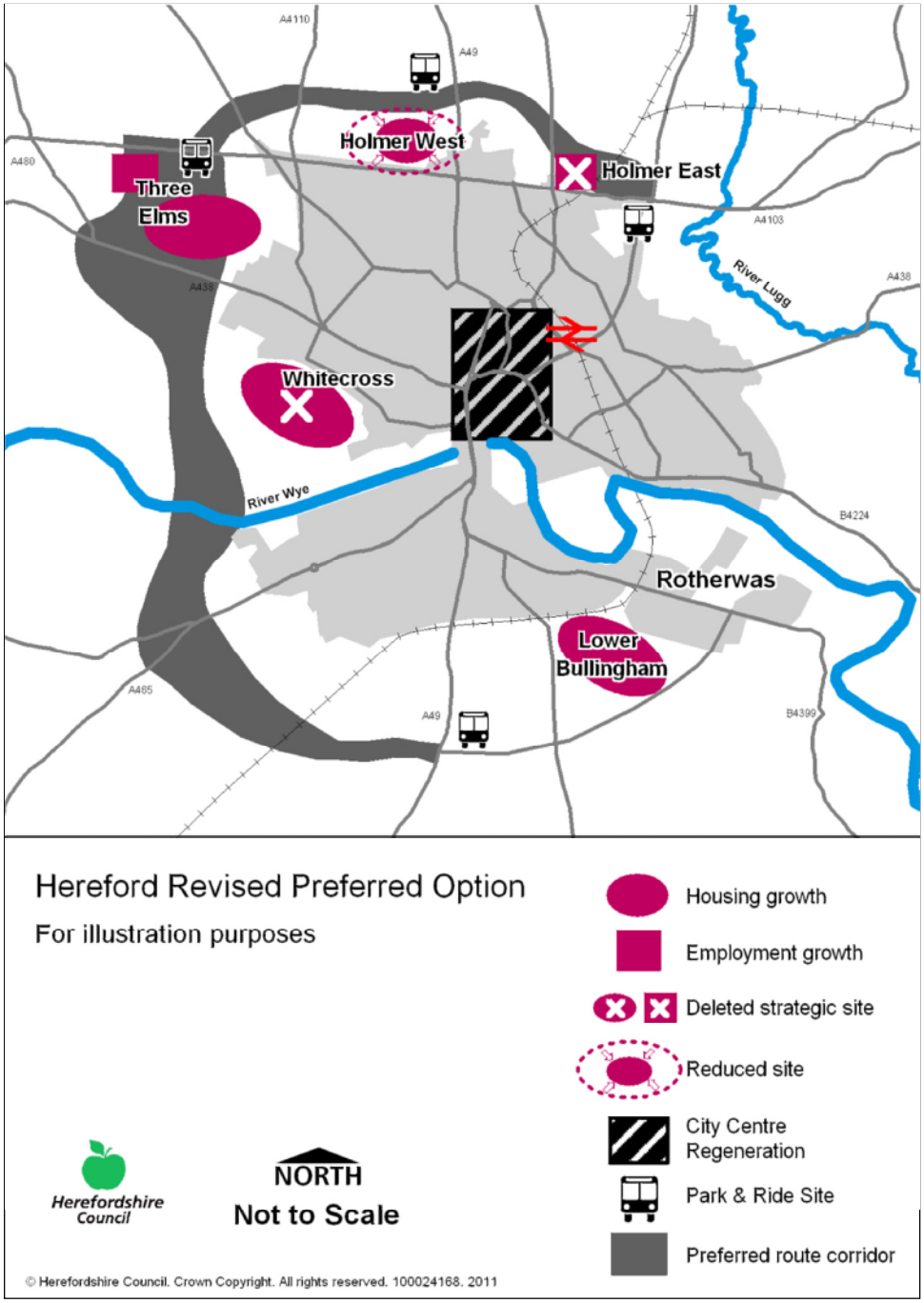

Figure 2: Hereford Revised Preferred Option

2.1.7. The predicted arrival and departure trips generated by the developments, illustrated in Figure 2, are combined with the TEMPRO V6.2 2031 demand matrices before being assigned to the No Relief Road and Western Relief Road networks.

2.2. Variable Demand Modelling

2.2.1. After the completion of building the networks and demand matrices to represent the different scenarios for 2026/2031 AM and PM peak periods, forecasting commenced using the DIADEM software in order to model variable demand.

2.2.2. For consistency this report uses the same methodologies and parameters used in the JMP Forecasting Report Chapter 2 and the Hereford Relief Road Interim Forecasting Report for Sustainable Option Packages (September 2010) in section 3.10 to 3.12 in its assessment. The assessments were evaluated using the 'Method of Successive Averages'[1] within the DIADEM program in order to reach acceptable convergence levels.

2.2.3. The 2026/2031 AM and PM No Relief Road models for each TEMPRO growth options and Sustainable Option Package 3 and Housing Option 4 and 5 are pivoted off the 2008 base year for the respective peak periods. The reduced housing scenario Option 5 with the Western Relief Road alignment is pivoted off the relevant reference cost and demand output from the No Relief Road models.

[1] This is the iterative method selected to achieve acceptable levels of convergence between supply and demand. The Method of Successive Averages is known as the slow but sure method to achieve acceptable levels of convergence.

3. Part One - Modal Split

3.1.1. The DIADEM model contains a mode component, which allows modal shift and results in a new set of demand matrices which may be different from the reference matrices. Thus, a new demand matrix for each modelled mode (i.e. car, public transport [PT], cycle and walk) is obtained after running the model for each scenario. The new demand matrices are then assigned to the respective network to produce the forecasts of travelling conditions under each scenario.

3.1.2. Tables 3 and 4 show the pre DIADEM forecast person trip totals for car, PT, cycle and walk demand matrices obtained from demand model for each modelled TEMPRO growth scenario for the AM and PM models respectively.

Table 3: AM Pre DIADEM Forecast Person Trip Totals

Scheme	Mode	Housing Option 4				Housing Option 5
		2026		2031		2031
		TEMPRO 5.4	TEMPRO 6.2	TEMPRO 5.4	TEMPRO 6.2	TEMPRO 6.2
Base	Car	19,921				
	PT	3,005				
	Cycle	850				
	Walk	6,043				
	Total	**29,918**				
No Relief Road	Car	22,102	21,332	22,254	21,663	20,740
	PT	4,062	4,001	3,985	4,041	3,857
	Cycle	1,936	1,888	1,913	1,909	1,912
	Walk	10,370	10,133	10,221	10,269	10,473
	Total	**38,470**	**37,354**	**38,373**	**37,882**	**36,981**

Table 4: PM Pre DIADEM Forecast Person Trip Totals						
Scheme	Mode	Housing Option 4				Housing Option 5
		2026		2031		2031
		TEMPRO 5.4	TEMPRO 6.2	TEMPRO 5.4	TEMPRO 6.2	TEMPRO 6.2
Base	Car	21,053				
	PT	2,025				
	Cycle	863				
	Walk	8,365				
	Total	**32,306**				
No Relief Road	Car	23,066	22,556	23,380	23,149	22,299
	PT	3,119	3,150	3,138	3,201	3,017
	Cycle	1,950	1,945	1,979	1,985	1,990
	Walk	13,090	13,076	13,239	13,502	13,679
	Total	**41,225**	**40,727**	**41,736**	**41,837**	**40,985**

3.1.3. The tables show the fixed trip matrices before they are assigned to the networks through Variable Demand Modelling using DIADEM.

3.1.4. The tables show that on the whole there is a slight reduction of forecast person trips between the TEMPRO V5.4 and V6.2 scenarios and a slight increase in forecast person trips between 2026 and 2031 scenarios.

3.1.5. As to be expected, with the reduced housing and employment allocations Housing Option 5 has the overall lowest number of forecast person trips.

3.1.6. Tables 5 and 6 show the post DIADEM forecast person trips for car, PT, cycle and walk demand matrices obtained from the demand model for each modelled scenario for the AM and PM models respectively.

Table 5: AM Post DIADEM Forecast Person Trip Totals						
Scheme	Mode	Housing Option 4				Housing Option 5
		2026		2031		2031
		TEMPRO 5.4	TEMPRO 6.2	TEMPRO 5.4	TEMPRO 6.2	TEMPRO 6.2
Base	Car	19,921				
	PT	3,005				
	Cycle	850				
	Walk	6,043				
	Total	**29,918**				
No Relief Road	Car	22,362	21,595	21,603	21,626	21,152
	PT	3,583	3,531	3,507	3,559	3,305
	Cycle	1,964	1,917	1,939	1,936	1,936
	Walk	10,578	10,341	10,403	10,461	10,674
	Total	**38,487**	**37,384**	**37,452**	**37,582**	**37,067**

Table 6: PM Post DIADEM Forecast Person Trip Totals						
Scheme	Mode	Housing Option 4				Housing Option 5
		2026		2031		2031
		TEMPRO 5.4	TEMPRO 6.2	TEMPRO 5.4	TEMPRO 6.2	TEMPRO 6.2
Base	Car	21,053				
	PT	2,025				
	Cycle	863				
	Walk	8,365				
	Total	**32,306**				
No Relief Road	Car	23,293	22,666	22,955	22,962	22,383
	PT	2,809	2,947	2,823	2,860	2,665
	Cycle	1,961	2,055	1,988	1,985	1,996
	Walk	13,173	13,605	13,316	13,481	13,789
	Total	**41,236**	**41,273**	**41,082**	**41,288**	**40,833**

3.1.7. In comparing the TEMPRO growth scenarios, it can be seen that all scenarios show a transfer of trips from PT to car, walk or cycle. For the forecast year of 2026 with Housing Option 4, there is a slight increase in car trips in both the AM and PM peak periods; however, for 2031 there is a slight reduction in car trips combined with a slight increase in walk trips. This pattern suggests that the network is near its capacity by 2031 and so persons are more inclined to walk than to travel by car.

3.1.8. The transfer of trips from PT to car, walk or cycle, are due to increases in the costs to travel by PT as compared to other modes. Increases in network congestion, in particularly affecting outbound PT trips, increases in fares and increases in values of time, causes public transport costs to increase at a higher rate than that of the other modes leading to a transfer of trips from PT to other modes of travel.

3.1.9. For the reduced housing scenario, the variable demand model predicts that for 2031 there will be a slight increase in car trips and walk trips and a larger decrease in PT trip. The largest increases in car trips occur during the AM peak period. The levels of decrease in PT trips are consistent between both housing options of around 500 trips in the AM peak and 350 trips in the PM peak. The slight increase in car trips in Housing Option 5 indicates that there is now slightly more capacity on the highway network than for Housing Option 4, hence a greater switch to car as the costs to travel by car reduces.

3.1.10. The results show that the difference in forecast person trips for all modes between each scenario is marginal.

4. Part One – TEMPRO Comparison - Model Performance Statistics

4.1.1. Model performance statistics were collected for all modes after assigning the demand matrices obtained from the demand model.

4.2. Non – Highway Models

4.2.1. The following service indicators are used to assess the PT, cycle and walk model performance:

- Total Distance (measured in person-kilometres);
- Total Time (measured in person-hours).

4.2.2. The comparison of total distance travelled within the modelled network (Herefordshire County) for the AM model is shown in Table 7.

Table 7: AM Peak Comparison of Total Distance Travelled (person km)

Scheme	Mode	Sub Mode	Housing Option 4				Housing Option 5
			2026		2031		2031
			TEMPRO 5.4	TEMPRO 6.2	TEMPRO 5.4	TEMPRO 6.2	TEMPRO 6.2
No Relief Road	PT	Bus	10,039	9,840	9,908	9,916	9,588
		Coach	430	419	418	425	408
		Rail	29,340	29,322	29,167	29,804	30,106
		Sub-Total	**39,809**	**39,581**	**39,493**	**40,144**	**40,102**
	Cycle		7,390	7,155	7,424	7,246	6,973
	Walk		33,199	32,176	33,280	32,609	31,933
	Total		**80,398**	**78,912**	**80,197**	**79,999**	**79,088**

4.2.3. For the non-car modes, it can be seen that there is a slight fall in distance travelled by bus, coach and rail between 2026 and 2031 TEMPRO V5.4 but an increase between 2026 and 2031 TEMPRO V6.2. For cycle and walk the distance travelled slightly reduces between TEMPRO V5.4 and V6.2 in both 2026 and 2031. Comparing all scenarios the differences between distance travelled by bus, coach, rail, walk and cycle is marginal. The comparison for the PM model is shown in Table 8.

Table 8: PM Peak Comparison of Total Distance Travelled (person km)							
Scheme	Mode	Sub Mode	Housing Option 4				Housing Option 5
			2026		2031		2031
			TEMPRO 5.4	TEMPRO 6.2	TEMPRO 5.4	TEMPRO 6.2	TEMPRO 6.2
No Relief Road	PT	Bus	9,038	9,706	9,176	9,282	8,809
		Coach	0	0	0	0	0
		Rail	17,113	17,79	17,317	18,057	18,237
		Sub-Total	**26,151**	**27,485**	**26,493**	**27,339**	**27,046**
	Cycle		7,180	7,737	7,619	7,472	7,253
	Walk		36,548	37,891	37,400	37,049	36,505
	Total		**69,872**	**73,113**	**71,512**	**71,860**	**70,804**

4.2.4. In the PM model there is a slight increase in person kilometres for public transport, cycle and walk modes between TEMPRO V5.4 and V6.2 in both 2026 and 2031. Similar to the AM model, the differences in person kilometres travelled between each scenario is marginal between the modelling scenarios. This indicates that we can be confident that the assessment based on the revised Housing Option 5, discussed later in the report is robust and we can be confident that the results given are because of implicitly modelling the changes in housing and employment numbers.

4.2.5. Tables 9 and 10 show the comparison of total travel time by non-car modes across scenarios and time-periods.

Table 9: AM Peak Comparison of Travel Time (person hours)							
Scheme	Mode	Sub Mode	Housing Option 4				Housing Option 5
			2026		2031		2031
			TEMPRO 5.4	TEMPRO 6.2	TEMPRO 5.4	TEMPRO 6.2	TEMPRO 6.2
No Relief Road	PT	Bus	724	712	712	717	676
		Coach	6	6	6	6	5
		Rail	333	333	331	339	341
		Sub-Total	**1,064**	**1,051**	**1,050**	**1,061**	**1,022**
	Cycle		493	477	495	483	465
	Walk		8,300	8,044	8,320	8,152	7,983
	Total		**9,857**	**9,572**	**9,865**	**9,697**	**9,470**

Table 10: PM Peak Comparison of Travel Time (person hours)							
Scheme	Mode	Sub Mode	Housing Option 4				Housing Option 5
			2026		2031		2031
			TEMPRO 5.4	TEMPRO 6.2	TEMPRO 5.4	TEMPRO 6.2	TEMPRO 6.2
No Relief Road	PT	Bus	491	525	496	501	472
		Coach	0	0	0	0	0
		Rail	186	193	188	196	198
		Sub-Total	**677**	**718**	**684**	**697**	**670**
	Cycle		479	516	508	498	484
	Walk		9,135	9,473	9,350	9,262	9,126
	Total		**10,968**	**10,702**	**10,542**	**10,457**	**10,280**

4.2.6. Comparing the TEMPRO V6.2 scenarios, it can be seen that the total travel time hours increase in the AM but reduce in the PM. All scenarios have very similar forecast travel time by non-car modes. Again, this gives confidence to the model results of Housing Option 5.

4.3. Highway Model

4.3.1. The latest highway models have assessed five different forecast scenarios using the No Relief Road networks. As discussed in the Introduction, an assessment has been made for the Western Relief Road alignment and will be discussed in Part 2 of this report. A comparison of the No Relief Road scenarios is based on network conditions using such measures as average speed, delays and queues in the network.

4.3.2. The comparisons of network performance in terms of delays, time spent in queues and average speed across the network for the AM and PM future year models are shown below in Tables 11 and 12.

Table 11: 2008/2026/2031 AM Peak Summary of Highway Network Performance

Indicators	Base Year	No Relief Road Demand Scenario				
	2008	Sustainable Option 3 H4 2026 T54	Sustainable Option 3 H4 2026 T62	Sustainable Option 3 H4 2031 T54	Sustainable Option 3 H4 2031 T62	Sustainable Option 3 H5 2031 T62
Total Time / Hours	1,923	2,299	2,361	2,415	2,390	2,237
Transient Queues / Hours	673	865	888	911	886	837
Over-capacity Queues / Hours	20	9	37	58	57	19
Link Delays / Hours	31	50	52	53	53	46
Total Distance / Km	61,348	69,235	69,595	70,015	69,965	67,475
Total Trips Loaded / pcu	15,802	18,036	17,850	17,877	17,873	17,661
Average Speed / Kph	31.9	30.1	29.4	28.9	29.2	30.2

Table 12: 2008/2026/2031 PM Peak Summary of Highway Network Performance						
Indicators	Base Year	No Relief Road Demand Scenario				
	2008	Sustainable Option 3 H4 2026 T54	Sustainable Option 3 H4 2026 T62	Sustainable Option 3 H4 2031 T54	Sustainable Option 3 H4 2031 T62	Sustainable Option 3 H5 2031 T62
Total Time / Hours	2,183	2,453	2,572	2,588	2,591	2,483
Transient Queues / Hours	823	946	955	964	965	934
Over-capacity Queues / Hours	82	63	145	141	141	117
Link Delays / Hours	29	47	51	52	53	47
Total Distance / Km	63,310	70,325	71,355	72,095	72,075	69,525
Total Trips Loaded / pcu	16,414	18,628	18,578	18,786	18,781	18,566
Average Speed / Kph	29.3	28.7	27.7	27.8	27.8	28.0

4.3.3. Comparison of the network statistics in the above two tables' reveals how the model predicts the travel and congestion conditions of the highway will change. The results show that in all scenarios without the Relief Road, queuing and travel delays are predicted to increase.

4.3.4. Although the average speed across the network does not change considerably, this may be misleading as it considers average speeds on all links in the network. A better indicator to show how the network performs is the link delays in the network, which is the sum of all link delay experienced by all road users in the network due to congestion. For the AM peak, there is an average increase of 64% in link delays with a maximum increase of 71% experienced in 2031 using the Housing Option 4 scenario. For the PM peak time period, there is an average increase of 72% in link delays with a maximum increase of 83% experienced in 2031 once again in the scenario containing Housing Option 4.

4.3.5. The results also show that there is a marginal worsening of travel conditions between the different forecast years 2026 and 2031 during both the AM and PM peak periods indicated by the slight reduction in the average speed of the simulation network and an increase in the total hours spent in over capacity queues on the highway network.

4.3.6. Comparing all the scenarios, the results are very similar, with the reduced Housing Option 5 performing the best. This is to be expected given the lower number of trips assigned onto the network as compared to the other scenarios.

4.3.7. The modelling results between future years and different TEMPRO growth rates are broadly similar, this gives confidence that when modelling Housing Options 4 and 5 with and without the Western Relief Road, the results given are implicitly due to the changes to the housing and employment numbers, and the changes to the network in the form of a Relief Road.

5. Part One – TEMPRO Comparison: Analysis of Highway Model Results

5.1. Journey Time Analysis

5.1.1. During the construction of the Base Year models, eight routes through the city were surveyed and average journey times for each route were obtained in order to provide an assessment of the impacts on typical journey times in Hereford in each of the future year highway models. These routes are shown in Figure 5.2 of JMP's forecasting report and have been extracted for the purpose of this report to compare journey times for all scenarios. Tables 13 and 14 show the comparison results.

Table 13: AM Peak Comparison of Journey Times

Scheme	Route	Average Modelled Journey Time / mm:ss					
		Sustainable Option Package 3					
		Base 2008	H4 2026 T54	H4 2026 T62	H4 2031 T54	H4 2031 T62	H5 2031 T62
No Relief Road	1	19:40	26:47	27:43	27:40	26:28	27:44
	2	18:40	23:50	25:21	25:26	25:21	24:16
	3	22:01	26:05	27:05	27:29	27:20	25:30
	4	21:44	23:40	23:57	23:57	23:48	23:20
	5	-	-	-	-	-	-
	6	18:37	31:26	33:11	34:16	34:16	31:26
	7	22:05	26:02	23:58	26:24	23:26	24:13
	8	20:16	25:09	26:12	26:37	26:32	25:20
	Total	**143:03**	**182:59**	**187:27**	**191:49**	**187:13**	**181:49**

Table 14: PM Peak Comparison of Journey Times							
Scheme	Route	Average Modelled Journey Time / mm:ss					
		Sustainable Option Package 3					
		Base 2008	H4 2026 T54	H4 2026 T62	H4 2031 T54	H4 2031 T62	H5 2031 T62
No Relief Road	1	22:12	30:04	32:03	32:13	32:06	31:41
	2	18:53	23:49	26:11	25:59	25:54	25:43
	3	23:01	26:13	27:26	27:27	27:22	27:20
	4	28:34	27:14	28:42	28:37	28:48	28:14
	5	-	-	-	-	-	-
	6	18:20	33:35	36:58	36:28	36:16	36:24
	7	14:11	28:19	28:09	26:23	26:42	26:53
	8	21:43	26:30	29:23	28:57	29:08	28:58
	Total	**156:54**	**195:44**	**208:52**	**206:04**	**206:16**	**205:13**

5.1.2. The total times shown in the tables show that all modelled scenarios journey times without a Relief Road are expected to worsen by over 40 minutes as compared to the 2008 base year. All results between each scenario are very similar with the reduced housing scenario Option 5 having the best-predicted total journey time in the AM peak period and best in the PM peak period for TEMPRO V6.2. The PM peak period has the highest total journey-time.

5.2. Over-Capacity Junctions

5.2.1. In the highway model, delays and queues at junctions are modelled explicitly. A junction that is operating at, or close to, its nominal capacity is likely to impose delays on vehicles using it.

5.2.2. The volume-to-capacity ratio is often used to denote how close to capacity a particular junction is. As the techniques used to estimate a junction's capacity were derived using statistical modelling techniques, there is always a degree of uncertainty regarding a calculation of a junction's capacity. For this reason, a junction operating at 85% of its calculated capacity is generally considered to be congested, as although it might appear to be operating within its calculated capacity, its actual capacity could be somewhat lower.

5.2.3. The SATURN models are interrogated in order to obtain the volume-to-capacity ratio at each modelled junction. Junctions operating at 85% of capacity and above are divided into three bands:

- 85% to 100% - operating at or close to capacity, delays are to be expected;
- 100% to 120% - operating over-capacity, delays are likely to be considerable;
- 120% and over - operating significantly over-capacity, delays will be considerable and could lead to widespread queuing.

5.2.4. The numbers of modelled junctions within each volume-to-capacity band are shown in Table 15 for the AM peak models and in Table 16 for the PM peak models. Table 17 shows the over capacity for both peaks combined.

Table 15: Junctions Over Capacity AM Peak

Volume to Capacity Ratio	2008 Base	2026 H4 T54 SO3	2026 H4 T62 SO3	2031 H4 T54 SO3	2031 H4 T62 SO3	2031 H5 T62 SO3
85% to 100%	14	21	25	24	22	26
100% to 120%	5	10	12	14	12	7
120% and over	0	0	0	0	0	0
Total	**19**	**31**	**37**	**38**	**34**	**33**

Table 16: Junctions Over Capacity PM Peak

Volume to Capacity Ratio	2008 Base	2026 H4 T54 SO3	2026 H4 T62 SO3	2031 H4 T54 SO3	2031 H4 T62 SO3	2031 H5 T62 SO3
85% to 100%	20	14	13	12	16	13
100% to 120%	9	16	18	19	21	18
120% and over	0	0	0	0	0	0
Total	**29**	**30**	**31**	**31**	**37**	**31**

Table 17: Junctions Over Capacity Both Peaks

Volume to Capacity Ratio	2008 Base	2026 H4 T54 SO3	2026 H4 T62 SO3	2031 H4 T54 SO3	2031 H4 T62 SO3	2031 H5 T62 SO3
85% to 100%	34	35	38	36	38	39
100% to 120%	14	26	30	33	33	25
120% and over	0	0	0	0	0	0
Total	**48**	**61**	**68**	**69**	**71**	**64**

5.2.5. Examination of these results, show that when both peak periods are combined there are slightly more junctions over capacity in 2031 than 2026. This is to be expected due to the higher number of over capacity queue hours present in the 2031 network assignments. The differences between the scenarios however are marginal with all scenarios expected to have a similar number of junctions over capacity.

5.2.6. Again, the modelling results between future years and different TEMPRO growth rates are broadly similar. This gives confidence that when modelling Housing Options 4 and 5 with and without the Western Relief Road; the results given are implicitly due to the changes to the housing and employment numbers, and the changes to the network in the form of a Relief Road. Furthermore, we can be confident when drawing comparisons between previous modelled scenarios.

6. Part Two – Impact of Relief Road - Modal Split

6.1.1. As stated in the introduction of the report, the reduced Housing Option 5 is assessed with a Western Relief Road alignment and results are compared to the No Relief Road scenario and the preferred option Housing Option 4 scenario.

6.1.2. Tables 18 and 19 show the pre DIADEM forecast person trip totals for car, public transport, cycle and walk demand matrices obtained from demand model for each modelled scenario for the AM and PM models respectively.

Table 18: AM Pre DIADEM Forecast Person Trip Totals

Scheme	Mode	Housing Option 5 (2031) (TEMPRO 6.2)	Scheme	Mode	Housing Option 5 (2031) (TEMPRO 6.2)
No Relief Road	Car	20,740	Western Relief Road	Car	20,740
	PT	3,857		PT	3,857
	Cycle	1,912		Cycle	1,912
	Walk	10,473		Walk	10,473
	Total	**36,981**		**Total**	**36,981**

Table 19: PM Pre DIADEM Forecast Person Trip Totals

Scheme	Mode	Housing Option 5 (2031) (TEMPRO 6.2)	Scheme	Mode	Housing Option 5 (2031) (TEMPRO 6.2)
No Relief Road	Car	22,299	Western Relief Road	Car	22,299
	PT	3,017		PT	3,017
	Cycle	1,990		Cycle	1,990
	Walk	13,679		Walk	13,679
	Total	**40,985**		**Total**	**40,985**

6.1.3. The tables show the fixed trip matrices before they are assigned to the networks through Variable Demand Modelling using DIADEM.

6.1.4. Tables 20 and 21 show the post DIADEM forecast person trips for car, public transport, cycle and walk demand matrices obtained from demand model for each modelled scenario for the AM and PM models respectively.

Table 20: AM Post DIADEM Forecast Person Trip Totals						
Scheme	**Mode**	**Housing Option 5 (2031) (TEMPRO 6.2)**	**Scheme**	**Mode**	**Housing Option 5 (2031) (TEMPRO 6.2)**	**Approx. Percentage Difference**
No Relief Road	Car	21,152	Western Relief Road	Car	21,296	+1%
	PT	3,305		PT	3,272	-1%
	Cycle	1,935		Cycle	1,918	-1%
	Walk	10,674		Walk	10,584	-1%
	Total	**37,067**		**Total**	**37,070**	**0**

Table 21: PM Post DIADEM Forecast Person Trip Totals						
Scheme	**Mode**	**Housing Option 5 (2031) (TEMPRO 6.2)**	**Scheme**	**Mode**	**Housing Option 5 (2031) (TEMPRO 6.2)**	**Approx. Percentage Difference**
No Relief Road	Car	22,383	Western Relief Road	Car	22,575	+1%
	PT	2,665		PT	2,626	-1%
	Cycle	1,996		Cycle	1,985	-2%
	Walk	13,789		Walk	13,678	-1%
	Total	**40,833**		**Total**	**40,837**	**0**

6.1.5. In comparing the No Relief Road options AM pre and post DIADEM assignments, the car and walk demand matrices show an increase and the PT demand decreases. For example, during the AM peak period, demand for travel by car is forecast to rise by 2% and the PM by 0.4%, whilst travel by Public transport is forecast to fall by 16% in the AM peak and by 13% in the PM peak.

6.1.6. This shift away from public transport, with the trips transferring to car and walk modes is predictable: The forecast cost of public transport increase due to increased congestion leading to increased journey times, and consequently travellers' value of time is forecast to grow. All these factors lead to public transport costs increasing at a rate higher than that for the other modes. The proportion of travellers with a car available is also forecast to increase; so it is not surprising that public transport usage is forecast to fall. The fall in public transport usage is accompanied by an increase in usage of the other modes.

6.1.7. The provision of the Western Relief Road leads to a shift of demand towards car and tends to increase the fall in demand for public transport. As the capacity increases in the model as a result of the implementation of a Relief Road the demand for travel by car becomes greater than in the No Relief Road scenario.

7. Part Two – Impact of Relief Road: model Performance Statistics

7.1.1. Model performance statistics are collected for all modes after assigning the demand matrices obtained from the demand model.

7.2. Non-Highway Models

7.2.1. The following service indicators are used to assess the PT, cycle and walk model performance:

- Total Distance (measured in person-kilometres);
- Total Time (measured in person-hours).

7.2.2. The comparison of total distance travelled within the modelled network (Herefordshire County) for the AM model is shown in Table 22.

Table 22: AM Peak Comparison of Total Distance Travelled (person-km)

Scheme	Mode	Sub Mode	Housing Option 5 (2031) (TEMPRO 6.2)	Scheme	Mode	Sub Mode	Housing Option 5 (2031) (TEMPRO 6.2)
No Relief Road	PT	Bus	9,588	Western Relief Road	PT	Bus	9,432
		Coach	408			Coach	405
		Rail	30,106			Rail	29,870
		Sub-Total	**40,102**			**Sub-Total**	**39,707**
	Cycle		6,973		Cycle		6,824
	Walk		31,933		Walk		31,419
	Total		**79,008**		**Total**		**77,950**

7.2.3. For the non-car modes, the addition of a Relief Road leads to a slight fall in the distance travelled by public transport, cycle and walk. The comparison for the PM model is shown in Table 23.

Table 23: PM Peak Comparison of Total Distance Travelled (person km)							
Scheme	**Mode**	**Sub Mode**	**Housing Option 5 (2031) (TEMPRO 6.2)**	**Scheme**	**Mode**	**Sub Mode**	**Housing Option 5 (2031) (TEMPRO 6.2)**
No Relief Road	PT	Bus	8,809	Western Relief Road	PT	Bus	8,394
		Coach	0			Coach	0
		Rail	18,237			Rail	18,395
		Sub-Total	**27,046**			**Sub-Total**	**26,789**
	Cycle		7,253		Cycle		7,007
	Walk		36,505		Walk		35,647
	Total		**70,804**		**Total**		**69,443**

7.2.4. Tables 24 and 25 show the comparison of total travel time by non-car modes across scenarios and time-periods.

Table 24: AM Peak Comparison of Total Time (person hours)							
Scheme	**Mode**	**Sub Mode**	**Housing Option 5 (2031) (TEMPRO 6.2)**	**Scheme**	**Mode**	**Sub Mode**	**Housing Option 5 (2031) (TEMPRO 6.2)**
No Relief Road	PT	Bus	676	Western Relief Road	PT	Bus	667
		Coach	5			Coach	6
		Rail	341			Rail	339
		Sub-Total	**1,022**			**Sub-Total**	**1,012**
	Cycle		465		Cycle		455
	Walk		7,983		Walk		7,855
	Total		**9,470**		**Total**		**9,322**

Table 25: PM Peak Comparison of Total Time (person hours)							
Scheme	**Mode**	**Sub Mode**	**Housing Option 5 (2031) (TEMPRO 6.2)**	**Scheme**	**Mode**	**Sub Mode**	**Housing Option 5 (2031) (TEMPRO 6.2)**
No Relief Road	PT	Bus	472	Western Relief Road	PT	Bus	451
		Coach	0			Coach	0
		Rail	198			Rail	196
		Sub-Total	**670**			**Sub-Total**	**647**
	Cycle		484		Cycle		467
	Walk		9,126		Walk		8,863
	Total		**10,280**		**Total**		**9,977**

7.2.5. It can be seen in the above tables that the addition of the Western Relief Road has a beneficial effect on no-car modes as there is a small reduction in the total travel time for the public transport, cycle and walk modes.

7.2.6. The 2031 highway network is capable of handling the mode shift assumption of 20% due to the Sustainability Option when the proposed network improvements are in place. Even though public transport usage have been slightly improved in the future year scenario with the provision of bus lanes in sustainable Option 3 for example, the increase in public transport fares and congestion and delays caused to public transport trips elsewhere on the network, particularly for outbound trips, has resulted in a minimal modal shift.

7.3. Highway Model

7.3.1. The comparisons of network performance for the AM and PM future year models are shown in Tables 26 to 27. The results also include an assessment of the CO_2 emissions.

Table 26: 2031 AM Peak Summary of Highway Network Performance					
Indicators	**Base 2008**	**NO RR Sustainable Option 3 H4 2031 T62**	**NO RR Sustainable Option 3 H5 2031 T62**	**West RR Sustainable Option 3 H4 2031 T62**	**West RR Sustainable Option 3 H5 2031 T62**
Total Time / hrs	1,923	2,390	2,237	2,161	2,017
Transient Queues / hrs	673	886	837	648	602
Over-Capacity Queues / hrs	20	57	19	1	0
Link Delays / hrs	31	53	46	61	45
Total Distance / km	61,348	69,965	67,475	81,472	76,465
Total Trips Loaded / pcu	15,802	17,873	17,661	18,359	17,769
Average Speed / kph	31.9	29.2	30.2	37.7	37.9
CO2 Kilograms	6,102	7,277	6,986	7,615	7,137

Table 27: 2031 PM Peak Summary of Highway Network Performance					
Indicators	**Base 2008**	**NO RR Sustainable Option 3 H4 2031 T62**	**NO RR Sustainable Option 3 H5 2031 T62**	**West RR Sustainable Option 3 H4 2031 T62**	**West RR Sustainable Option 3 H5 2031 T62**
Total Time / Hours	2,183	2,591	2,483	2,547	2,250
Transient Queues / Hours	823	965	934	832	723
Over-capacity Queues / Hours	82	141	117	39	18
Link Delays / Hours	29	53	47	83	58
Total Distance / Km	63,310	72,075	69,525	89,793	81,155
Total Trips Loaded / pcu	16,414	18,781	18,566	19,765	18,713
Average Speed / Kph	29.0	27.8	28.0	35.2	36.1
CO_2 Kilograms	6,561	7,642	7,338	8,625	7,746

7.3.2. The results show that with the implementation of a Western Relief Road alignment that overall the highway network performs more favourably. The average speed of the network improves significantly from 30.2 to 37.9 kph in the AM peak for Housing Option 5 with the addition of a Relief Road; an improvement on Base Year of 18.8%. Similarly Housing Option 4 shows the same improvement but the average speeds are slightly lower than that of Housing Option 5. The corresponding PM peak average speed improves significantly from 28.0 to 36.1 kph for Housing Option 5; an improvement on Base Year of 20.5%. Housing Option 4 average speed improves from 27.8 to 35.2 in the PM peak. With the Western Relief Road in place the networks overall average speed is greater than the base year by up to approximately 7kph indicating that the network is less congested and experiences fewer delays.

7.3.3. Time spent in transient queues and over-capacity queues on the network are also forecasted to significantly reduce after the implementation of the Relief Road. Over-capacity queues reduce from 19 hours to 0 hours for Housing Option 5 in the AM peak and 117 to 18 hours in the PM peak. This represents a 100% improvement on Base Year for the AM peak period and 78% improvement in the PM peak period. Housing Option 4 over capacity queues also show a reduction but time spent queuing in the network is still higher than Housing Option 5 particularly in the PM peak period.

7.3.4. The levels of CO2 present in the network are forecasted to increase with the implementation of the Relief Road for both Housing Options. In the AM peak the levels of CO2 is expected to increase by 2% and the PM peak the levels increase by 5.6% for Housing Option 5.

7.3.5. Housing Option 4 levels of CO2 present in the network increase at a higher rate than Housing Option 5 by 4.6% in the AM peak and 12.8% in the PM peak. Housing Option 5 CO2 levels increase from the base year by 14.5% in the AM peak and 15% in the PM peak in the period between 2008 and 2031.

7.3.6. Contributory factors for the increase in CO2 levels are a combination of more trips loaded onto the highway network and the creation of a wider network, resulting in an improvement in average speeds and increase in distance travelled after the implementation of the Western Relief Road. This is analysed in greater detail in Chapter 8.

7.3.7. As a result of the increase in overall average network speed and the decrease in delay time on the network, the Western Relief Road scenarios have more trips assigned to the network than the No Relief Road scenario. This can explain why trips by PT are shifting back to car at a slightly higher rate than the No Relief Road scenario as expressed in Tables 22 to 25 above.

8. Part Two – Impact of Relief Road: Analysis of Highway Model Results

8.1. Impact of Relief Road

8.1.1. Analysis was undertaken to assess the impact a Relief Road has on the main roads in and around Hereford and the differences between a No Relief Road and a Western Relief Road alignment. Differences between Housing Option 4 and Housing Option 5 are also discussed. Figure 3 below shows the site locations that were used for the flow comparisons. This figure is the same figure that was used in the JMP Hereford Multi Modal Forecasting Report 2009 in Chapter 5 and as such those ID numbers used for the Eastern Relief Road alignment are not subject to this report.

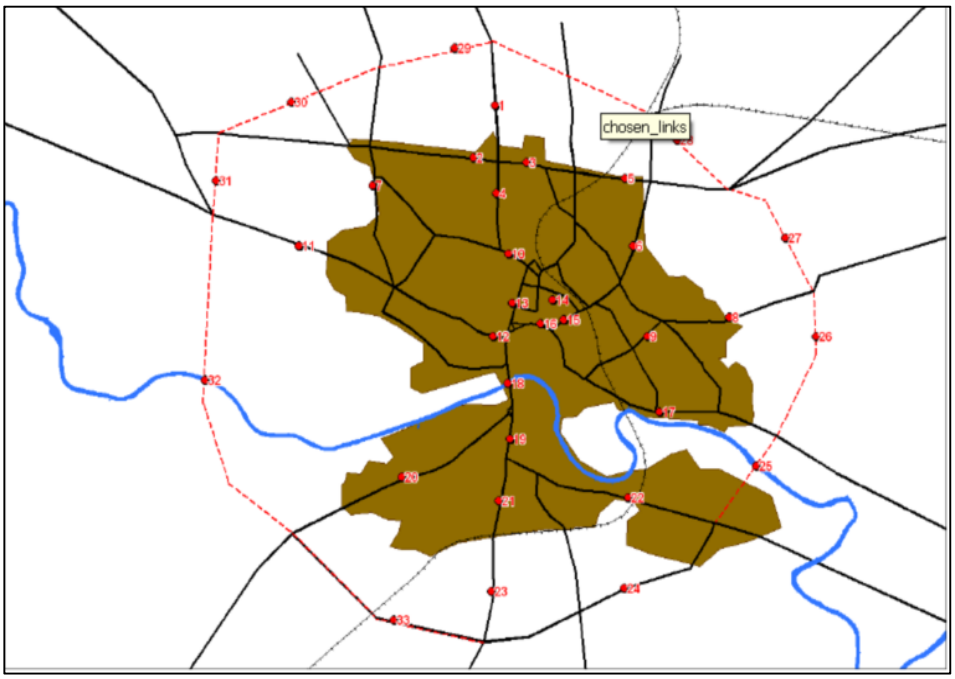

Figure 3: Site Locations for Flow Comparisons

8.1.2. Table 28 below shows the total flows on the main roads in Hereford for the 2031 future year for the No Relief Road scenario during the AM peak period for Housing Option 4 and Housing Option 5 along with a percentage difference between each scenario.

Table 28: No Relief Road AM PCU Per Hour								
No	Location	Map ID	Name	Dir	Base	Housing Option 4 SO3	Housing Option 5 SO3	Percentage Difference Between Option 4 and 5
1	A49 north of Holmer	1	A49	NB	517	454	535	18%
1	A49 north of Holmer	1	A49	SB	667	564	635	13%
2	Holmer Road opp Racecourse	4	A49	NB	598	621	645	4%
2	Holmer Road opp Racecourse	4	A49	SB	961	1105	1092	-1%
3	Newtown Road	10	A49	EB	1068	1275	1260	-1%
3	Newtown Road	10	A49	WB	673	640	738	15%
4	Edgar Street at Football Ground	13	A49	NB	1015	1533	1520	-1%
4	Edgar Street at Football Ground	13	A49	SB	950	1562	1551	-1%
5	Victoria Street	18	A49	NB	1783	2085	2040	-2%
5	Victoria Street	18	A49	SB	1563	1738	1714	-1%
6	Ross Road nr Boycott Rd	19	A49	NB	1182	1188	1152	-3%
6	Ross Road nr Boycott Rd	19	A49	SB	763	380	377	-1%
7	Ross Road nr Mayberry Ave	21	A49	NB	753	776	776	0%
7	Ross Road nr Mayberry Ave	21	A49	SB	467	519	487	-6%
9	A49 Ross Rd at Grafton	23	A49	NB	366	412	425	3%
9	A49 Ross Rd at Grafton	23	A49	SB	504	639	591	-7%
10	Roman Road east of A49	2	A4103	EB	866	1316	1155	-12%
10	Roman Road east of A49	2	A4103	WB	555	715	680	-5%
11	Roman Road west of A49	3	A4103	EB	676	656	631	-4%
11	Roman Road west of A49	3	A4103	WB	653	637	614	-4%
12	Roman Road nr Staniers Way	5	A4103	EB	389	526	545	4%
12	Roman Road nr Staniers Way	5	A4103	WB	334	690	602	-13%
13	Alyestone Hill	6	A465	NB	323	584	543	-7%

Table 28: No Relief Road AM PCU Per Hour

No	Location	Map ID	Name	Dir	Base	Housing Option 4 SO3	Housing Option 5 SO3	Percentage Difference Between Option 4 and 5
13	Alyestone Hill	6	A465	SB	446	733	695	-5%
14	Commercial Road at Bus Station	15	A465	NB	850	711	680	-4%
14	Commercial Road at Bus Station	15	A465	SB	705	128	146	14%
15	Belmont Road	20	A465	EB	538	797	687	-14%
15	Belmont Road	20	A465	WB	529	500	502	0%
16	Ledbury Road nr Quarry Rd	9	A438	NB	364	376	334	-11%
16	Ledbury Road nr Quarry Rd	9	A438	SB	482	351	433	23%
17	Blue School Street	16	A438	EB	1179	693	677	-2%
17	Blue School Street	16	A438	WB	1294	397	379	-5%
18	Eign Street	12	A438	EB	786	1041	987	-5%
18	Eign Street	12	A438	WB	590	612	713	17%
19	Kings Acre Road	11	A438	EB	532	422	460	9%
19	Kings Acre Road	11	A438	WB	379	341	362	6%
20	Three Elms Road	7	A4110	NB	272	561	447	-20%
20	Three Elms Road	7	A4110	SB	482	455	406	-11%
21	ESG Link Road	14		EB	0	364	353	-3%
21	ESG Link Road	14		WB	0	178	220	24%
22	Hampton Park Road	17		EB	183	273	257	-6%
22	Hampton Park Road	17		WB	375	329	336	2%
23	Holme Lacy Road	22		EB	502	681	628	-8%
23	Holme Lacy Road	22		WB	331	602	517	-14%
24	Rotherwas Access Road	24		EB	95	273	284	4%

8.1.3. Looking at the differences between the two housing options, Housing Option 5 has the highest flow on the A49 North of Holmer with an increase in traffic of 18% Northbound and 13% southbound. Newtown Road southbound also has a larger proportion of traffic of 15% in Housing Option 5 than Housing Option 4 and Edgar Street Grid Link Road has roughly 40 more vehicles travelling westbound in Housing Option 5 than Housing Option 4.

8.1.4. Of the selected roads in table 28, 29 out of 45 have lower traffic flow volumes in the AM peak with Housing Option 5 as compared to Housing Option 4. The largest decreases occur on Aylestone Hill of up to -7% difference, Belmont Road at -14% and Three Elms Road of up to -20% difference. The differences in traffic volumes on Three Elms Road can be explained by the reduction in the provision of 500 dwellings at Three Elms Road in Housing Option 5 compared to Housing Option 4.

8.1.5. There are minimal differences in traffic flow volumes between the two housing options on city centre routes notably Edgar Street and Victoria Street.

8.1.6. Table 29 shows the total flows on the main roads in Hereford for the 2031 future year for the Western Relief Road scenario during the AM peak period for Housing Option 4 and Housing Option 5 along with a percentage difference between each Scenario.

Table 29: Western Relief Road AM PCU Per Hour								
No	Location	Map ID	Name	Dir	Base	Housing Option 4 SO3	Housing Option 5 SO3	Percentage Difference Between Option 4 and 5
1	A49 north of Holmer	1	A49	NB	517	375	376	0%
1	A49 north of Holmer	1	A49	SB	667	665	678	2%
2	Holmer Road opp Racecourse	4	A49	NB	598	534	503	-6%
2	Holmer Road opp Racecourse	4	A49	SB	961	1025	1035	1%
3	Newtown Road	10	A49	EB	1068	1075	1058	-2%
3	Newtown Road	10	A49	WB	673	588	589	0%
4	Edgar Street at Football Ground	13	A49	NB	1015	1297	1383	7%
4	Edgar Street at Football Ground	13	A49	SB	950	1322	1395	6%
5	Victoria Street	18	A49	NB	1783	1724	1743	1%
5	Victoria Street	18	A49	SB	1563	1332	1342	1%
6	Ross Road nr Boycott Rd	19	A49	NB	1182	1043	1021	-2%
6	Ross Road nr Boycott Rd	19	A49	SB	763	268	287	7%
7	Ross Road nr Mayberry Ave	21	A49	NB	753	658	648	-2%
7	Ross Road nr Mayberry Ave	21	A49	SB	467	385	396	3%
9	A49 Ross Rd at Grafton	23	A49	NB	366	388	399	3%
9	A49 Ross Rd at Grafton	23	A49	SB	504	623	528	-15%
10	Roman Road east of A49	2	A4103	EB	866	707	635	-10%
10	Roman Road east of A49	2	A4103	WB	555	490	473	-4%
11	Roman Road west of A49	3	A4103	EB	676	584	529	-9%
11	Roman Road west of A49	3	A4103	WB	653	574	561	-2%
12	Roman Road nr Staniers Way	5	A4103	EB	389	215	231	8%
12	Roman Road nr Staniers Way	5	A4103	WB	334	443	401	-9%
13	Alyestone Hill	6	A465	NB	323	618	573	-7%

Table 29: Western Relief Road AM PCU Per Hour								
No	Location	Map ID	Name	Dir	Base	Housing Option 4 SO3	Housing Option 5 SO3	Percentage Difference Between Option 4 and 5
13	Alyestone Hill	6	A465	SB	446	741	682	-8%
14	Commercial Road at Bus Station	15	A465	NB	850	651	681	5%
14	Commercial Road at Bus Station	15	A465	SB	705	135	133	-2%
15	Belmont Road	20	A465	EB	538	507	536	6%
15	Belmont Road	20	A465	WB	529	377	395	5%
16	Ledbury Road nr Quarry Rd	9	A438	NB	364	356	327	-8%
16	Ledbury Road nr Quarry Rd	9	A438	SB	482	454	400	-12%
17	Blue School Street	16	A438	EB	1179	691	649	-6%
17	Blue School Street	16	A438	WB	1294	359	370	3%
18	Eign Street	12	A438	EB	786	824	800	-3%
18	Eign Street	12	A438	WB	590	680	703	3%
19	Kings Acre Road	11	A438	EB	532	403	395	-2%
19	Kings Acre Road	11	A438	WB	379	491	373	-24%
20	Three Elms Road	7	A4110	NB	272	424	345	-19%
20	Three Elms Road	7	A4110	SB	482	459	371	-19%
21	ESG Link Road	14		EB	0	312	366	17%
21	ESG Link Road	14		WB	0	198	218	10%
22	Hampton Park Road	17		EB	183	217	198	-9%
22	Hampton Park Road	17		WB	375	283	291	3%
23	Holme Lacy Road	22		EB	502	509	467	-8%
23	Holme Lacy Road	22		WB	331	558	514	-8%
24	Rotherwas Access Road	24		EB	95	550	508	-8%
24	Rotherwas Access Road	24		WB	31	200	202	1%
28	West RR at Shelwick Green	28		EB		568	505	-11%
28	West RR at Shelwick Green	28		WB		386	366	-5%

Table 29: Western Relief Road AM PCU Per Hour								
No	Location	Map ID	Name	Dir	Base	Housing Option 4 SO3	Housing Option 5 SO3	Percentage Difference Between Option 4 and 5
29	West RR at Lyde Arundel	29		EB		952	843	-11%
29	West RR at Lyde Arundel	29		WB		491	458	-7%
30	West RR nr Towtree Lane	30		EB		305	253	-17%
30	West RR nr Towtree Lane	30		WB		200	200	0%
31	West RR nr Swainshill	31		NB		666	569	-15%
31	West RR nr Swainshill	31		SB		526	536	2%
32	West RR at Western river crossing	32		NB		550	481	-12%
32	West RR at Western river crossing	32		SB		778	666	-14%
33	West RR nr Grafton	33		EB		591	480	-19%
33	West RR nr Grafton	33		WB		484	453	-6%

8.1.7. Looking at Table 29 and the differences between the two housing options, Housing Option 5 has higher proportion of traffic on Edgar Street of up to 7%, however there is minimal difference on other city centre roads between the two housing options such as Victoria Street, Eign Street and Blue School Street.

8.1.8. Some of the largest decreases between the two housing options occur east of the city with a reduction of -8% on Aylestone Hill and -12% on Ledbury Road. As in the AM peak there is also a reduction on Three Elms Road in Housing Option 5.

8.1.9. Looking at the Western Relief Road links 11 out of 12 sections have lower traffic volumes in Housing Option 5 than Housing Option 4, this is to be expected given the lower number of trips assigned to the network in Housing Option 5.

8.1.10. Table 30 shows the total flows on the main roads in Hereford for the 2031 future year for the No Relief Road scenario during the PM peak period for Housing Option 4 and Housing Option 5 along with a percentage difference between each Scenario.

Table 30: No Relief Road PM PCU Per Hour								
No	Location	Map ID	Name	Dir	Base	Housing Option 4 SO3	Housing Option 5 SO3	Percentage Difference Between Option 4 and 5
1	A49 north of Holmer	1	A49	NB	506	484	530	10%
1	A49 north of Holmer	1	A49	SB	553	581	484	-17%
2	Holmer Road opp Racecourse	4	A49	NB	786	658	758	15%
2	Holmer Road opp Racecourse	4	A49	SB	726	657	720	10%
3	Newtown Road	10	A49	EB	820	924	954	3%
3	Newtown Road	10	A49	WB	943	1116	1223	10%
4	Edgar Street at Football Ground	13	A49	NB	764	934	1001	7%
4	Edgar Street at Football Ground	13	A49	SB	1069	1575	1646	4%
5	Victoria Street	18	A49	NB	1823	2027	1938	-4%
5	Victoria Street	18	A49	SB	2085	2089	2094	0%
6	Ross Road nr Boycott Rd	19	A49	NB	1031	1151	1107	-4%
6	Ross Road nr Boycott Rd	19	A49	SB	829	595	602	1%
7	Ross Road nr Mayberry Ave	21	A49	NB	521	724	675	-7%
7	Ross Road nr Mayberry Ave	21	A49	SB	565	659	648	-2%
9	A49 Ross Rd at Grafton	23	A49	NB	386	590	520	-12%
9	A49 Ross Rd at Grafton	23	A49	SB	361	592	580	-2%
10	Roman Road east of A49	2	A4103	EB	560	803	842	5%
10	Roman Road east of A49	2	A4103	WB	816	1217	1066	-12%
11	Roman Road west of A49	3	A4103	EB	674	677	668	-1%
11	Roman Road west of A49	3	A4103	WB	737	848	820	-3%
12	Roman Road nr Staniers Way	5	A4103	EB	221	489	440	-10%
12	Roman Road nr Staniers Way	5	A4103	WB	333	564	577	2%
13	Alyestone Hill	6	A465	NB	452	682	624	-8%
13	Alyestone Hill	6	A465	SB	303	678	558	-18%

Table 30: No Relief Road PM PCU Per Hour								
No	Location	Map ID	Name	Dir	Base	Housing Option 4 SO3	Housing Option 5 SO3	Percentage Difference Between Option 4 and 5
14	Commercial Road at Bus Station	15	A465	NB	859	382	328	-14%
14	Commercial Road at Bus Station	15	A465	SB	691	178	173	-3%
15	Belmont Road	20	A465	EB	1010	907	901	-1%
15	Belmont Road	20	A465	WB	1075	1056	1110	5%
16	Ledbury Road nr Quarry Rd	9	A438	NB	473	535	527	-2%
16	Ledbury Road nr Quarry Rd	9	A438	SB	232	213	164	-23%
17	Blue School Street	16	A438	EB	1053	743	726	-2%
17	Blue School Street	16	A438	WB	1228	402	380	-6%
18	Eign Street	12	A438	EB	748	966	854	-12%
18	Eign Street	12	A438	WB	936	962	945	-2%
19	Kings Acre Road	11	A438	EB	417	477	478	0%
19	Kings Acre Road	11	A438	WB	433	419	453	8%
20	Three Elms Road	7	A4110	NB	391	625	552	-12%
20	Three Elms Road	7	A4110	SB	304	675	422	-37%
21	ESG Link Road	14		EB	0	220	229	4%
21	ESG Link Road	14		WB	0	508	537	6%
22	Hampton Park Road	17		EB	296	330	310	-6%
22	Hampton Park Road	17		WB	170	186	172	-7%
23	Holme Lacy Road	22		EB	196	410	377	-8%
23	Holme Lacy Road	22		WB	432	601	522	-13%
24	Rotherwas Access Road	24		EB	26	171	149	-13%
24	Rotherwas Access Road	24		WB	107	457	430	-6%

8.1.11. Table 30 shows that the biggest percentage increases in traffic between Housing Option 5 and Housing Option 4 occur on Holmer Road opposite the Race Course with a 15% increase northbound and 10% southbound. Newtown Road also has higher volumes of traffic of up to 10% westbound.

8.1.12. The greatest percentage decreases in traffic between Housing Option 5 and Housing Option 4 with the No Relief Road scenario occur on Holme Lacy Road and Rotherwas access Road of up to minus 13%. Aylestone Hill also experiences a reduction in traffic volume of up to minus 18%.

8.1.13. Table 31 shows the total flows on the main roads in Hereford for the 2031 future year for the Western Relief Road scenario during the PM peak period for Housing Option 4 and Housing Option 5 along with a percentage difference between each Scenario.

Table 31: Western Relief Road PM PCU Per Hour

No	Location	Map ID	Name	Dir	Base	Housing Option 4 SO3	Housing Option 5 SO3	Percentage Difference Between Option 4 and 5
1	A49 north of Holmer	1	A49	NB	506	596	614	3%
1	A49 north of Holmer	1	A49	SB	667	447	410	-8%
2	Holmer Road opp Racecourse	4	A49	NB	598	784	819	5%
2	Holmer Road opp Racecourse	4	A49	SB	961	662	665	0%
3	Newtown Road	10	A49	EB	1068	925	895	-3%
3	Newtown Road	10	A49	WB	673	1135	1138	0%
4	Edgar Street at Football Ground	13	A49	NB	1015	1140	1042	-9%
4	Edgar Street at Football Ground	13	A49	SB	950	1692	1683	-1%
5	Victoria Street	18	A49	NB	1783	1870	1573	-16%
5	Victoria Street	18	A49	SB	1563	1909	1927	1%
6	Ross Road nr Boycott Rd	19	A49	NB	1182	980	744	-24%
6	Ross Road nr Boycott Rd	19	A49	SB	763	562	557	-1%
7	Ross Road nr Mayberry Ave	21	A49	NB	753	518	412	-20%
7	Ross Road nr Mayberry Ave	21	A49	SB	467	676	638	-6%
9	A49 Ross Rd at Grafton	23	A49	NB	366	614	568	-7%
9	A49 Ross Rd at Grafton	23	A49	SB	504	466	380	-18%
10	Roman Road east of A49	2	A4103	EB	866	486	455	-6%
10	Roman Road east of A49	2	A4103	WB	555	755	702	-7%

Table 31: Western Relief Road PM PCU Per Hour								
No	Location	Map ID	Name	Dir	Base	Housing Option 4 SO3	Housing Option 5 SO3	Percentage Difference Between Option 4 and 5
11	Roman Road west of A49	3	A4103	EB	676	557	523	-6%
11	Roman Road west of A49	3	A4103	WB	653	717	674	-6%
12	Roman Road nr Staniers Way	5	A4103	EB	389	260	267	3%
12	Roman Road nr Staniers Way	5	A4103	WB	334	363	390	8%
13	Alyestone Hill	6	A465	NB	323	633	664	5%
13	Alyestone Hill	6	A465	SB	446	609	522	-14%
14	Commercial Road at Bus Station	15	A465	NB	850	414	343	-17%
14	Commercial Road at Bus Station	15	A465	SB	705	180	163	-9%
15	Belmont Road	20	A465	EB	538	766	755	-1%
15	Belmont Road	20	A465	WB	529	774	861	11%
16	Ledbury Road nr Quarry Rd	9	A438	NB	364	508	539	6%
16	Ledbury Road nr Quarry Rd	9	A438	SB	482	164	154	-6%
17	Blue School Street	16	A438	EB	1179	729	728	0%
17	Blue School Street	16	A438	WB	1294	361	336	-7%
18	Eign Street	12	A438	EB	786	640	602	-6%
18	Eign Street	12	A438	WB	590	778	752	-3%
19	Kings Acre Road	11	A438	EB	532	454	334	-26%
19	Kings Acre Road	11	A438	WB	379	416	407	-2%
20	Three Elms Road	7	A4110	NB	272	354	332	-6%
20	Three Elms Road	7	A4110	SB	482	555	493	-11%
21	ESG Link Road	14		EB	0	243	233	-4%
21	ESG Link Road	14		WB	0	506	535	6%
22	Hampton Park Road	17		EB	183	319	303	-5%
22	Hampton Park Road	17		WB	375	188	128	-32%
23	Holme Lacy Road	22		EB	502	359	327	-9%

Table 31: Western Relief Road PM PCU Per Hour								
No	Location	Map ID	Name	Dir	Base	Housing Option 4 SO3	Housing Option 5 SO3	Percentage Difference Between Option 4 and 5
23	Holme Lacy Road	22		WB	331	515	504	-2%
24	Rotherwas Access Road	24		EB	95	364	262	-28%
24	Rotherwas Access Road	24		WB	31	680	579	-15%
28	West RR at Shelwick Green	28		EB		382	354	-7%
28	West RR at Shelwick Green	28		WB		450	408	-9%
29	West RR at Lyde Arundel	29		EB		735	623	-15%
29	West RR at Lyde Arundel	29		WB		853	775	-9%
30	West RR nr Towtree Lane	30		EB		491	423	-14%
30	West RR nr Towtree Lane	30		WB		409	359	-12%
31	West RR nr Swainshill	31		NB		842	739	-12%
31	West RR nr Swainshill	31		SB		942	789	-16%
32	West RR at Western river crossing	32		NB		903	734	-19%
32	West RR at Western river crossing	32		SB		732	602	-18%
33	West RR nr Grafton	33		EB		564	465	-18%
33	West RR nr Grafton	33		WB		965	825	-15%

8.1.14. Comparing the two Housing Options with the Western Relief Road overall, due to the lower numbers of traffic assigned to the network, most links selected above have lower traffic volumes in Housing Option 5 than Housing Option 4. Roads within the city centre of Hereford have lower volumes predicted with Housing Option 5 than Housing Option 4. For example northbound traffic on Victoria Street is 15% lower in Housing Option 5. Commercial Road near to the bus station is lower in both directions by up to 17%.

8.1.15. Looking at the sections of road on the Western Relief Road, all 12 sections in Table 30 have assigned flows that are lower in Housing Option 5 of up to 19% or 169 vehicles than Housing Option 4.

8.1.16. Table 32 shows the percentage differences in total flows on the main roads in Hereford for the 2031 future year between the No Relief Road and the Western Relief Road scenario during the AM peak period for Housing Option 4 and Housing Option 5.

Table 32: Percentage Differences between No Relief Road and Western Relief Road AM PCU per hour

No	Location	Map ID	Name	Dir	Percentage Difference Between No Relief Road and WRR Option 4	Percentage Difference Between No Relief Road and WRR Option 5
1	A49 north of Holmer	1	A49	NB	-21%	-42%
1	A49 north of Holmer	1	A49	SB	15%	6%
2	Holmer Road opp Racecourse	4	A49	NB	-16%	-28%
2	Holmer Road opp Racecourse	4	A49	SB	-8%	-5%
3	Newtown Road	10	A49	EB	-19%	-19%
3	Newtown Road	10	A49	WB	-9%	-25%
4	Edgar Street at Football Ground	13	A49	NB	-18%	-10%
4	Edgar Street at Football Ground	13	A49	SB	-18%	-11%
5	Victoria Street	18	A49	NB	-21%	-17%
5	Victoria Street	18	A49	SB	-31%	-28%
6	Ross Road nr Boycott Rd	19	A49	NB	-14%	-13%
6	Ross Road nr Boycott Rd	19	A49	SB	-42%	-31%
7	Ross Road nr Mayberry Ave	21	A49	NB	-18%	-20%
7	Ross Road nr Mayberry Ave	21	A49	SB	-35%	-23%
9	A49 Ross Rd at Grafton	23	A49	NB	-6%	-6%
9	A49 Ross Rd at Grafton	23	A49	SB	-3%	-12%
10	Roman Road east of A49	2	A4103	EB	-86%	-82%
10	Roman Road east of A49	2	A4103	WB	-46%	-44%
11	Roman Road west of A49	3	A4103	EB	-12%	-19%
11	Roman Road west of A49	3	A4103	WB	-11%	-10%
12	Roman Road nr Staniers Way	5	A4103	EB	-145%	-136%
12	Roman Road nr Staniers Way	5	A4103	WB	-56%	-50%
13	Alyestone Hill	6	A465	NB	5%	5%
13	Alyestone Hill	6	A465	SB	1%	-2%
14	Commercial Road at Bus Station	15	A465	NB	-9%	0%
14	Commercial Road at Bus Station	15	A465	SB	5%	-10%
15	Belmont Road	20	A465	EB	-57%	-28%

Table 32: Percentage Differences between No Relief Road and Western Relief Road AM PCU per hour

No	Location	Map ID	Name	Dir	Percentage Difference Between No Relief Road and WRR Option 4	Percentage Difference Between No Relief Road and WRR Option 5
15	Belmont Road	20	A465	WB	-33%	-27%
16	Ledbury Road nr Quarry Rd	9	A438	NB	-6%	-2%
16	Ledbury Road nr Quarry Rd	9	A438	SB	23%	-8%
17	Blue School Street	16	A438	EB	0%	-4%
17	Blue School Street	16	A438	WB	-11%	-2%
18	Eign Street	12	A438	EB	-26%	-23%
18	Eign Street	12	A438	WB	10%	-1%
19	Kings Acre Road	11	A438	EB	-5%	-16%
19	Kings Acre Road	11	A438	WB	31%	3%
20	Three Elms Road	7	A4110	NB	-33%	-30%
20	Three Elms Road	7	A4110	SB	1%	-10%
21	ESG Link Road	14		EB	-16%	4%
21	ESG Link Road	14		WB	10%	-1%
22	Hampton Park Road	17		EB	-26%	-30%
22	Hampton Park Road	17		WB	-16%	-16%
23	Holme Lacy Road	22		EB	-34%	-35%
23	Holme Lacy Road	22		WB	-8%	-1%
24	Rotherwas Access Road	24		EB	50%	44%
24	Rotherwas Access Road	24		WB	49%	48%

8.1.17. Examining Table 32, it can be seen that provision of a Western Relief Road provides congestion relief across the Hereford study area. Housing Option 4 with a Western Relief Road provides congestion relief for 34 out of 46 of the selected roads in Table 32. Housing Option 5 scenario with a Western Relief Road is predicted to have lower traffic volumes on 39 out of the 46 roads selected.

8.1.18. Difference plots have been produced in Figures 4 and 5 below showing the differences in traffic flow volumes between the Western Relief Road scenario and the Housing Option 4 and 5 scenarios respectively for the AM peak period. Flow increases shown in green indicate that the provision of a Western Relief Road is predicted to have higher traffic volumes, whilst decreases in traffic volumes shown in blue indicate that the provision of a Western Relief Road has lower traffic volumes.

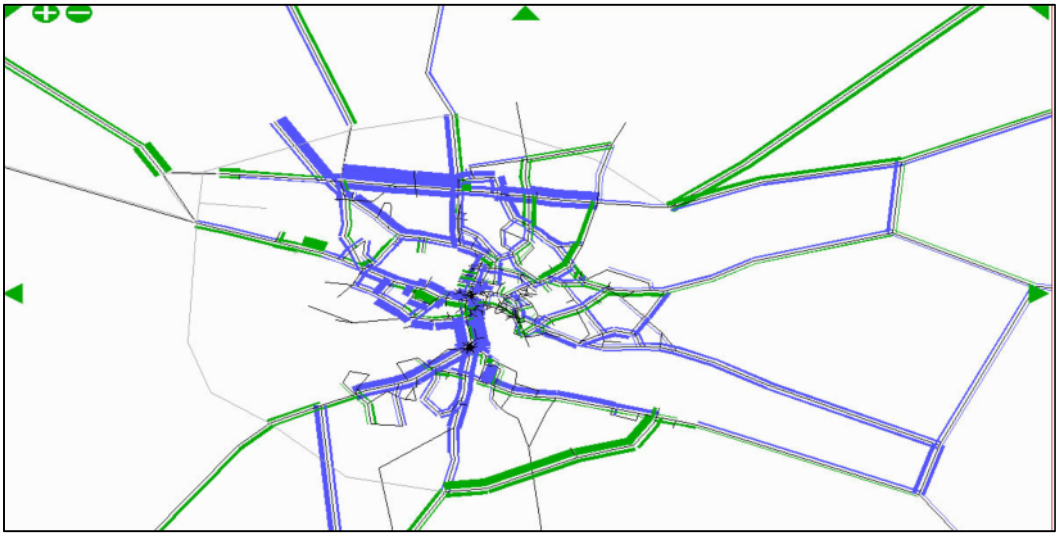

Figure 4: Western Relief Road Minus No Relief Road Scenario AM Peak Housing Option 4

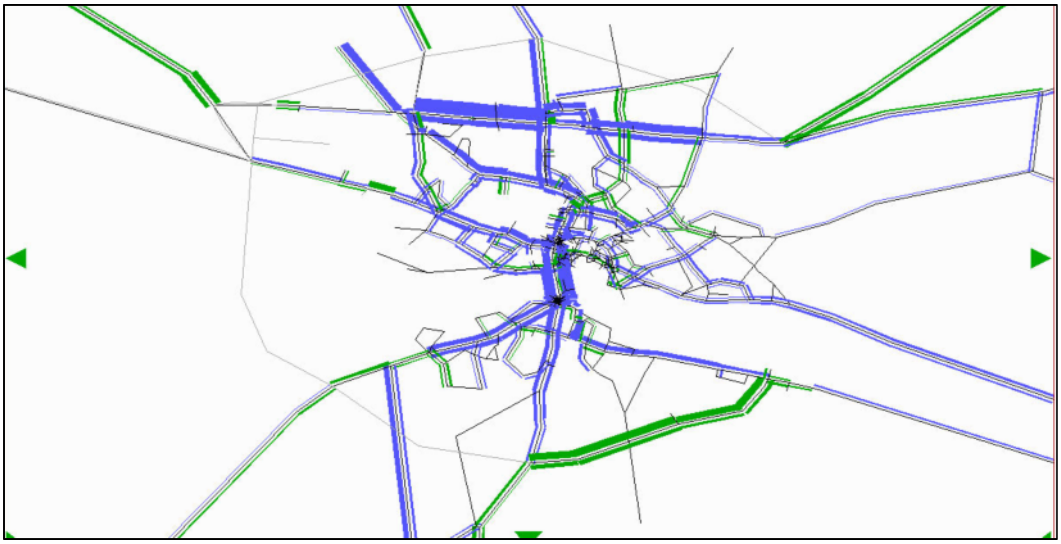

Figure 5: Western Relief Road Minus No Relief Road Scenario AM Peak Housing Option 5

8.1.19. The largest decreases occur on Roman Road particularly near to Staniers Way with a drop in traffic volume of up to 140% southbound highlighted by the thicker blue lines in Figures 4 and 5 above. Belmont Road traffic drops in both directions of up to 57% more, this drop occurs more so for Housing Option 4 than Housing Option 5. Hampton Park Road and Holme Lacey Road eastbound also have large reductions of 30% with a Western Relief Road.

8.1.20. There is predicted to be little change on some roads east of the city such as Aylestone Hill which experiences an increase of 5% of traffic with the Western Relief Road, indicating that the Western Relief Road is predicted to provide better congestion relief on the western areas of the city. This is further illustrated in figures 4 and 5 above by the predominately blue areas highlighted in the western areas of the city, and the green areas indicated on Aylestone Hill.

8.1.21. Rotherwas Access road is predicted to carry volumes of up to 50% higher with the opening of a Western Relief Road shown by the thick green line on this road in Figures 4 and 5 above.

8.1.22. Table 33 shows the percentage differences in total flows on the main roads in Hereford for the 2031 future year between the No Relief Road and the Western Relief Road scenario during the PM peak period for Housing Option 4 and Housing Option 5.

Table 33: Percentage Differences between No Relief Road and Western Relief Road PM PCU per hour

No	Location	Map ID	Name	Dir	Percentage Difference Between No Relief Road and WRR Option 4	Percentage Difference Between No Relief Road and WRR Option 5
1	A49 north of Holmer	1	A49	NB	19%	14%
1	A49 north of Holmer	1	A49	SB	-30%	-18%
2	Holmer Road opp Racecourse	4	A49	NB	16%	7%
2	Holmer Road opp Racecourse	4	A49	SB	1%	-8%
3	Newtown Road	10	A49	EB	0%	-7%
3	Newtown Road	10	A49	WB	2%	-7%
4	Edgar Street at Football Ground	13	A49	NB	18%	4%
4	Edgar Street at Football Ground	13	A49	SB	7%	2%
5	Victoria Street	18	A49	NB	-8%	-23%
5	Victoria Street	18	A49	SB	-9%	-9%
6	Ross Road nr Boycott Rd	19	A49	NB	-18%	-49%
6	Ross Road nr Boycott Rd	19	A49	SB	-6%	-8%
7	Ross Road nr Mayberry Ave	21	A49	NB	-40%	-64%
7	Ross Road nr Mayberry Ave	21	A49	SB	2%	-2%
9	A49 Ross Rd at Grafton	23	A49	NB	4%	8%
9	A49 Ross Rd at Grafton	23	A49	SB	-27%	-53%
10	Roman Road east of A49	2	A4103	EB	-65%	-85%
10	Roman Road east of A49	2	A4103	WB	-61%	-52%

Table 33: Percentage Differences between No Relief Road and Western Relief Road PM PCU per hour

No	Location	Map ID	Name	Dir	Percentage Difference Between No Relief Road and WRR Option 4	Percentage Difference Between No Relief Road and WRR Option 5
11	Roman Road west of A49	3	A4103	EB	-21%	-28%
11	Roman Road west of A49	3	A4103	WB	-18%	-22%
12	Roman Road nr Staniers Way	5	A4103	EB	-88%	-64%
12	Roman Road nr Staniers Way	5	A4103	WB	-56%	-48%
13	Alyestone Hill	6	A465	NB	-8%	6%
13	Alyestone Hill	6	A465	SB	-11%	-7%
14	Commercial Road at Bus Station	15	A465	NB	8%	4%
14	Commercial Road at Bus Station	15	A465	SB	1%	-6%
15	Belmont Road	20	A465	EB	-18%	-19%
15	Belmont Road	20	A465	WB	-36%	-29%
16	Ledbury Road nr Quarry Rd	9	A438	NB	-5%	2%
16	Ledbury Road nr Quarry Rd	9	A438	SB	-30%	-6%
17	Blue School Street	16	A438	EB	-2%	0%
17	Blue School Street	16	A438	WB	-11%	-13%
18	Eign Street	12	A438	EB	-51%	-42%
18	Eign Street	12	A438	WB	-24%	-26%
19	Kings Acre Road	11	A438	EB	-5%	-43%
19	Kings Acre Road	11	A438	WB	-1%	-11%
20	Three Elms Road	7	A4110	NB	-77%	-66%
20	Three Elms Road	7	A4110	SB	-22%	14%
21	ESG Link Road	14		EB	9%	2%
21	ESG Link Road	14		WB	0%	0%
22	Hampton Park Road	17		EB	-4%	-2%
22	Hampton Park Road	17		WB	1%	-35%
23	Holme Lacy Road	22		EB	-14%	-16%
23	Holme Lacy Road	22		WB	-17%	-4%
24	Rotherwas Access Road	24		EB	53%	43%

Table 33: Percentage Differences between No Relief Road and Western Relief Road PM PCU per hour						
No	**Location**	**Map ID**	**Name**	**Dir**	**Percentage Difference Between No Relief Road and WRR Option 4**	**Percentage Difference Between No Relief Road and WRR Option 5**
24	Rotherwas Access Road	24		WB	33%	26%

8.1.23. The PM peak shows that, as in the AM peak period, the provision of a Western Relief Road provides congestion relief on key routes in the Hereford study area given in Table 33. It is predicted that the provision of a Western Relief Road will result in a decrease in traffic flow volumes on 31 out of the 46 key routes with the Housing Option 4 scenario and 32 out of the 46 key routes with Housing Option 5 scenario.

8.1.24. As for the AM difference plots have been produced in Figures 6 and 7 below showing the differences in traffic flow volumes between the Western Relief Road scenario and the Housing Option 4 and 5 scenarios respectively for the PM peak period. Flow increases are shown in green whilst decreases in traffic volumes are shown in blue.

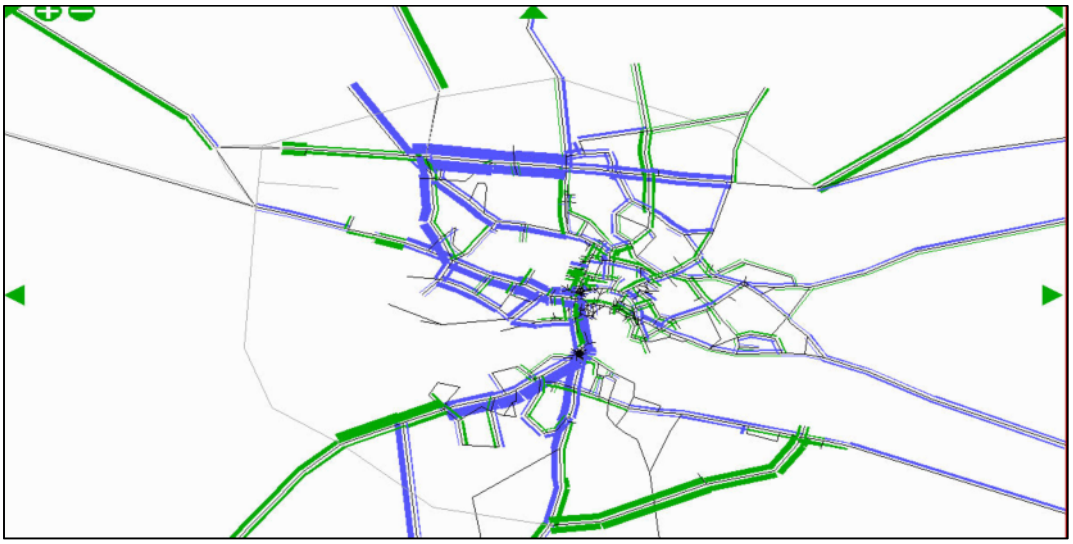

Figure 6: Western Relief Road Minus No Relief Road PM Peak Housing Option 4

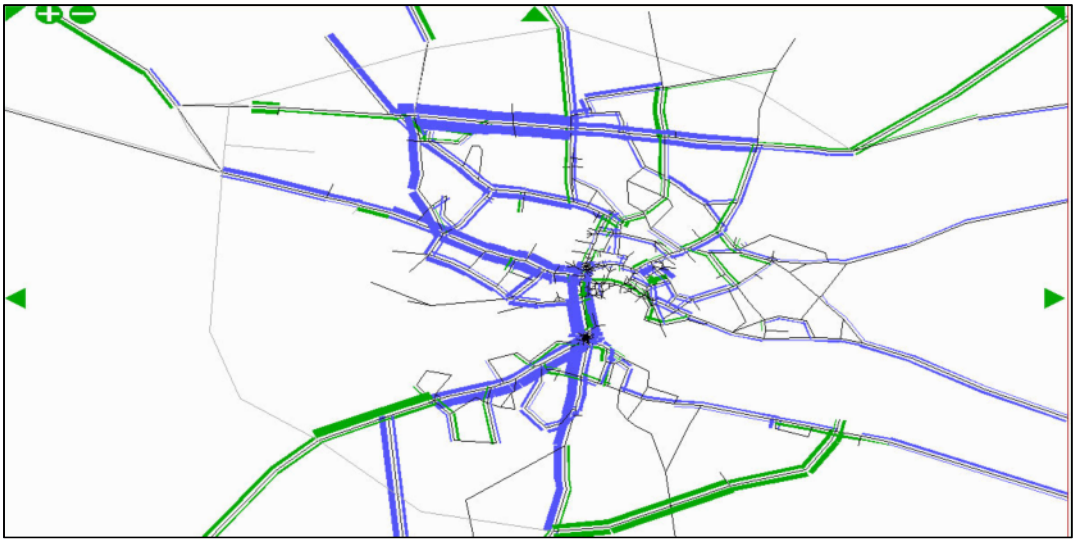

Figure 7: Western Releif Road Minus No Relief Road PM Peak Housing Option 5

8.1.25. The provision of a Western Relief Road is expected to provide a decrease in traffic flow volumes within Hereford city centre with predicted decreases of approximately 25% in both directions on Eign Street and Belmont Road highlighted by the blue lines shown in Figures 6 and 7 above. The drop in traffic volume is more pronounced in Housing Option 5 than Housing Option 4 on Victoria Street with an expected reduction of 23% northbound and 9% southbound. This is highlighted by the thicker blue lines at these points in Figure 7 with Housing Option 5 than Figure 6 with Housing Option 4.

8.1.26. The largest decreases in traffic flows between the Western Relief Road and the No Relief Road scenario in the PM peak are expected in north and western areas of the city near to the provision of the Relief Road, in particular on Roman Road with the largest drop in traffic volumes of 85% east of the A49 travelling eastbound.

8.1.27. There are slight increases predicted in traffic flow volumes on some routes east of the city such as Ledbury Road with a predicted increase of 2%. Commercial Road northbound has an increase of 4% as a result of the Western Relief Road. These are highlighted in Figures 6 and 7 above by the presence of the green lines at these points indicating an increase in traffic flow volumes.

8.1.28. There are some variations between predicted congestion relief between the two housing options. For example on Newtown Road Housing Option 5 is predicted to have a decrease of 7% in traffic but it is expected that the traffic volumes between the Western Relief Road and No Relief Road scenario for Housing Option 4 to be unchanged.

8.1.29. Tables 34 and 35 below show the 24 Hour Average Annual Daily Traffic Flow Volumes calculated by factoring the Peak hour traffic volumes shown in the tables above using a factor derived from long term 24 hour Automatic Traffic Counts. Table 34 shows the main roads in Hereford for the 2008 Base Year and 2031 future year for the No Relief Road and Table 35 shows the 2031 future year AADT flows for the Western Relief Road scenario for Housing Option 4 and Housing Option 5.

Table 34: No Relief Road 24 Hour AADT PCU

No	Location	Map ID	Name	Dir	Base	Option 4	Option 5
1	A49 north of Holmer	1	A49	NB	6507	5963	6775
1	A49 north of Holmer	1	A49	SB	7756	7280	7116
2	Holmer Road opp Racecourse	4	A49	NB	8802	8135	8925
2	Holmer Road opp Racecourse	4	A49	SB	10728	11208	11524
3	Newtown Road	10	A49	EB	12007	13987	14083
3	Newtown Road	10	A49	WB	10275	11167	12468
4	Edgar Street at Football Ground	13	A49	NB	11315	15687	16035
4	Edgar Street at Football Ground	13	A49	SB	12841	19951	20335
5	Victoria Street	18	A49	NB	22933	26153	25302
5	Victoria Street	18	A49	SB	23201	24339	24222
6	Ross Road nr Boycott Rd	19	A49	NB	14072	14878	14369
6	Ross Road nr Boycott Rd	19	A49	SB	10123	6203	6228
7	Ross Road nr Mayberry Ave	21	A49	NB	8105	9537	9228
7	Ross Road nr Mayberry Ave	21	A49	SB	6562	7489	7213
9	A49 Ross Rd at Grafton	23	A49	NB	4786	6373	6012
9	A49 Ross Rd at Grafton	23	A49	SB	5503	7834	7448
10	Roman Road east of A49	2	A4103	EB	9068	13478	12699
10	Roman Road east of A49	2	A4103	WB	8719	12288	11109
11	Roman Road west of A49	3	A4103	EB	8584	8474	8264
11	Roman Road west of A49	3	A4103	WB	8841	9444	9120
12	Roman Road nr Staniers Way	5	A4103	EB	3882	6458	6264
12	Roman Road nr Staniers Way	5	A4103	WB	4242	7976	7494
13	Alyestone Hill	6	A465	NB	4928	8050	7427
13	Alyestone Hill	6	A465	SB	4763	8973	7974

Table 34: No Relief Road 24 Hour AADT PCU

No	Location	Map ID	Name	Dir	Base	Option 4	Option 5
14	Commercial Road at Bus Station	15	A465	NB	10868	6950	6409
14	Commercial Road at Bus Station	15	A465	SB	8881	1947	2029
15	Belmont Road	20	A465	EB	9846	10839	10100
15	Belmont Road	20	A465	WB	10201	9899	10253
16	Ledbury Road nr Quarry Rd	9	A438	NB	5325	5794	5476
16	Ledbury Road nr Quarry Rd	9	A438	SB	4539	3584	3795
17	Blue School Street	16	A438	EB	14198	9131	8922
17	Blue School Street	16	A438	WB	16042	5084	4828
18	Eign Street	12	A438	EB	9755	12765	11709
18	Eign Street	12	A438	WB	9708	10008	10548
19	Kings Acre Road	11	A438	EB	6033	5714	5966
19	Kings Acre Road	11	A438	WB	5167	4835	5182
20	Three Elms Road	7	A4110	NB	4215	7547	6354
20	Three Elms Road	7	A4110	SB	4998	7188	5270
21	ESG Link Road	14		EB	0	3711	3702
21	ESG Link Road	14		WB	0	4361	4816
22	Hampton Park Road	17		EB	3048	3834	3607
22	Hampton Park Road	17		WB	3466	3273	3235
23	Holme Lacy Road	22		EB	4442	6939	6393
23	Holme Lacy Road	22		WB	4854	7655	6609
24	Rotherwas Access Road	24		EB	772	2823	2757
24	Rotherwas Access Road	24		WB	876	3548	3396

Table 35: Western Relief Road 24 Hour AADT PCU						
No	**Location**	**Map ID**	**Name**	**Dir**	**Option 4**	**Option 5**
1	A49 north of Holmer	1	A49	NB	6175	6295
1	A49 north of Holmer	1	A49	SB	7070	6917
2	Holmer Road opp Racecourse	4	A49	NB	8379	8412
2	Holmer Road opp Racecourse	4	A49	SB	10731	10811
3	Newtown Road	10	A49	EB	12719	12425
3	Newtown Road	10	A49	WB	10959	10984
4	Edgar Street at Football Ground	13	A49	NB	15501	15422
4	Edgar Street at Football Ground	13	A49	SB	19169	19573
5	Victoria Street	18	A49	NB	22856	21092
5	Victoria Street	18	A49	SB	20613	20791
6	Ross Road nr Boycott Rd	19	A49	NB	12864	11225
6	Ross Road nr Boycott Rd	19	A49	SB	5279	5366
7	Ross Road nr Mayberry Ave	21	A49	NB	7483	6741
7	Ross Road nr Mayberry Ave	21	A49	SB	6748	6573
9	A49 Ross Rd at Grafton	23	A49	NB	6368	6153
9	A49 Ross Rd at Grafton	23	A49	SB	6925	5771
10	Roman Road east of A49	2	A4103	EB	7589	6929
10	Roman Road east of A49	2	A4103	WB	7919	7471
11	Roman Road west of A49	3	A4103	EB	7256	6689
11	Roman Road west of A49	3	A4103	WB	8209	7852
12	Roman Road nr Staniers Way	5	A4103	EB	3022	3170
12	Roman Road nr Staniers Way	5	A4103	WB	5121	5033
13	Alyestone Hill	6	A465	NB	7957	7865
13	Alyestone Hill	6	A465	SB	8583	7661
14	Commercial Road at Bus Station	15	A465	NB	6777	6517
14	Commercial Road at Bus Station	15	A465	SB	2004	1883
15	Belmont Road	20	A465	EB	8097	8215
15	Belmont Road	20	A465	WB	7319	7988
16	Ledbury Road nr Quarry Rd	9	A438	NB	5500	5505

Table 35: Western Relief Road 24 Hour AADT PCU

No	Location	Map ID	Name	Dir	Option 4	Option 5
16	Ledbury Road nr Quarry Rd	9	A438	SB	3928	3523
17	Blue School Street	16	A438	EB	9034	8760
17	Blue School Street	16	A438	WB	4579	4494
18	Eign Street	12	A438	EB	9309	8917
18	Eign Street	12	A438	WB	9272	9254
19	Kings Acre Road	11	A438	EB	5450	4640
19	Kings Acre Road	11	A438	WB	5766	4960
20	Three Elms Road	7	A4110	NB	4946	4301
20	Three Elms Road	7	A4110	SB	6449	5495
21	ESG Link Road	14		EB	3531	3812
21	ESG Link Road	14		WB	4480	4793
22	Hampton Park Road	17		EB	3407	3186
22	Hampton Park Road	17		WB	2997	2662
23	Holme Lacy Road	22		EB	5519	5046
23	Holme Lacy Road	22		WB	6821	6476
24	Rotherwas Access Road	24		EB	5809	4898
24	Rotherwas Access Road	24		WB	5593	4968
28	West RR at Shelwick Green	28		EB	6043	5466
28	West RR at Shelwick Green	28		WB	5320	4919
29	West RR at Lyde Arundel	29		EB	10728	9323
29	West RR at Lyde Arundel	29		WB	8546	7841
30	West RR nr Towtree Lane	30		EB	5062	4299
30	West RR nr Towtree Lane	30		WB	3868	3555
31	West RR nr Swainshill	31		NB	9596	8318
31	West RR nr Swainshill	31		SB	9337	8424
32	West RR at Western river crossing	32		NB	9238	7729
32	West RR at Western river crossing	32		SB	9603	8069
33	West RR nr Grafton	33		EB	7345	6010
33	West RR nr Grafton	33		WB	9214	8123

8.2. Select Link Analysis

8.2.1. In this section of the report, the impacts of Housing Options 4 and 5 on the trip distribution patterns of the Hereford road network were assessed using a select link analysis on a number of strategically important radials and orbital links.

8.2.2. A select link analysis is a function within SATURN software which allows a user to inspect the travel distribution of traffic using a certain link or stretch of road. It graphically displays the origins and destinations of traffic travelling through a stated stretch of road. It displays the routes which traffic used both to reach that road from their origin and the routes the traffic uses to reach its destinations after it has passed through the selected stretch of road.

8.2.3. Three locations were used for the select link analysis in this section. The three locations are as follows:

- A438 West;
- A49 Greyfriars Bridge;
- The Western Relief Road at the river crossing.

8.2.4. The three locations used for the select link analysis is shown in Figure 4. Using these locations it will be possible to visually inspect the volume of traffic which are through-trips and the volumes of traffic which are intra-city trips.

8.2.5. Select link analysis plots were produced for Housing Options 4 and 5 and for the AM and PM time periods. Select link analysis plots are produced by direction and to reduce the number of plots produced and to avoid cluttering in this report, it was decided to produce select link analysis plots for the main direction of traffic flow in the respective AM and PM time periods. Therefore, in the AM time period, plots were produced in the eastbound direction on the A438, in the northbound direction on the A49 Greyfriars Bridge and in the southbound direction on the Western relief road. Plots for the PM time period were produced for the opposite direction from the AM.

8.2.6. The select link analysis was also carried out for the no relief road and Western Relief Road scenarios to observe what impact the introduction of the relief road has on the traffic distributions at the three locations listed above.

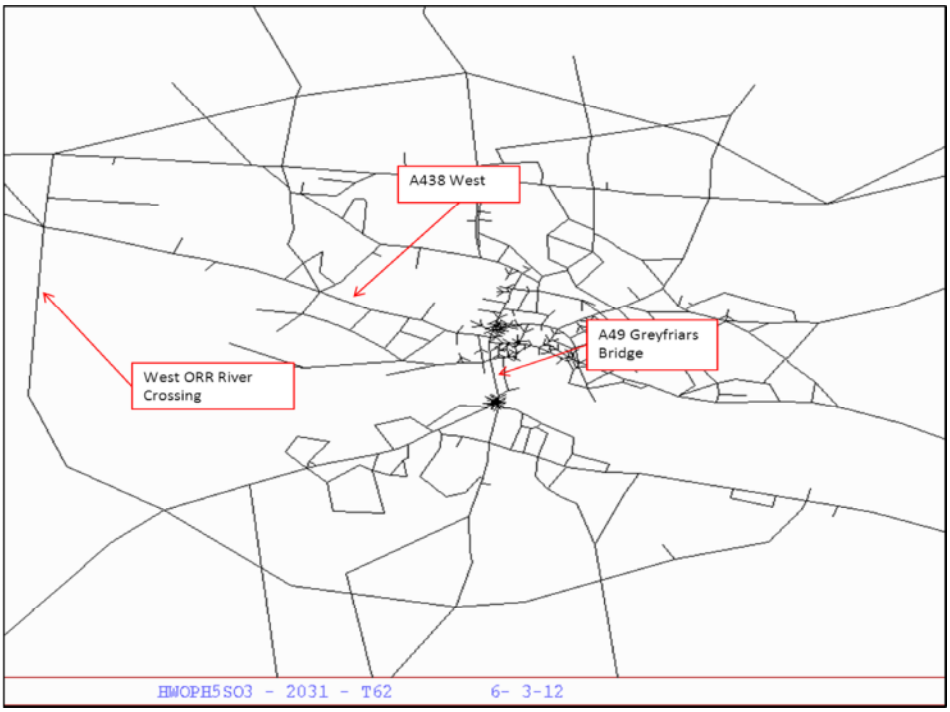

Figure 8: Select Link Analysis Site Locations

8.2.7. Figures 5 to 8 show the select link analysis plots for the A348 west for Options 4 and 5 and for the AM and PM peak. The no relief road network scenario was used for these plots.

8.2.8. The green bandwidths shown on the plots indicate traffic volumes, the thicker the bandwidth the greater the traffic volume. The numbers annotated on the bandwidths also indicate traffic volumes with the volumes shown being in total PCUs for all modes.

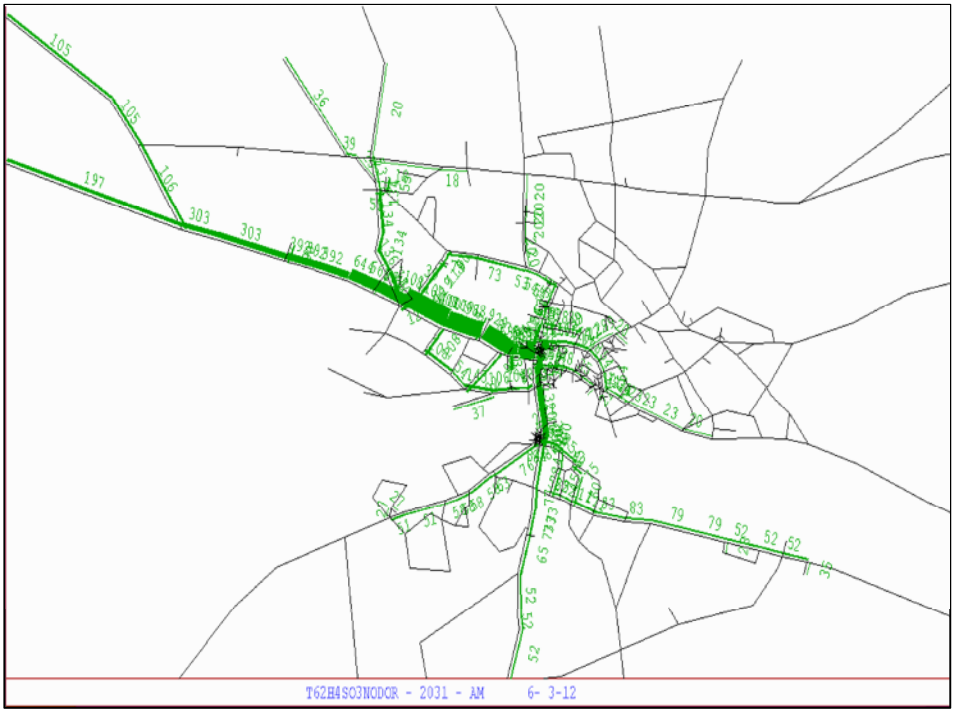

Figure 9: Housing Option 4 AM, on A438 Whitecross Rd – EB (no relief road)

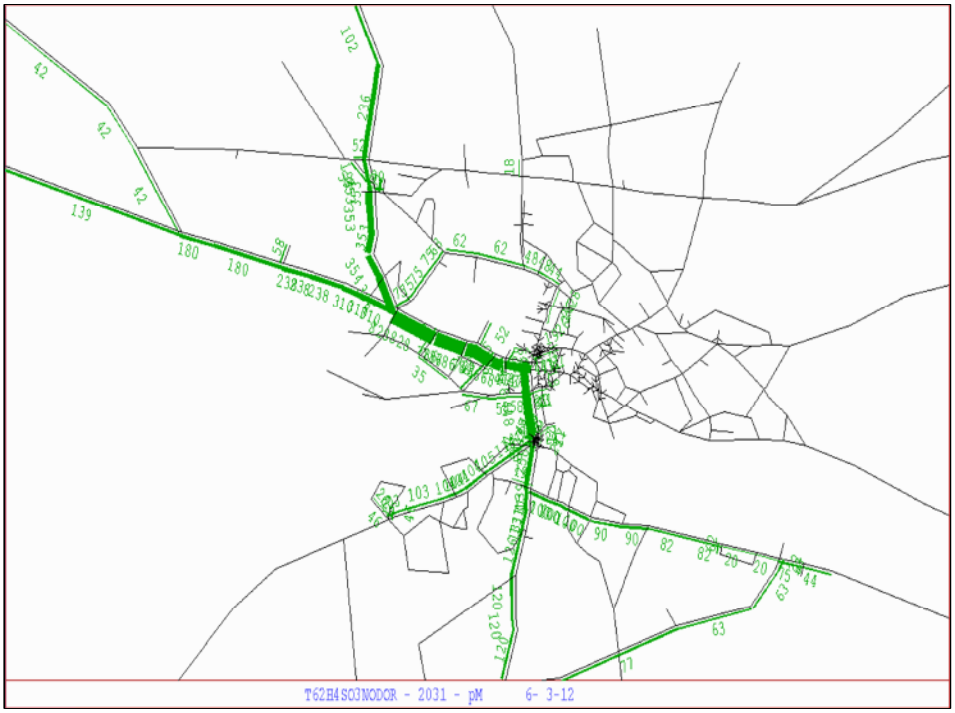

Figure 10: Housing Option 4 PM, on A438 Whitecross Rd – WB (no relief road)

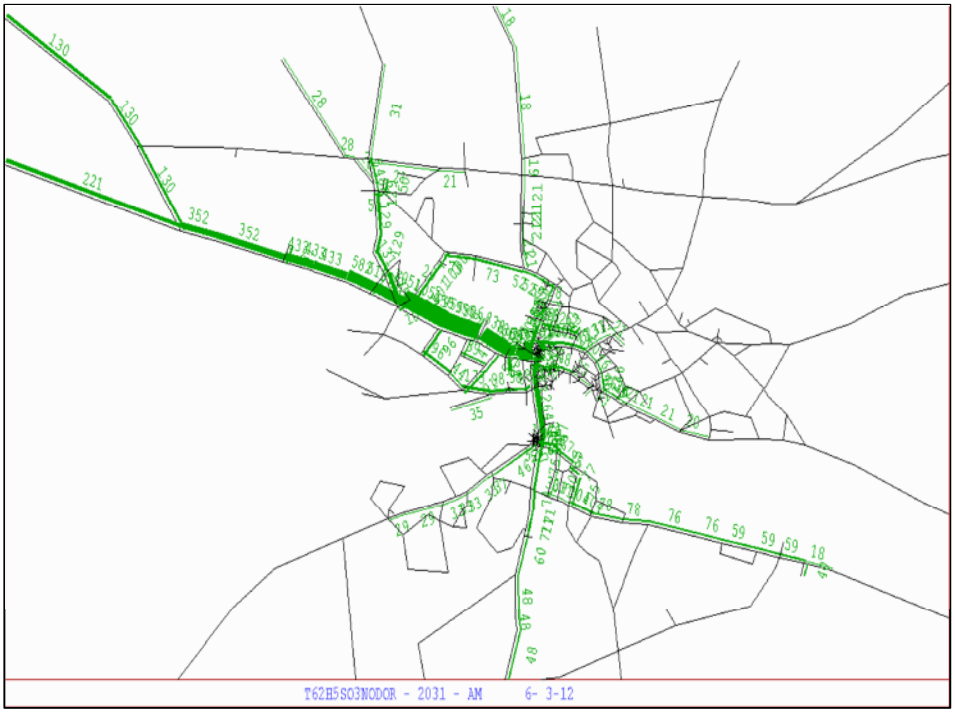

Figure 11: Housing Option 5 AM, on A438 Whitecross Rd – EB (no relief road)

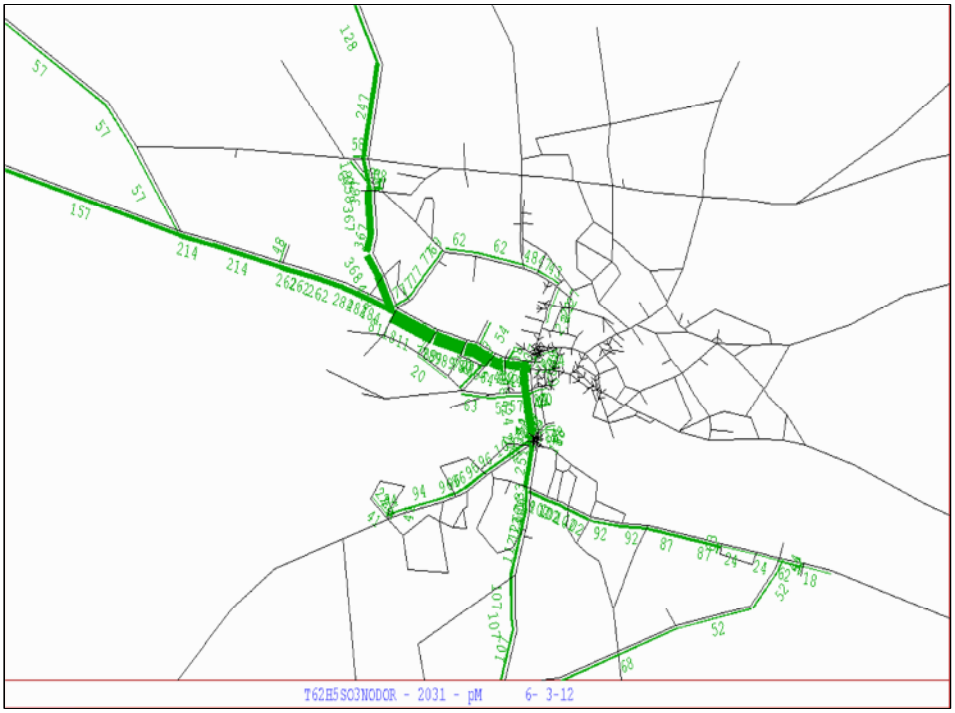

Figure 12: Housing Option 5 PM, on A438 Whitecross Rd – WB (no relief road)

8.2.9. As can be seen from these plots, the A438 acts mainly as a radial feeder to the centre of the city with a small proportion of the traffic on the road through-traffic passing through the centre of the city to access the south.

8.2.10. The most significant volumes of longer distance trips occur in the plots for the PM time period and in particular for Option 4 where 210 PCUs of traffic are longer distance trips which have origins in the south of the city.

8.2.11. Figures 9 to 12 show the select link analysis plots for the A49 Greyfriars bridge for Options 4 and 5 and for the AM and PM peak. The no relief road network scenario was used for these plots.

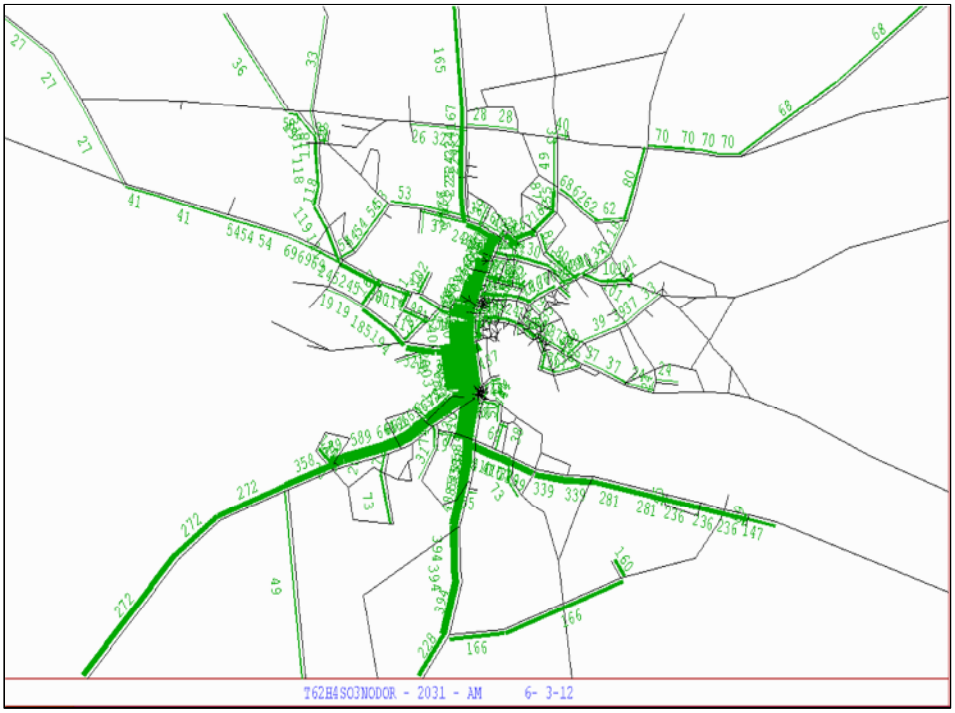

Figure 13: Housing Option 4 AM, on A49 Greyfriars Bridge – NB (no relief road)

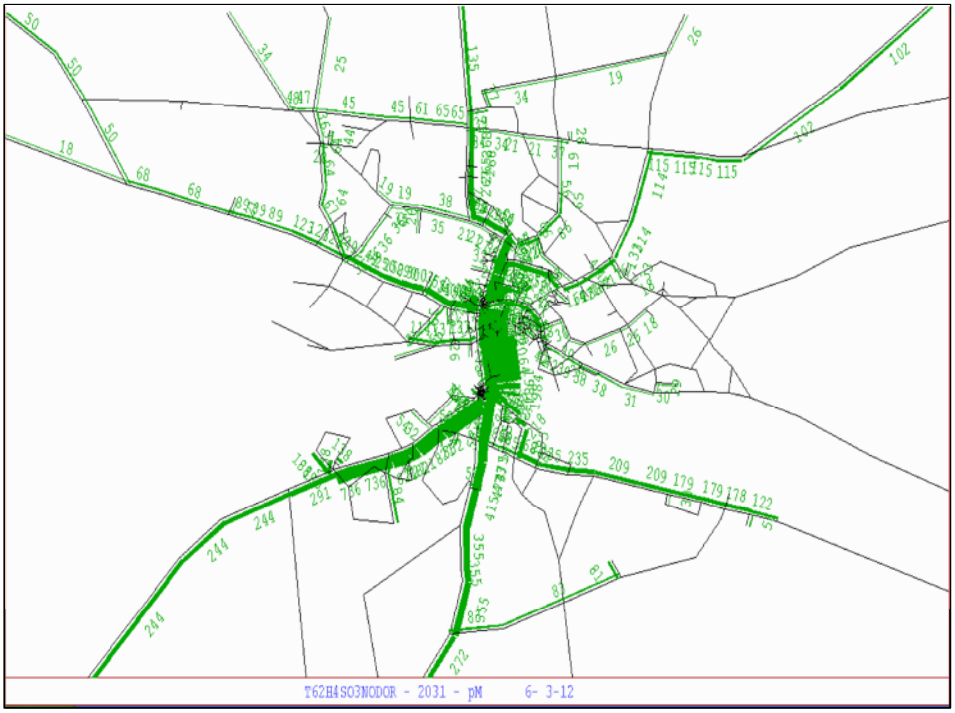

Figure 14: Housing Option 4 PM, on A49 Greyfriars Bridge – SB (no relief road)

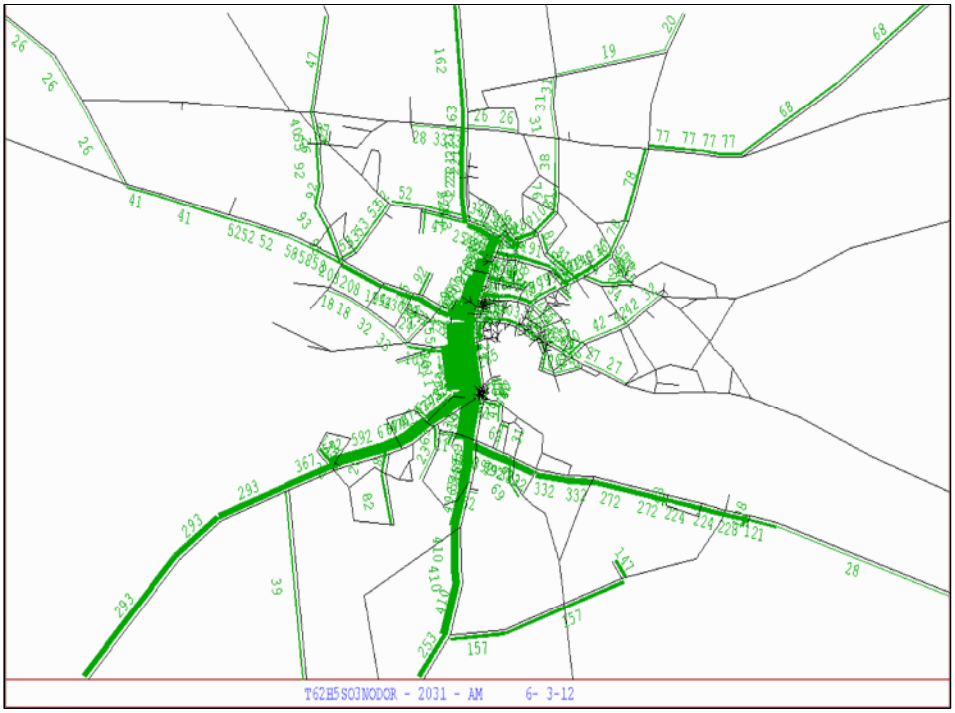

Figure 15: Housing Option 5 AM, on A49 Greyfriars Bridge – NB (no relief road)

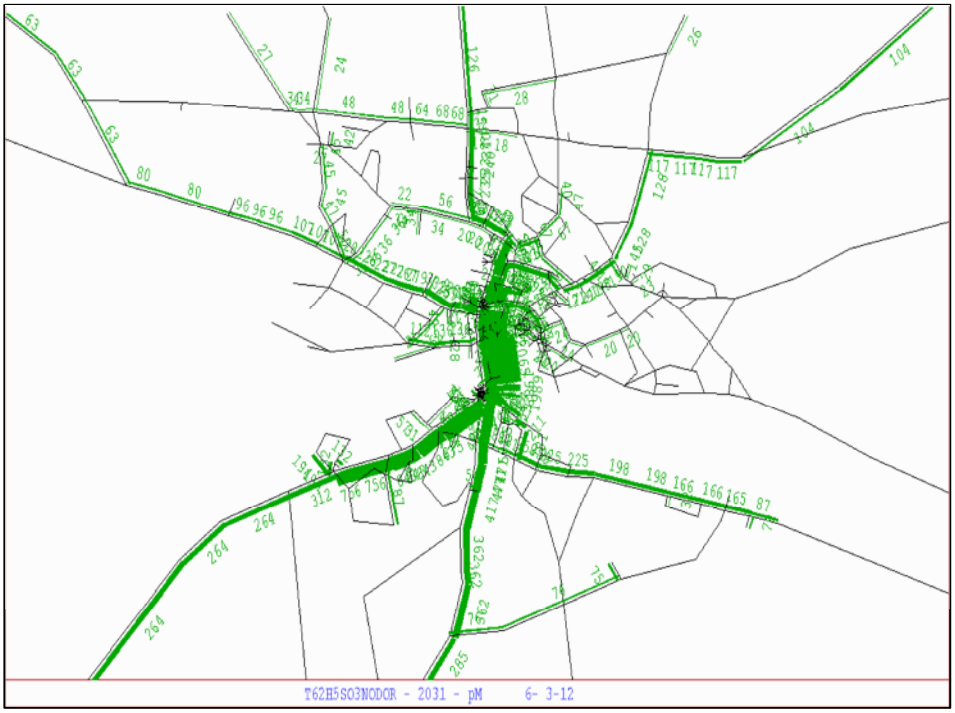

Figure 16: Housing Option 5 PM, on A49 Greyfriars Bridge – SB (no relief road)

8.2.12. The travel distributions of traffic passing over the Greyfriars Bridge can be seen in the above four plots and the main directions of traffic approaching and exiting the bridge. Traffic volumes are consistent for both housing options and there is no significant difference between the options in terms of traffic volumes crossing the bridge.

8.2.13. There are also no significant changes in the distribution of traffic volumes across the network between the two scenarios. The largest change in volumes between the two options occurs on the A465 Belmont road in both time periods. However, this difference is within 10% and does not represent a significant change in volumes of traffic using the A465 and travelling across the bridge.

8.2.14. Shown below in Figures 13 to 16 are the select link analysis plots for the A348 west for Options 4 and 5 and for the AM and PM peak. In these plots it is assumed the Western Relief Road is in place.

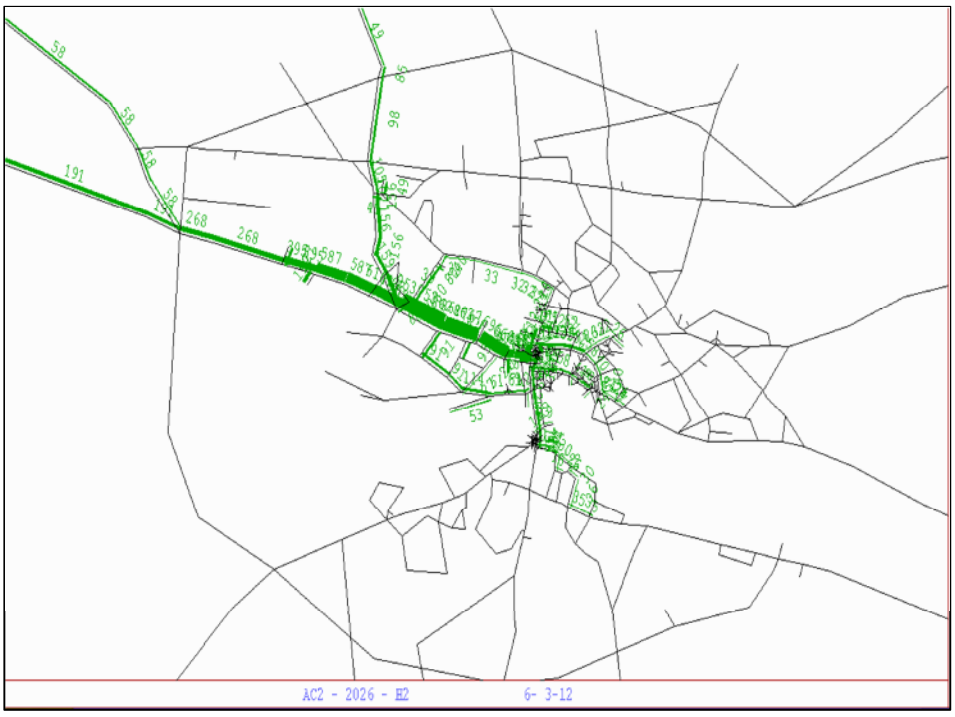

Figure 17: Housing Option 4 AM, on A438 Whitecross Rd – EB (with Western Relief Road)

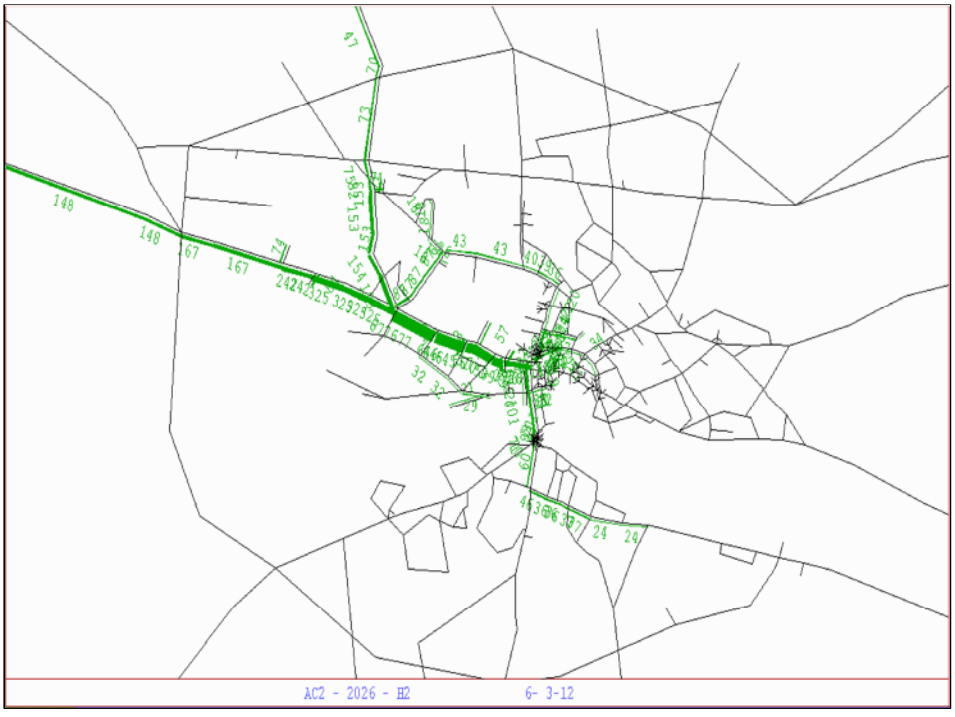

Figure 18: Housing Option 4 PM, on A438 Whitecross Rd – WB (with Western Relief Road)

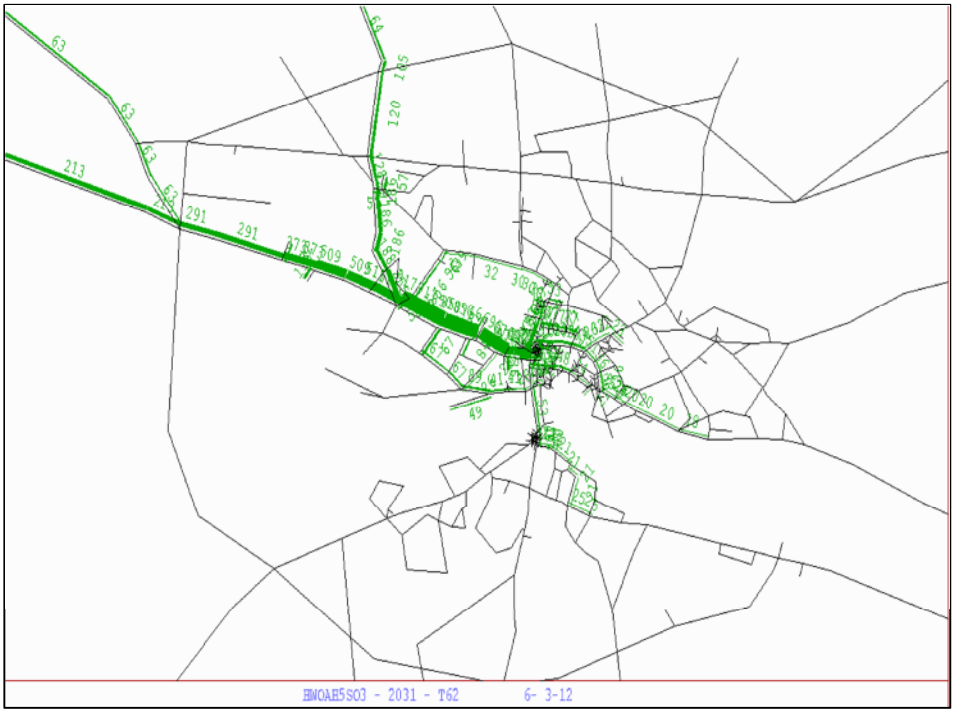

Figure 19: Housing Option 5 AM, on A438 Whitecross Rd – EB (with Western Relief Road)

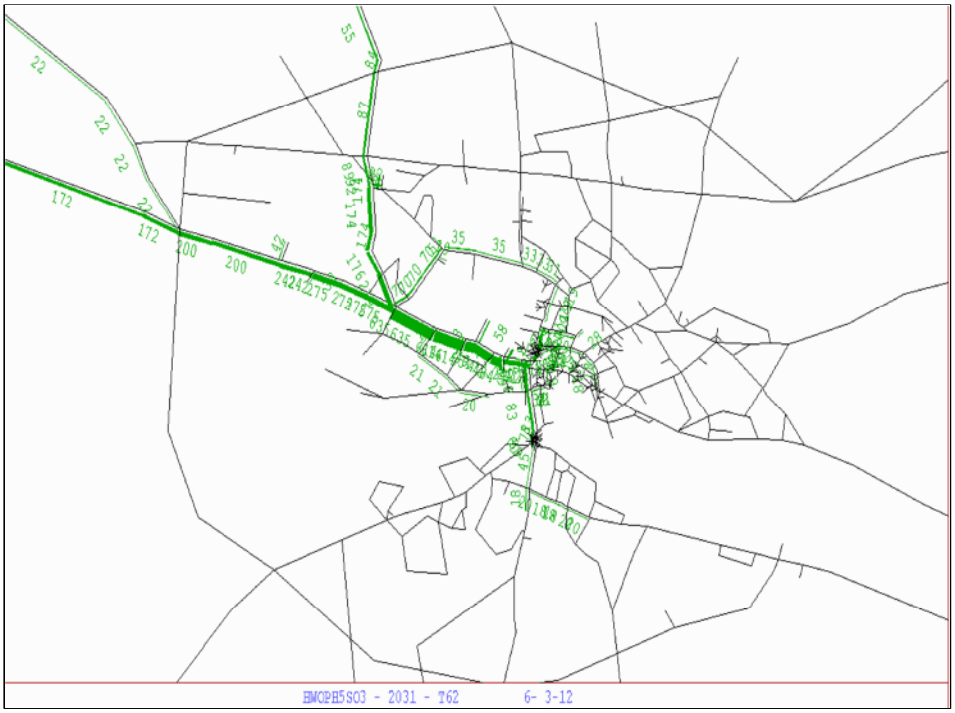

Figure 20: Housing Option 5 PM, on A438 Whitecross Rd – WB (with Western Relief Road)

8.2.15. As can be seen from Figures 13 to 16, the A438 continues to act as a radial feeder to the centre of the city after the introduction of the Western Relief Road in both housing Options and in each time period.

8.2.16. There is a significant fall in the level of the traffic volumes on the A438 in each housing Option and time period of approximately 15% - 25% with the introduction of the Western Relief Road.

8.2.17. There is no significant difference in traffic volumes and travel distributions between the housing Options after the introduction of the relief road. In both hosing Options, the volumes of traffic accessing the south of the city from the A438 is negligible and both housing Options experience the same reduction in travel patterns.

8.2.18. Shown below in Figures 17 to 20 are the select link analysis plots for the A49 Greyfriars Bridge for Options 4 and 5 and for the AM and PM peak. In these plots it is assumed the Western Relief Road is in place.

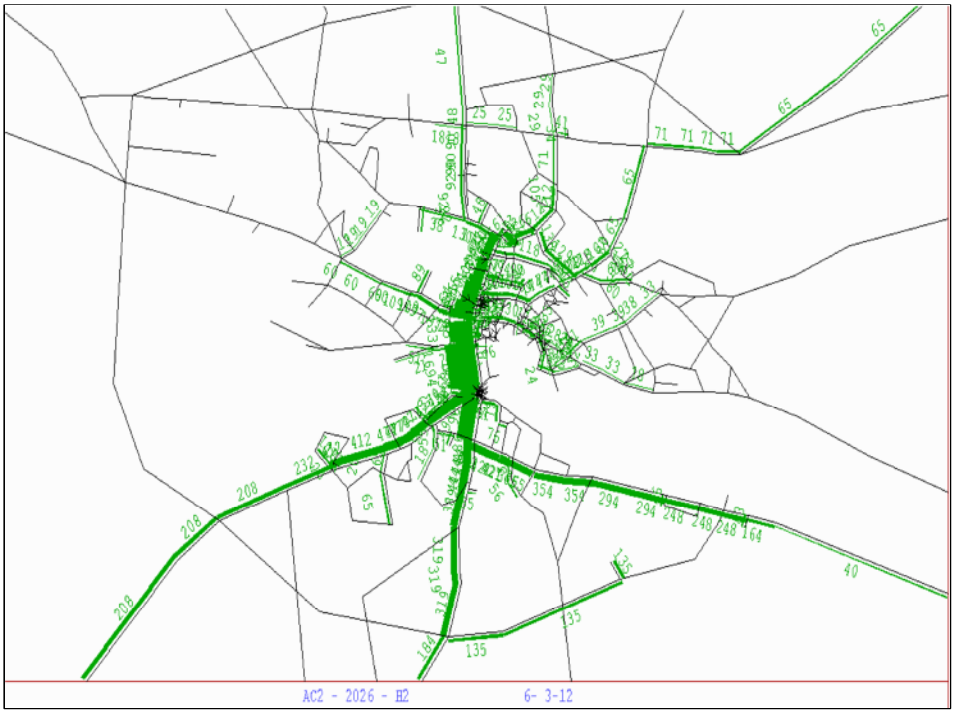

Figure 21: Housing Option 4 AM, on A49 Greysfriar Bridge – NB (with Western Relief Road)

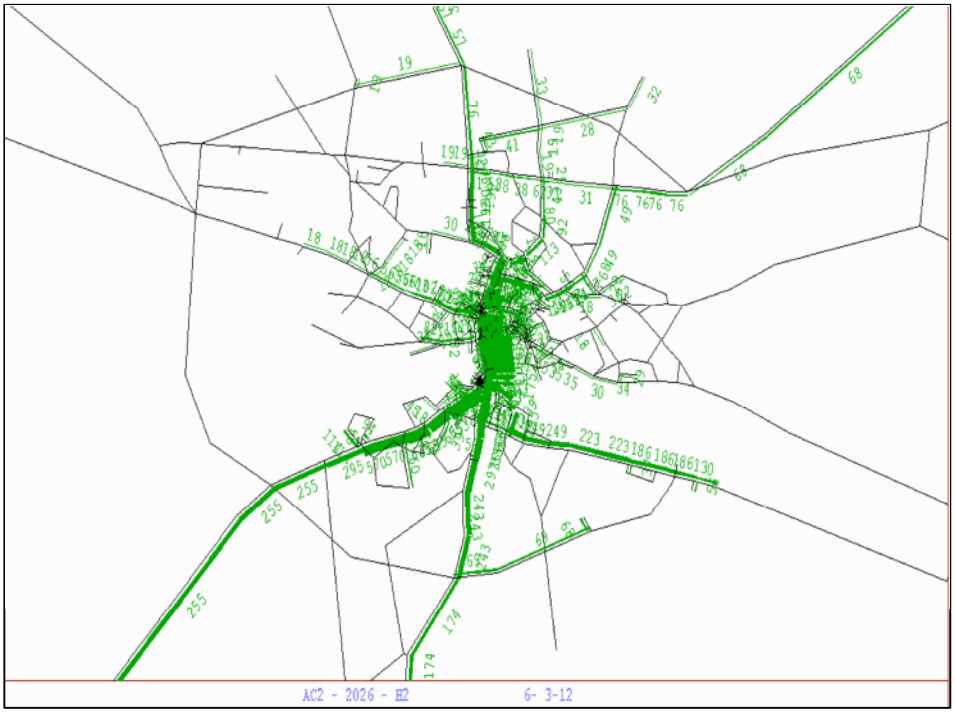

Figure 22: Housing Option 4 PM, on A49 Greysfriar Bridge – SB (with Western Relief Road)

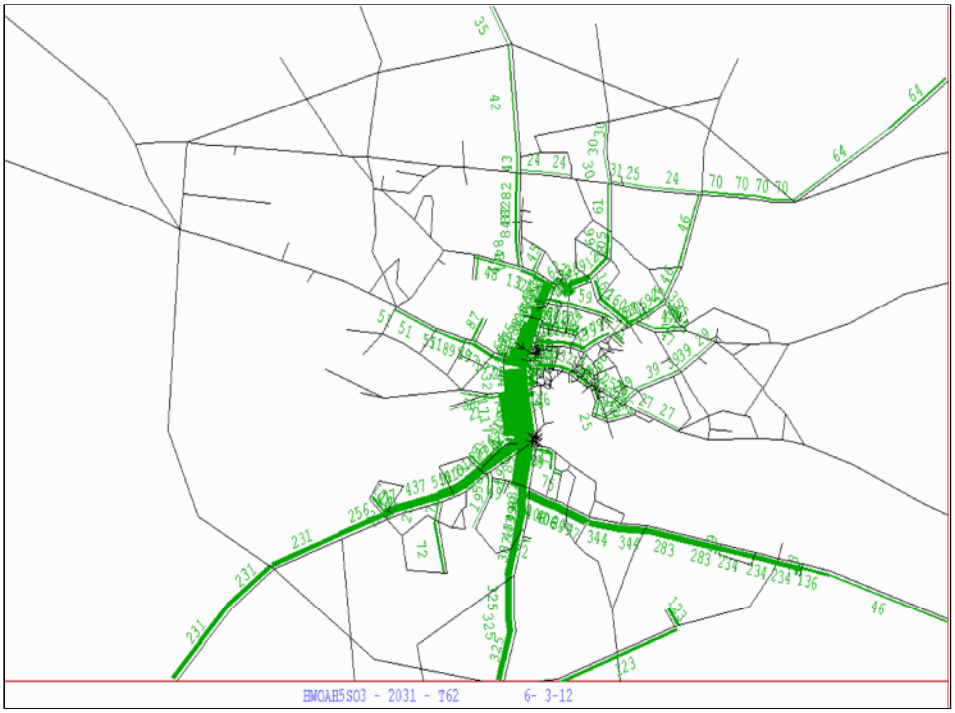

Figure 23: Housing Option 5 AM, on A49 Greysfriar Bridge – NB (with Western Relief Road)

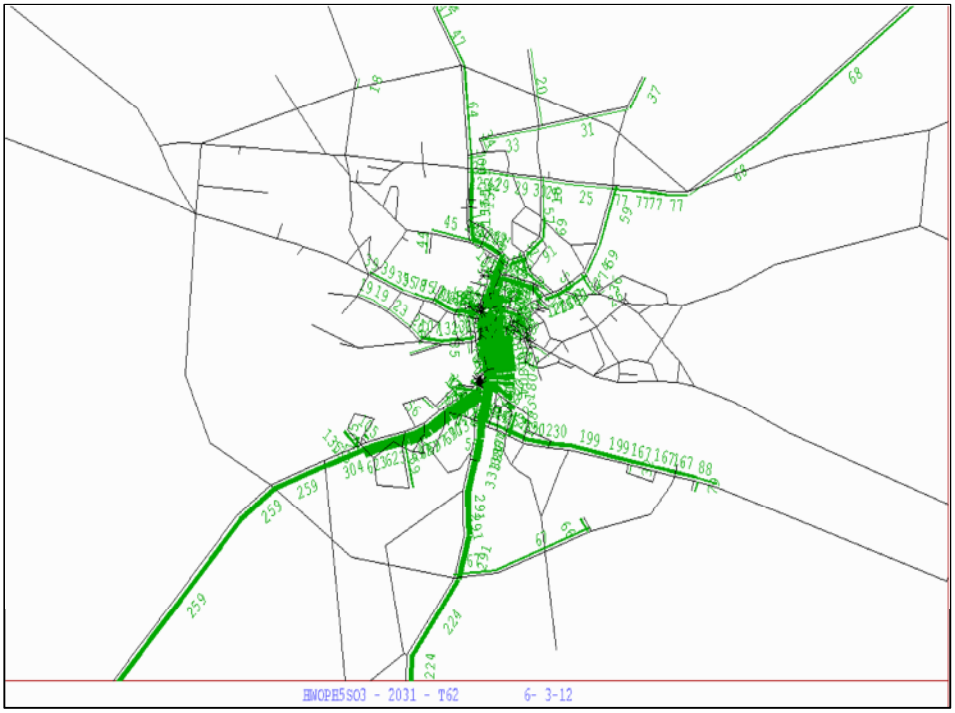

Figure 24: Housing Option 5 PM, on A49 Greysfriar Bridge – SB (with Western Relief Road)

8.2.19. As can be seen from these plots in comparison to the select link analysis plots in Figures 9 to 12, there is a significant drop in the level of through traffic passing across Greyfriars Bridge and passing through the city. This should be expected with the introduction of the Western relief Road. The reduction in through traffic volumes is approximately even for both Housing Options.

8.2.20. The travel distributions also remain the same for both housing Options with no significant difference (i.e. >10%) among any of the radial routes which leading to the Greyfriars Bridge between the housing Options.

8.2.21. Figures 21 to 24 illustrate the select link analysis plots for the Western Relief Road for Options 4 and 5 and for the AM and PM peak. The select link analysis plots have been selected at the river crossing point on the bridge.

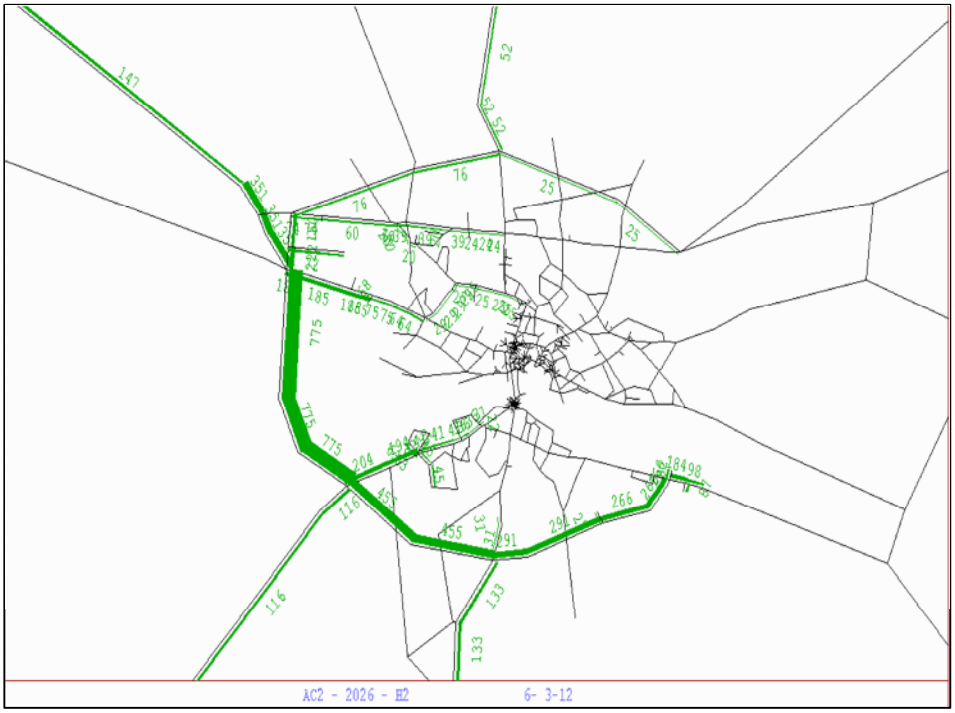

Figure 25: Housing Option 4 AM, on the Western Relief Road – SB

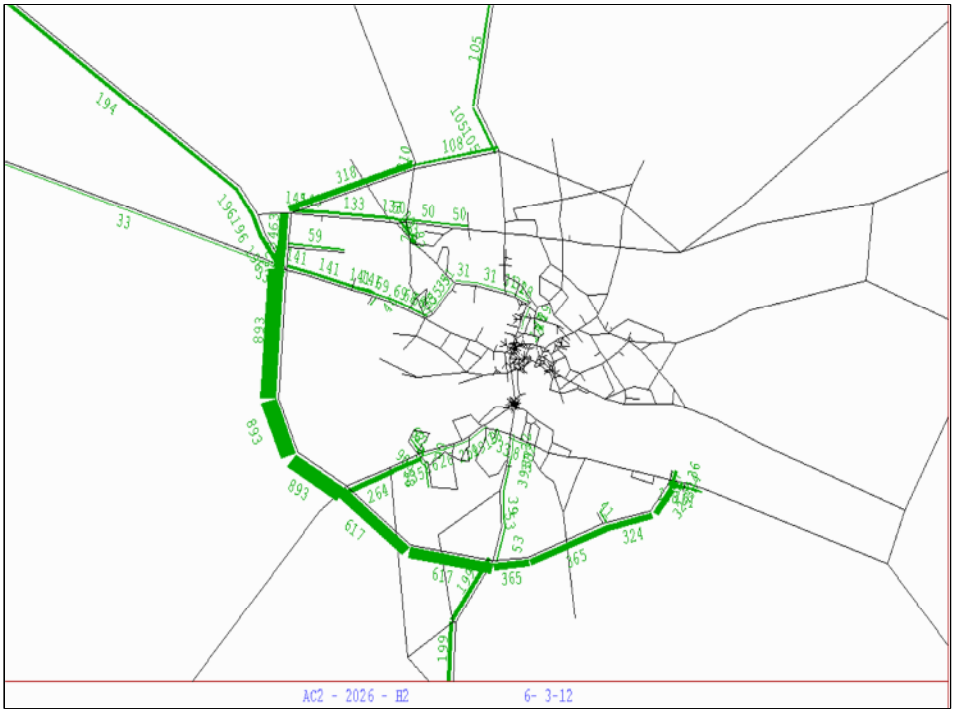

Figure 26: Housing Option 4 PM, on the Western Relief Road – NB

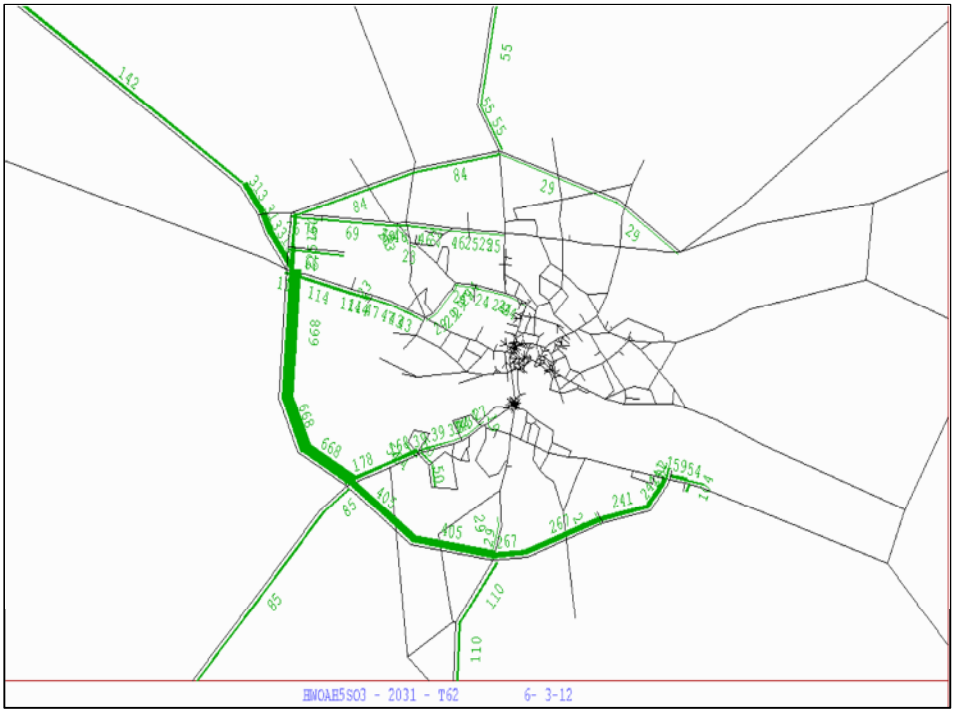

Figure 27: Housing Option 5 AM, on the Western Relief Road – SB

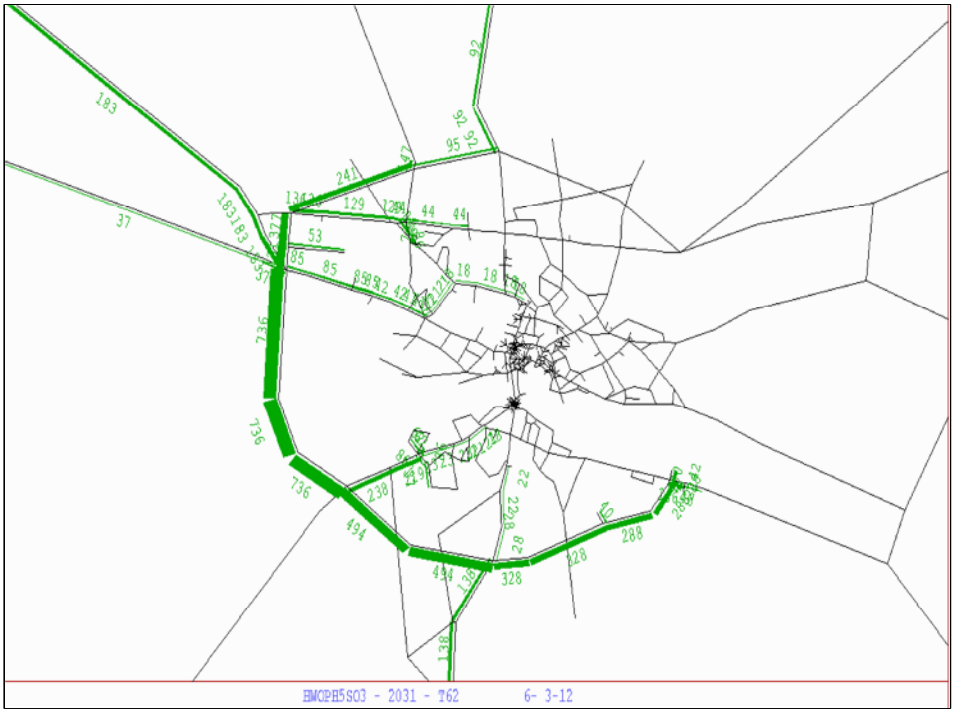

Figure 28: Housing Option 5 PM, on the Western Relief Road – NB

8.2.22. From these plots, it can be seen that there is a 14% reduction in flow in Housing Option 5 in comparison to Housing Option 4 in the AM peak. Similarly, there is a reduction of 18% in traffic flow in Housing Option 5 in the PM peak.

8.2.23. The travel distribution patterns for both housing Options are comparable with the same primary origins and destinations. Both housing options also have comparable traffic volumes accessing the relief road from the main radials into Hereford.

8.3. Journey Time Analysis

8.3.1. The same journey time routes as used in Chapter 6 were surveyed and average journey times for each route were obtained in order to provide an assessment of the impacts on typical journey times in Hereford in each of the future year highway models. Tables 36 and 37 show the comparison results for all the scenarios.

Table 36: AM Peak Comparison of Journey Times

Average Modelled Journey Time / mm:ss				
Route	No Relief Road		Western Relief Road	
	H4 2031 T62 SO3	H5 2031 T62 SO3	H4 2031 T62 SO3	H5 2031 T62 SO3
1	26:28	27:44	23:37	23:54
2	25:21	24:16	20:26	21:59
3	27:20	25:30	24:39	24:05
4	23:48	23:20	22:43	22:08
5	-	-	-	-
6	34:16	31:26	27:34	27:43
7	23:26	24:13	20:11	20:13
8	26:32	25:20	22:30	22:31
Total	**187:13**	**181:49**	**161:40**	**162:33**

Table 37: PM Peak Comparison of Journey Times				
Average Modelled Journey Time / mm:ss				
Route	No Relief Road		Western Relief Road	
	H4 2031 T62 SO3	H5 2031 T62 SO3	H4 2031 T62 SO3	H5 2031 T62 SO3
1	32:06	31:41	27:05	26:11
2	25:54	25:43	21:36	22:04
3	27:22	27:20	26:25	25:46
4	28:48	28:14	25:02	24:36
5	-	-	-	-
6	36:16	36:24	33:05	32:17
7	26:42	26:53	23:55	20:39
8	29:08	28:58	26:10	25:14
Total	**206:16**	**205:13**	**183:10**	**176:47**

8.3.2. It can be seen that the addition of a Relief Road improves the overall total journey times across the network. For Housing Option 5 the AM peak predicts a journey-time saving of approximately 19 minutes and the PM peak a saving of almost 30 minutes as a direct result of the Relief Road.

8.3.3. Overall, total journey times for Housing Option 5 are also expected to be improved above that predicted for Housing Option 4. For example the journey-time savings for Housing Option 5 across the network are in the order of 7 minutes during the PM peak period as compared to Housing Option 4.

8.3.4. The results obtained support the data shown in Tables 26 and 27, which show that provision of a Relief Road improves the overall average network speed when compared to the No Relief Road scenario.

8.4. Impact on A49 Trunk Road

8.4.1. The modelled journey times from the AM and PM models on the A49 Trunk Road are shown in Table 38.

Table 38: AM/PM Peak Comparison of Modelled Journey Times on A49				
Direction	AM Modelled Journey Time / mm:ss			
	No Relief Road		Western Relief Road	
	H4 2031 T62 SO3	H5 2031 T62 SO3	H4 2031 T62 SO3	H5 2031 T62 SO3
NB	16:46	16:49	15:29	15:17
SB	17:09	16:51	14:56	14:55
Total	**33:55**	**33:40**	**30:25**	**30:12**
Direction	PM Modelled Journey Time / mm:ss			
	No Relief Road		Western Relief Road	
	H4 2031 T62 SO3	H5 2031 T62 SO3	H4 2031 T62 SO3	H5 2031 T62 SO3
NB	21:26	20:42	16:30	15:48
SB	19:17	19:17	15:49	15:27
Total	**40:43**	**39:59**	**32:19**	**31:15**

8.4.2. The results show that the PM peak period has a higher journey time, particularly for northbound traffic, on the A49 than the AM peak period. Comparing the two scenarios for Housing Option 5 it can be seen that the inclusion of a Western Relief Road improves the total two way journey time on the A49 by approximately 3 minutes in the AM peak and 9 minutes in the PM peak

8.4.3. The journey times predicted on the A49 northbound and southbound in both peak periods between Housing Option 4 and Housing Option 5 are broadly similar and the Western Relief Road has the same amount of impact on journey time in both scenarios.

8.4.4. Looking at the journey time variance between the peak periods it would approximately take an extra 5 minutes more to travel northbound on the A49 through Hereford in the PM peak period and an extra 3 minutes southbound during the PM peak period without the Relief Road. The Western Relief Road reduces the journey times between the peak periods to within a minute of each other in both directions. This indicates that the Western Relief Road provides greater journey time certainty for traffic using the A49 and as a result can be a key measure to provide for economic growth within Hereford.

8.5. Over-Capacity Junctions

8.5.1. The numbers of modelled junctions within each volume-to-capacity band are shown in Table 39 for the AM peak models and in Table 40 for the PM peak models. Table 41 shows the over capacity for both peaks combined.

Table 39: Junctions Over Capacity AM Peak				
Volume to Capacity Ratio	No Relief Road		Western Relief Road	
	H4 2031 T62 SO3	H5 2031 T62 SO3	H4 2031 T62 SO3	H5 2031 T62 SO3
85% to 100%	22	26	13	13
100% to 120%	12	7	4	1
120% and over	0	0	0	0
Total	**34**	**33**	**17**	**14**

Table 40: Junctions Over Capacity PM Peak				
Volume to Capacity Ratio	No Relief Road		Western Relief Road	
	H4 2031 T62 SO3	H5 2031 T62 SO3	H4 2031 T62 SO3	H5 2031 T62 SO3
85% to 100%	16	13	13	11
100% to 120%	21	18	9	9
120% and over	0	0	0	0
Total	**37**	**31**	**22**	**20**

Table 41: Junctions Over Capacity Both Peak				
Volume to Capacity Ratio	No Relief Road		Western Relief Road	
	H4 2031 T62 SO3	H5 2031 T62 SO3	H4 2031 T62 SO3	H5 2031 T62 SO3
85% to 100%	38	39	26	24
100% to 120%	33	25	13	10
120% and over	0	0	0	0
Total	**71**	**64**	**39**	**34**

8.5.2. Examination of these results, show that provision of a Western Relief Road leads to a considerable reduction in the total number of over-capacity junctions present in the Hereford Study Area. There is little to choose between the different Housing Options.

8.6. Trip Length Distribution Analysis

8.6.1. The trip matrices have been carefully inspected to make an assessment of any changes to the trip patterns and actual trip lengths forecasted between the No Relief Road and Western Relief Road scenarios. Figures 25 and 26 show the actual trip length distribution plots for the No Relief Road and Western Relief Road after the Variable Demand Modelling for the AM and PM peak total vehicles respectively, distance is given in metres with the largest distance travelled being between 11400 to 11700m.

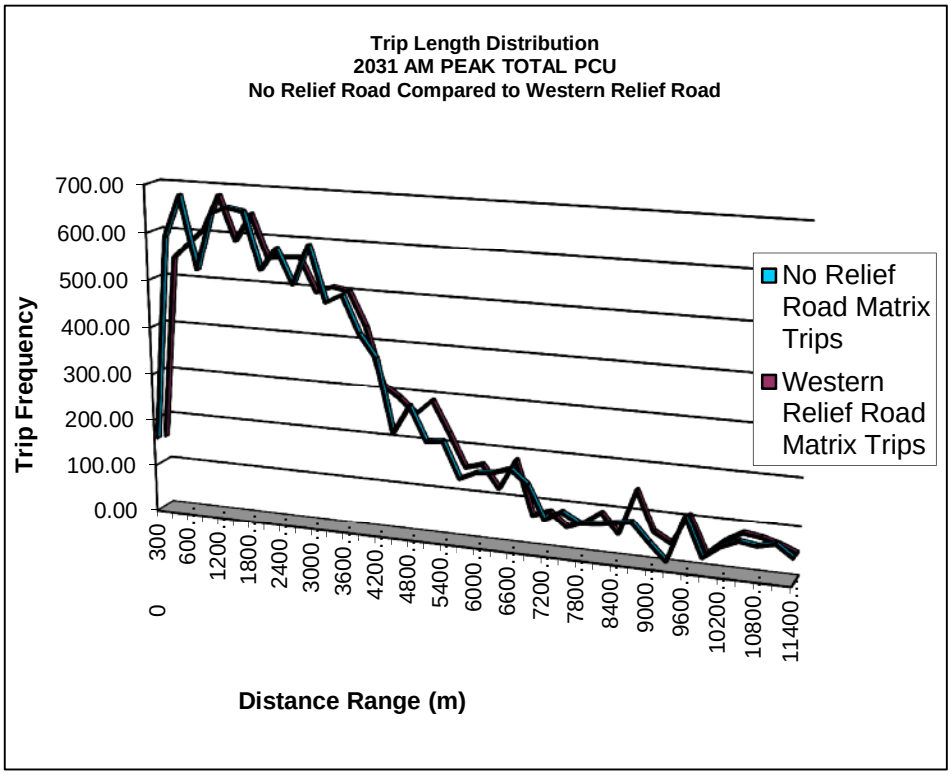

Figure 29: Trip Length Distribution Analysis – AM Peak

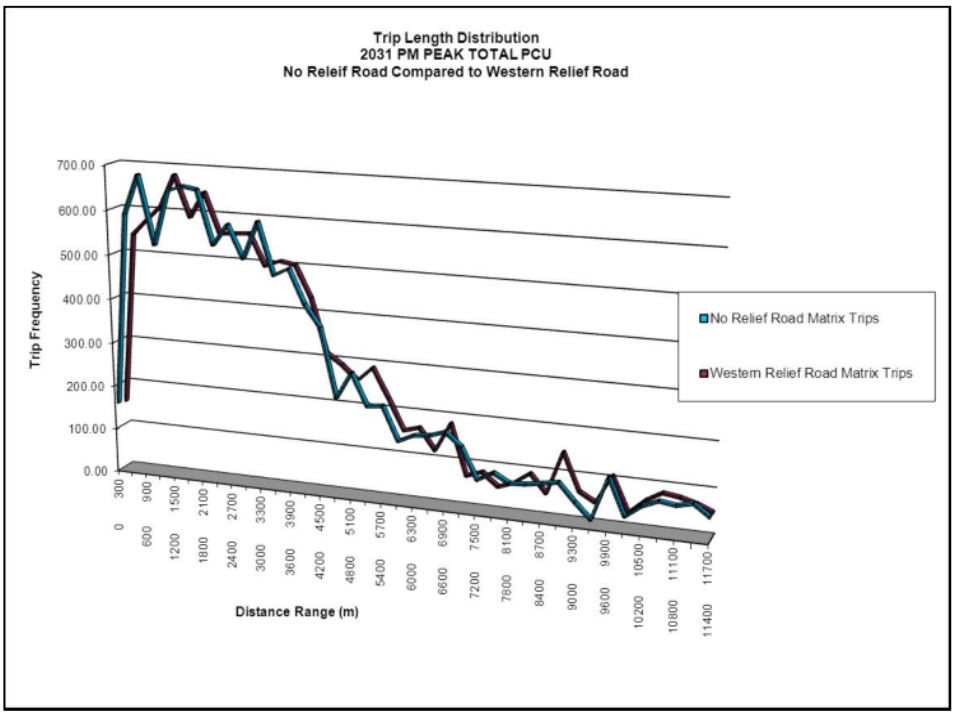

Figure 30: Trip Length Distribution Analysis – PM Peak

8.6.2. Overall the figures show that there are no significant changes of trip lengths and trip patterns between the No Relief Road and Western Relief Road scenario in both peak periods.

8.6.3. During the AM peak period total vehicle short distance trips of up to 2400m decrease by 2% with the provision of a Western Relief Road. Total vehicle longer distance trips on the network of over 10000m increase by 12% from 350 vehicles to 397 vehicles with the provision of a Relief Road.

8.6.4. During the PM peak period short distance trips of up to 2400m decrease by 3% and longer distance trips of over 10000m also reduce by 1% with the provision of a Relief Road.

9. CONCLUSIONS

9.1.1. This report has been commissioned in order to assess the impacts of reduced housing and employment growth allocations in Hereford. This, in conjunction with revised TEMPRO forecasts and a revised future year scenario, is assessed in order to justify the need for a Relief Road in Hereford and draw comparisons with the previous preferred option Housing Option 4 with a Western Relief Road and Sustainable Transport Package 3.

9.1.2. The report has described the methodology to model a reduced housing and development option and comparisons have been made between 2008 base year conditions and the previously preferred housing and employment growth option in order to understand the impact of the reduced housing and employment growth option with and without a Hereford Relief Road.

9.1.3. The future year transport networks and demand matrices were directly taken from the previous forecasting work for the Sustainable Option 3 networks for the No Relief Road, western alignment and the Housing Option 4 growth matrices. Details of which have been provided in TPi / Amey's Hereford Relief Road Interim Forecasting Report for Sustainable Option Packages (September 2010) in Chapters 2 and 3.

9.1.4. There is now a revised future forecasting year of 2031and a new version of TEMPRO, and consequently in order to accurately assess the impact of the reduced housing allocations, an assessment has been made of the impact of the revised future year and a revised TEMPRO growth rate. All the assessments have been based upon the No Relief Road networks with Sustainable Option Package 3 and a comparison has been made with previous scenarios.

9.1.5. In general, the modelling results between the 2026 and 2031 future year assignments and between the TEMRPO V5.4 and V6.2 assignments are very similar. There are no significant differences and it can be concluded that the changes in the future year and TEMPRO growth factors does not have a significant impact on the results for the reduced Housing Option 5 assignments. As a result it can be seen that the modelling results for the reduced housing scenario are applicable to the scheme rather than to differences in the forecast year or TEMPRO growth rates and therefore all future year modelling will use the revised TEMPRO.

9.1.6. All the assessments with a No Relief Road Scenario including the revised Housing Option 5 Sustainable Option 3 package with the new TEMPRO and 2031 forecast future year, indicate that there is a need for congestion relief in the form of a Relief Road.

9.1.7. The Variable Demand Modelling assignments showed that for each sustainable transport option that despite a modal transfer of trips from car trips to PT, cycle and walk trips some trips would shift back to use car as a form of transport. The transfer of trips from PT to car, walk or cycle are due to increases in the costs to travel by PT as compared to other modes. Increases in network congestion increases in fares and increases in values of time causes public transport costs to increase at a higher rate than that of the other modes leading to a transfer of trips from PT to other modes of travel.

9.1.8. Overall, the results show that the increase in travel demand, as forecast by TEMPRO, is predicted to worsen the congestion within Hereford. Adding the additional trips associated with the reduced growth housing allocation will still exacerbate these congestion problems, leading to longer journey times and extensive queuing. Despite the reduction in the numbers of housing allocations and employment levels and inclusion of Sustainable Option Package 3 the problems of congestion within Hereford remain and results are comparable with previous growth point scenario options already tested in previous reports. Consequently in combination with sustainable transport measures there is a need to provide congestion relief in the form of a Relief Road despite the reduction in the number of dwellings and employment sites in Housing Option 5 networks.

9.1.9. Provision of a Relief Road on a western alignment with the reduced housing and employment growth point is forecast to provide relief from these congestion problems. Traffic flow volumes across the Hereford Network are forecast to reduce with reductions of between 500 to 800 vehicles in the AM peak on key City Centre routes such as Greyfriars Bridge due to the provision of a Western Relief Road. Greyfriars Bridge experiences an average of a 19% reduction in traffic flows between the AM and PM peak time periods with the introduction of the Western relief Road. It is predicted that the Relief Road would provide better congestion relief for areas in the West and North of the Hereford study area than in the eastern parts of the study area.

9.1.10. Overall Housing Option 5 networks show more favourable results to Housing Option 4 networks. This is not surprising given the lesser number of trips assigned to the network in Housing Option 5.

9.1.11. By most indicators, with the exclusion of CO2 levels, conditions on the highway network with the additional trips and a western alignment are no worse than conditions under 2008 base year conditions.

9.1.12. A comparison of the network statistics in the no relief road scenarios revealed how the model predicts conditions of the highway to change in future years. The results show that all scenarios without the Relief Road are predicted to operate considerably worse than the base year 2008 conditions.

9.1.13. Comparison of the highway network performance statistics, revealed how the model predicted the travel and congestion conditions of the highway would change. The results show that in all scenarios without the Relief Road, queuing and travel delays are predicted to increase.

9.1.14. Assessment of the journey time variance between the peak periods shows that the Western Relief Road reduces the journey times between the peak periods to within a minute of each other in both directions. This indicates that the Western Relief Road provides greater journey time certainty for traffic using the A49 and as a result can be a key measure to provide for economic growth within Hereford.