# 6. Highway Measures

### INTRODUCTION

6.1 The preceding chapters have outlined the series of measures which were identified and appraised in the development of the GBSTS strategy, starting with measures designed to encourage the use of alternative modes to the car, followed by the management of demand and then improvements to the public transport network. This sequence highlighted the emphasis within the strategy development process adopted by the study; examining and promoting alternatives to the car and making best use of existing infrastructure before considering changes or additions to the road system.

6.2 As highlighted in Chapter 2, the impacts of the growth in population and employment across the study area between the base year, 2003, and the forecast year, 2031, together with the increased prosperity over the period, are to increase the car mode share from 89% to 91% in the morning peak period, while at the same time raising the level of delay across the road network by 230%. The introduction of the measures outlined earlier to encourage the use of alternative modes and to enhance public transport have a significant impact on the operation of the transport system, with the mode split for car use reduced to 76% in the morning peak period with the level of congestion cut by over a third (36%) from the 2031 Do Minimum position.

6.3 Although the other measures had made large inroads into resolving the problems, there were still residual areas of significant congestion which remained. Highway improvement measures were therefore designed to solve the remaining congestion and delays across the study area.

6.4 The consideration of highway measure followed a similar pattern to the overall process adopted throughout the study. Firstly, opportunities to make better use of the existing highway capacity were assessed before the potential of enhancements to the highway capacity were considered, with emphasis on the strategic highway network. This process is reflected in the format used to describe the highway measures in this chapter.

### MAKING BEST USE OF THE STRATEGIC HIGHWAY NETWORK

6.5 Before embarking on extensions to the highway network in the study area, it is important to ensure that the best use is being made of the existing infrastructure and capacity across the strategic highway network. This may be achieved through a wide range of potential measures which are outlined below. In concentrating on the strategic road network, there is emphasis on the measures designed to resolve issues on the motorway and major trunk roads. However, many of the measures are also appropriate to the rest of the main road network in the study area.

#### Planned Maintenance

6.6 Planned maintenance can help to minimise disruption on the motorway and trunk road network. Seasonal and daily variations in traffic flows and the regular occurrence of congestion on the motorway network are well known. Maintenance works, particularly those requiring lane possessions, should be programmed to avoid periods when traffic volumes are greatest in order to minimise the disruption to traffic especially overnight. With significant levels of holiday traffic to/from Devon, Cornwall and Somerset passing through the study area, the HA is adopting a policy of no maintenance on its network during the summer. A further strategy, recently tested by the HA, has been to promote hybrid improvement and major maintenance schemes in order to combine new works and maintenance operations within a single contract.

### Reductions of Incidents

6.7 An important factor in the causes of congestion on the strategic road network is the occurrence of accidents and incidents. A number of measures could be implemented to reduce the occurrence of incidents, particularly on motorways:

- better training and instruction to drivers in motorway driving;
- increased police activity on the motorway to identify drivers behaving in such a way as to cause incidents;
- use of CCTV to identify poor driving;
- stricter enforcement of penalties for drivers who are found behaving dangerously; and
- use of variable message signs to control speeds, and to warn motorists of accidents, incidents and other hazards ahead.

6.8 The above measures would complement ongoing initiatives, such as accident hotspot identification, being operated by the HA and local authorities.

### Incident Management

6.9 Incident management is vital for minimising the impact of:

- accidents;
- breakdowns;
- spillages;
- shedding of loads;
- removal of debris;
- fires; and
- terrorist threats.

6.10 As vehicle flows on the network increase, incidents are likely to become more frequent and to lead to significant reductions in capacity. Any incident that reduces the capacity below traffic demand creates queues. There are significant benefits from clearing up incidents quickly. However, this is becoming more difficult with increasing legislation governing procedures that must be carried out at the scene of the incident. Such procedures include extensive investigation, particularly in the case of a fatality, and the increasing possibility of litigation by those involved in the incident if, during clearance of the incident, the authorities inflict damage on vehicles, goods or property. Continued partnership working between the HA, police and other authorities is key to the management of incidents in the study area. The HA and police are seeking ways of speeding up the clearance of incidents; trials are underway in the use of satellite navigation systems and digital recording in order to accelerate the re-opening of roads following major incidents.

6.11 The Highways Agency's recent introduction (December 2005) of Traffic Officers within the study area will help in reducing the occurrence and impact of incidents. Operating on the motorway and trunk road network, the role of the Traffic Officers includes:

- participation at motor vehicle accidents;
- removal of damaged and abandoned vehicles;
- clearance of debris from the carriageway;
- undertaking high visibility patrols;
- provision of mobile or temporary road closures; and
- supporting the police in their duties.

6.12 The introduction of Traffic Officers is supported by seven Regional Control Centres across England operated by staff from the HA which has taken over responsibility from the police. Altogether, when the scheme is fully implemented, there will be about 1,200 Traffic Officers and 300 Regional Control staff working across England. There are clear limits and delineation between police and Traffic Officers with the police retaining responsibility for investigating criminal offences and, in the case of major accidents, the police will continue to be in charge at the scene.

*Incident Occurrence*

6.13 An incident is brought to the attention of the control room in a number of different ways:

- automatic detection – through the Motorway Incident Detection and Automatic Signalisation (MIDAS) system, data from the loop detectors is fed into pre-set algorithms that determine present and future flow characteristics and recognise the occurrence of flow breakdown;
- CCTV control room – the occurrence and severity of the incident can be determined, followed by a decision on the appropriate level of attendance, which can be arranged without waiting for a patrol to investigate the incident. This can immediately reduce incident duration by about 10 minutes, which may be significant for some types of injury;
- detection by police patrol and HA Traffic Officers;
- public detection – using the emergency phones on the side of the motorway or via their mobile phones; and
- 'Eye in the Sky' – helicopters reporting on congestion levels.

6.14 Once an incident is detected, the control room has to assess its severity. Traditionally, this is by immediate attendance of the nearest police patrol, which then identifies the scale of the incident and the action to be taken. CCTV permits control room staff to start assessment immediately, thus shortening the time to despatch the appropriate services.

6.15 Fast detection of an incident on its own reduces the response time by only a few minutes and its direct impact on the total duration of an incident is therefore limited. However, there may be a significant indirect effect e.g. by the avoidance of secondary accidents. Also, a few minutes earlier medical treatment can significantly affect survival rates.

6.16 The introduction of incident detection systems will have a range of effects, including:

- reducing the duration of the incident;
- increasing the hourly vehicle flow;
- reducing the consequent delays experienced by traffic; and
- reducing the severity of injury experienced by those involved.

6.17 Traditional practice has been to alert a police vehicle on patrol to attend the scene of the incident immediately. The Regional Control Centres also alert the HA Traffic Officers who will deal with the incident unless the police need to be involved. The scale of the incident can be assessed and any additional resources can be called upon. The need for patrol attendance for validating the initial report before all the necessary resources can be mobilised contributes significantly to the response time.

6.18 Excluding the overall co-ordination of the incident clear up, a major duty of the police or the Traffic Officer is to gather the required level of evidence from the incident scene. In the case of a fatality, this is a process that can take several hours. The police service Road Death Investigation Manual (which incorporates the requirements from the European Human Rights Legislation) requires that all deaths, whether on a road or otherwise, should be investigated to the same standard. From the police point of view, there are few opportunities to shortcut this process. The documentation of evidence is critical to the determination of the overall clear-up time of an incident and, if anything, the evidential requirements are likely to become more stringent. The police and HA should therefore continue to focus on areas where their operation can be speeded up through more advanced methods such as electronic and videogrammetry techniques which are currently under trial.

6.19 The use of standard diversionary signs should minimise the level of police effort necessary to achieve the benefits of significant traffic diversion. However, in practice, it can be time-consuming for the police to gain access to and operate the diversion route trigger signs, and these resources could often be better employed in dealing with the incident itself. With the increasing deployment of higher technology solutions, electronic VMS would be preferable. Diversions off the motorway network may, in general, be best limited to major incidents when, for example, the motorway is completely closed for a significant duration. Often the impacts of diversions on the local road network produce significant levels of congestion which take long periods to dissipate. This is particularly true on sections of the network in the study area where there are limited alternative routes, e.g. the River Avon Crossing. The increased availability of in-car satellite navigation systems will help in the wider use of alternative routes without the need for additional signing.

### *Incident Clear-Up*

6.20 Once the police are satisfied with their documentation of the incident scene, the clear-up operation can begin perhaps in stages. Appropriate clear-up resources include Route Stewards and Incident Support Units, and also approved recovery garages. Liability over the vehicle involved in an incident and its load is a particular issue for recovery crews. Insurance companies, wishing to minimise loss payouts by maximising the salvageable remains of the vehicles and goods (instead of writing them off) hold the recovery crews liable. The crews therefore spend more time and care over the recovery process. A change to legislation is needed so that the police and recovery crews can assess the most efficient means to clear the debris and put the liability with the insurers.

### Signing, Surveillance and Automated Systems

6.21 Recent advances in technology have led to the potential to introduce more ‘intelligent’ signing/traffic control systems that can provide information in response to changing traffic conditions. Although available elsewhere in the UK, there would be merit in extending their availability across the study area. The systems more commonly available are:

- driver information systems which use variable message signs (VMS) and can increase journey times for some traffic when there is congestion;
  - real-time response to incidents, enabling immediate activation of lane control signals, incident warning signs, and advisory alternative route signs;
  - reduction in congestion, which lowers the chances of additional accidents occurring and eases the route for emergency services; and
  - reduced need for manual resources, with staff concentrating more on directing emergency services and road crews.
- incident warning systems with roadside displays designed to reduce accidents by highlighting congestion, obstructions or incidents ahead; and
- Controlled Motorways which use detectors to reduce speed limits automatically during peak periods in response to traffic speed and flow conditions to improve traffic flows and journey times and to reduce accidents by delaying or preventing the onset of stop-start conditions.

#### *Active Traffic Management (ATM)*

6.22 A trial of ATM is underway on the M42 between Junctions 3A and 7. ATM aims to make best use of the existing road space through the application of new and existing technologies and infrastructure and new operational procedures.

6.23 ATM contains the follow menu of potential techniques:

- lightweight gantries with lane specific signals and signs, variable speed limits, digital enforcement equipment and enhanced message signs;
- CCTV cameras and automatic queue detection (i.e. MIDAS) to monitor traffic conditions;
- rapid incident response teams to remove obstructions, assist with traffic management and repair roadside equipment;
- ramp metering by signal control on the entry slip roads;
- lane marshalling by destination and/or vehicle type; and
- controlled use of the hard shoulder as an additional traffic lane.

6.24 The benefits of ATM are:

- reduced congestion through more efficient use of existing road space;
- faster response to incidents and reduced clear-up times;
- enhanced driver information;
- more reliable journey times; and
- reduced driver stress.

6.25 GBSTS supports the introduction of ATM measures on the motorway network in the Greater Bristol area. Much of the infrastructure necessary to implement the measures, in terms of improved telecommunications equipment and signs, is being installed across the area to facilitate the widespread use of ATM, with resulting benefits to the operation of the network.

## NEW HIGHWAY SCHEMES

6.26 As identified at the start of this chapter, the improvements to the highway network were considered after the range of alternative policy measures. They were designed to resolve residual congestion on the strategic road network.

6.27 There were two elements to the identification of potential highway schemes to be assessed by the study:

- specific schemes identified in the study Brief; and
- further schemes designed to resolve particular highway capacity constraints in the future, which are not addressed by schemes in the Brief, dealing separately with:
  - the motorway network,
  - schemes on the remainder of the strategic network.

### Schemes Identified in the Study Brief

6.28 In the Brief for GBSTS, a number of highway improvement schemes were identified, many of which have had a long history of development and assessment. These schemes represent a mixture of strategic and local improvements. One of the aims of the study was to establish whether such schemes could play a role in resolving the residual problems on the highway network or whether new measures would be required. In this assessment, one of the key issues for GBSTS is whether a scheme’s impact is purely local or whether there are wider strategic benefits from its implementation. At the same time, in examining the performance of the long-established schemes, there was the opportunity to identify whether they would be likely to have a role in the future highway network in the sub-region or whether they should no longer be considered.

6.29 The principal highway schemes identified in the Brief for the study were:

- Avon Ring Road Southern Section (A4 Bath Road to A370) including:
  - A4320 St Philips Causeway to A4 Bath Road to Callington Road Link,
  - A4 Hicks Gate to A37,

- Cater Road to A38 Bridgwater Road,
- A38 Bridgwater Road to A370 Link;

- Link Road from A370 to M5 Junction 20;
- Link Road from M4 to A4174;
- provision of M5 Junction 21A in support of Weston-super-Mare regeneration, taking account of the diversion on east-west routes across the Mendip Hills;
- A4 Saltford Bypass;
- A37 Whitchurch Bypass;
- A37 Clutton/Temple Cloud Bypass;
- Banwell Bypass and associated schemes; and
- M49 Intermediate Junction, Avonmouth/Severnside.

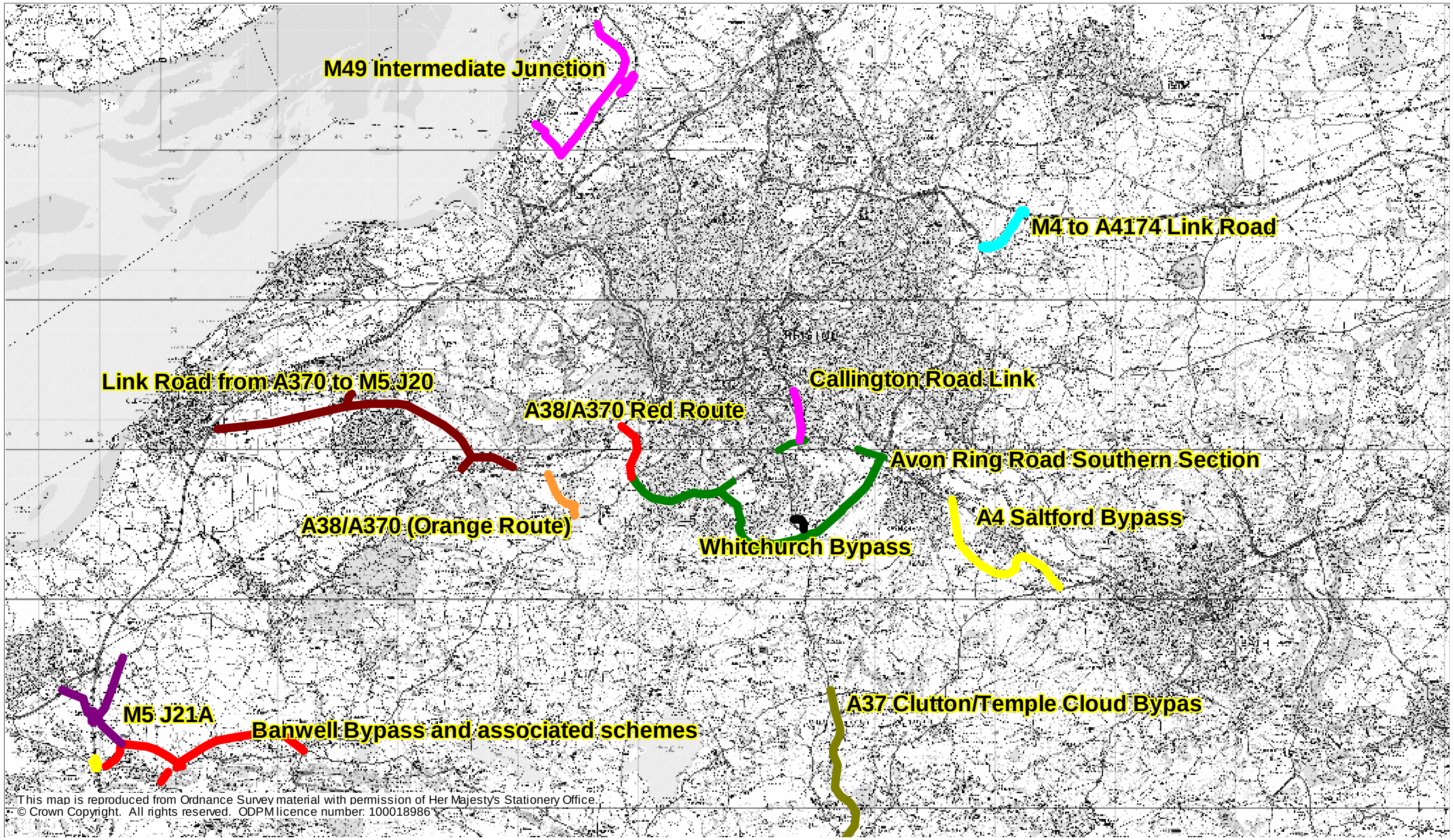
6.30 Figure 6.1 shows the location and broad alignment of the schemes which were specified in the Brief.

6.31 In the initial appraisal of the individual highway schemes, it was important to assess the performance of schemes on a consistent basis; hence, the attention was concentrated on the morning peak period in the GBSTS horizon year of 2031. At the same time, an initial economic appraisal was undertaken to provide an estimate of the relative performance of each scheme together with their broad environmental impacts. On the basis of this initial appraisal, the performance of the individual schemes could be assessed to help decide whether they should be included in the more detailed appraisal of the strategy itself.

6.32 At the outset, it is necessary to understand the importance of the interface between the local and strategic networks. On occasions, problems on the strategic network (e.g. at motorway junctions) are caused by capacity constraints on the local network and hence measures may be necessary on the local network to resolve the problems on the strategic network. At the same time, the reverse effect may also be encountered, in which constraints on the strategic network have impacts on the local network; this is particularly true through the heavy traffic volumes on the motorway network in the summer.

6.33 In the following section, we summarise the initial appraisal of the schemes identified in the Brief, before considering additional schemes designed to solve specific residual problems on the strategic highway network, particularly in relation to the motorway system in the study area.

**Figure 6.1 – Potential Highway Schemes Considered by the Study**




Note: The schemes in this diagram are conceptual and defined for appraisal purposes.

### ASSESSMENT OF HIGHWAY SCHEMES IN THE STUDY BRIEF

6.34 Within this section, we summarise the initial assessment and appraisal of highway schemes identified in the GBSTS Brief, considering the schemes in the order listed in the previous section. The initial appraisal considered each scheme on a consistent basis. Within the Greater Bristol Model, a network containing all the schemes was developed and the effect of the full package of schemes was assessed. The impact of an individual scheme was then assessed by **removing** the scheme from the overall package and reviewing the consequent change in the performance of the package. One consequence of this approach was that the impact of schemes was tested in relation to the full package of potential schemes, some of which would not be retained in the eventual strategy.

6.35 The appraisal of the individual schemes includes an estimate of the capital costs of the scheme including preparation and supervision. In line with guidance from HM Treasury, the costs also include an allowance for optimism bias which recognises that, in scheme appraisal, there has been a tendency to understate capital costs and hence the optimism bias represents a correction to the initial estimate. To provide an indication of the magnitude of the optimism bias, the costs are shown inclusive and exclusive of the bias. At this stage, the overall costs exclude an estimate for land acquisition; such costs are likely to be closely linked to the precise alignment of the scheme and hence are not appropriate for inclusion in the costs of conceptual schemes.

### Avon Ring Road (Southern Section) or South Bristol Ring Road

6.36 Currently, traffic movements between the southern end of the Avon Ring Road (at the junction with the A4 at Hicks Gate) and the A37, A38 and A370 corridors involve circuitous routes along heavily congested radial sections of the highway network in south Bristol with significant delays at key junctions. The position could be exacerbated in the future with the potential addition of significant levels of development in south Bristol by 2031, including Ashton Vale, Whitchurch and Keynsham, as well as further growth on brownfield sites and new employment-related growth within Bristol.

6.37 In considering the schemes in south Bristol that might form an extension to the Avon Ring Road, we examined the connection between the A4 and the A38 separately from the A38-A370 link, although the two elements are strongly inter-connected and together are termed the South Bristol Ring Road (SBRR).

6.38 A number of alternative means of catering for the additional traffic have been examined (see Figure 6.2). The on-line route (currently safeguarded) between the A4 and A38 would include the following sections:

- from Hicks Gate along A4 Bath Road to West Town Lane junction with A4174;
- along A4174 West Town Lane/Callington Road/Airport Road/Hengrove Way to the roundabout junction with Hartcliffe Way;

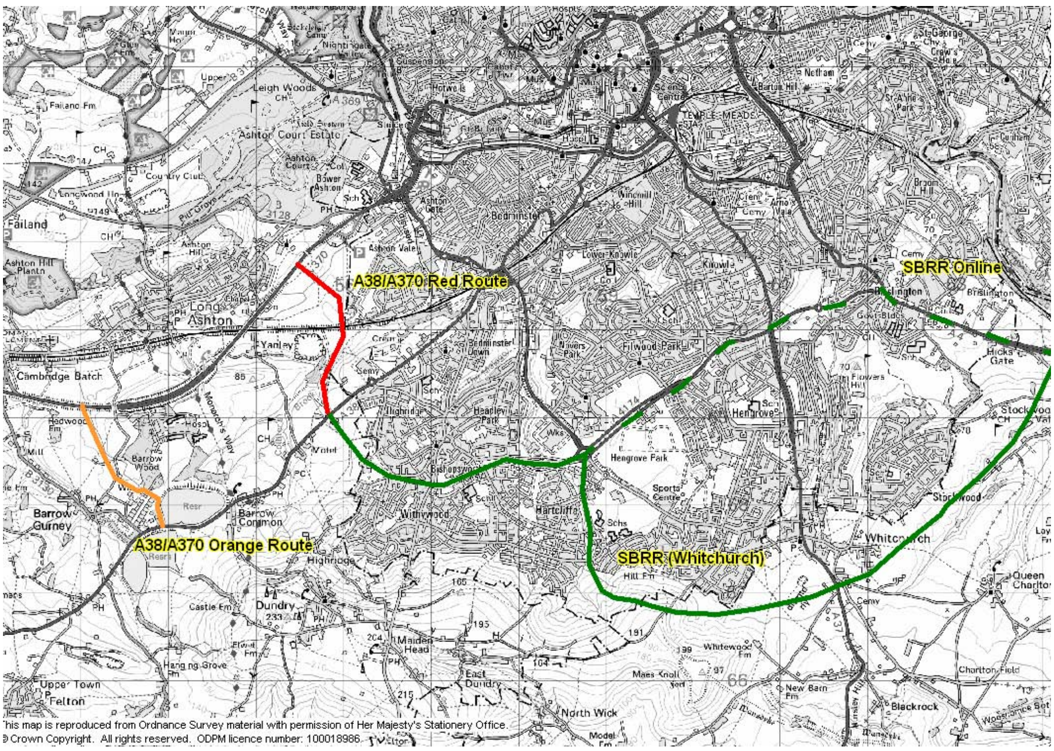
- continuing south west along Hengrove Way and a new Cater Road link to King George's Road and Highridge Green before crossing Highridge Common to join the A38 Bridgwater Road.

6.39 An alternative route through Whitchurch could include:

- from Hicks Gate, following a new alignment south-west towards Whitchurch, to the east of the existing Stockwood residential area;
- crossing A37 at Whitchurch and then running to the south of Hengrove before heading north on Hawkfield Road to the roundabout junction with the existing A4174 at Hartcliffe Way and Hengrove Way; and
- following the alignment of the on-line route along Hengrove Way, Cater Road link, King George's Road, Highridge Green and Highridge Common to the A38.

6.40 In each case, the route would be designed to dual carriageway standard.

**Figure 6.2 – Alignments of South Bristol Schemes**




Note: The schemes in this diagram are conceptual and defined for appraisal purposes.

6.41 In the assessment of the options, it was found that the volume of traffic using the on-line alignment would lead to significant congestion at major junctions along the route particularly at Brislington between the A4 Bath Road and the A4174 Callington Road and between the A4174 and A37. To relieve the congestion at these junctions would require significant measures involving grade-separated junctions with extensive property acquisition likely. Furthermore, the alignment does not provide satisfactory links to the proposed new developments at Whitchurch and Keynsham. Hence, although the option is not recommended at this time, it could be given further consideration at a later date.

6.42 The study's preferred option for the scheme is therefore to extend the current alignment of the Avon Ring Road as a dual carriageway with two lanes in each direction across the A4 at Hicks Gate towards Whitchurch, then following the southern boundary of the built-up area before joining the A4174 at the southern end of Hartcliffe Way and continuing south-west along the on-line alignment outlined above. The alternative southern option achieves the bypass role more effectively. Some key aspects of the performance of the scheme are shown in Table 6.1.

**Table 6.1 – Key Impacts of Avon Ring Road (Southern Section) (average morning peak hour)**

| Measure | Impact |
|---|---|
| Vehicle Trips | 0.6% increase |
| Vehicle Kilometres | 0.9% reduction |
| Total Vehicle Delay on highway network (hours) | 6% reduction |
| Average Vehicle Speed (Highway) | 4% increase |
| Bus Passenger Kilometres | 9% increase |

6.43 Overall, implementing the Avon Ring Road Southern Section (ARR(S)) results in a 6% reduction in total vehicle delay across the whole study area; consequently, the average speed across the network is increased by 4%. There is a substantial increase in bus passenger kilometres (9%) brought about by increased bus speeds due to the relief to roads, especially the main radial routes, inside the Bristol urban area.

6.44 Figures 6.3 and 6.4 show the impact of the ARR(S) on the highway network, both in terms of vehicle flow (Figure 6.3) and capacity utilisation (Figure 6.4).

6.45 Figure 6.3 shows that the ARR(S) scheme provides benefits to the strategic highway network; there is relief to the motorway network from M5 Junction 19 round to M4 Junction 19 and on the M32 as vehicles take advantage of the new direct routes using the new road. Large sections of the local road network within Bristol receive some relief due to the scheme. This occurs because, for many journeys, the ARR(S) provides a good route where there is no clear alternative, avoiding the need for traffic to find a path through congested parts of central and south Bristol. Links brought into the relatively uncongested category as a result of the ARR(S), i.e. with flows less than 85% of their capacity, are shown in green in Figure 6.4. The scheme has impacts over a wide area, and certain links, shown in blue, are pushed above the 85% capacity threshold as a result of changing traffic patterns.

6.46 Flows on the existing Avon Ring Road increase as a result of the scheme, particularly between Hicks Gate and the junction with the A420 at Warmley (see Figure 6.3). This puts a number of junctions on the ring road under pressure, and suggests that, in the absence of any other measures such as demand management, secondary measures would be required to increase junction capacity.

**Figure 6.3 – Difference in Flow as a Result of Implementing ARR(S) (average morning peak hour)**

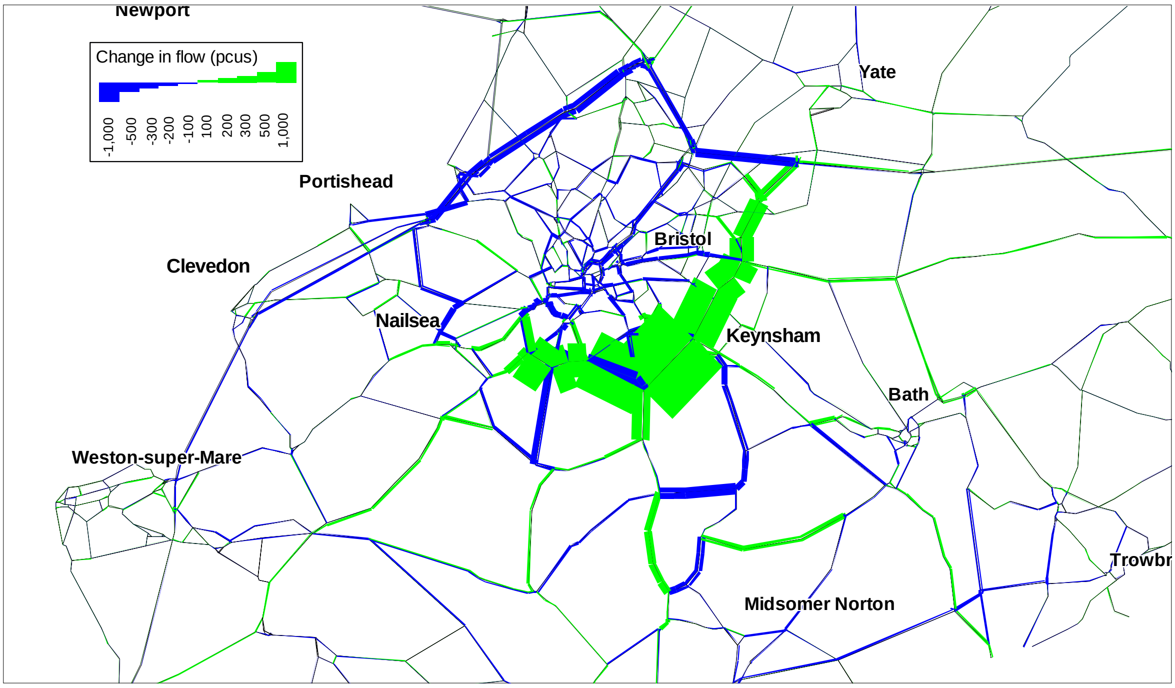
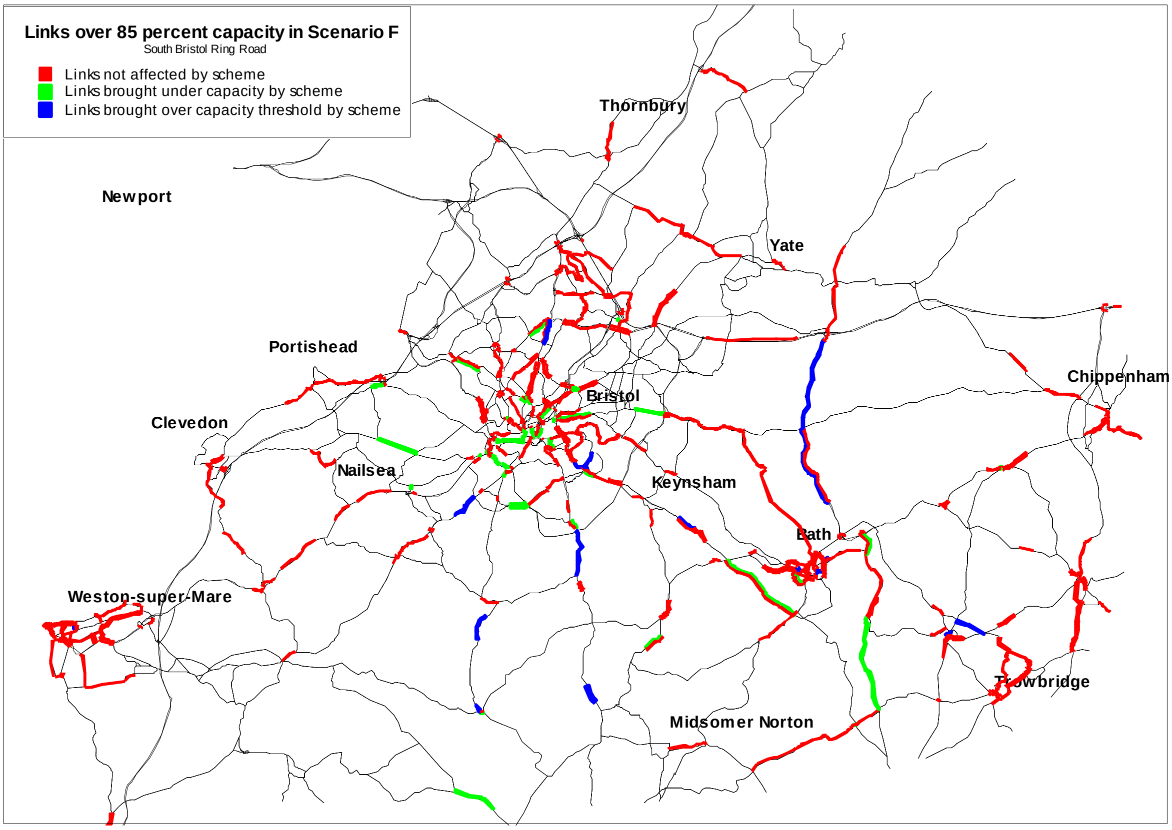



**Figure 6.4 – Difference in Capacity Utilisation as a Result of Implementing ARR(S) (average morning peak hour)**



6.47 Table 6.2 shows the impact of the ARR(S) on the travel times for typical journeys across the south Bristol area. This indicates that orbital journey times are improved considerably by the scheme. In addition, there are journey time savings of between 4 and 6 minutes per trip for local journeys within south Bristol which benefit from congestion relief. For trips from central Bristol to BIA, congestion relief results in a time saving of around 3 minutes.

**Table 6.2 – Impact of ARR(S) on Journey Times (minutes in average morning peak hour)**

| Route | Without ARR(S) | With ARR(S) |
|---|---|---|
| Whitchurch to Kingswood | 43 | 9 |
| Keynsham to Long Ashton | 42 | 20 |
| Nailsea to Pucklechurch | 48 | 38 |
| Bristol City Centre to Bristol International Airport | 22 | 19 |

6.48 Table 6.3 gives the key indicators for the economic performance of the scheme. This shows that the overall economic performance is very strong, with large user benefits which considerably outweigh the scheme costs, resulting in an NPV of £960 million and a BCR of 16. The benefits mainly come from the travel time savings experienced by a large number of highway users. A significant feature of the scheme is that it serves major areas of new development. Although the demand for travel created by the new development plays an important role in the appraisal of the scheme, further analysis showed that, even without the new developments, there is a strong economic performance.

**Table 6.3 – Economic Performance of Avon Ring Road (Southern Section)**

| | |
|---|---|
| **Cost (2005,Q1) £mill, inc Optimism Bias** | £112 |
| **Cost (2005,Q1) £mill, excl Optimism Bias** | £77 |
| **PVC (£ mill, 2002 prices & values)** | £63 |
| **PVB (£ mill, 2002 prices & values)** | £1,020 |
| **NPV (£ mill, 2002 prices & values)** | £957 |
| **BCR** | 16.2 |

6.49 The Avon Ring Road (Southern Section) would provide a completely new route around south Bristol, avoiding the need for traffic wishing to make orbital journeys to follow routes along congested radial roads in the built-up urban area. The scheme would also serve the major new developments at Whitchurch, Keynsham and Ashton Vale. It delivers large travel time savings and has a very strong justification in transport terms. For this reason it is included as a key element of the GBSTS strategy.

### A38-A370 Link

6.50 Two separate alignments for the link have been considered – the Red and Orange routes identified in earlier work on alternative schemes linking the A38 and A370. The Red route follows an alignment that extends the Avon Ring Road (see Figure 6.1 above) in a north-west direction from the A38 to the A370 while the Orange route lies further to the south-west and provides more local links including a bypass of Barrow Gurney. The potential extensive developments in the area generate significant increases in demand compared with the present. The two schemes are located close to the proposed developments, with the Red route lying broadly at the eastern boundary and the Orange route on the western boundary. Hence, there is close interaction between the schemes and the development, with the potential for private sector contributions for the scheme.

6.51 A comparison of the overall performance of the Red and Orange schemes is given in Table 6.4. This shows that, while the Red route has a modest impact on delays across the network, implementing the A38/A370 Orange route along with the Red route has very little effect on the overall network performance, with no additional reduction in total vehicle delay above that achieved by the Red route on its own.

**Table 6.4 – Key Impacts of A38–A370 Link Options (average morning peak hour)**

| Measure | Red Route | Orange Route |
|---|---|---|
| Vehicle Trips | 0.1% increase | impact not significant |
| Vehicle Kilometres | impact not significant | impact not significant |
| Total Vehicle Delay on highway network (hours) | 0.4% reduction | 0.04% reduction |
| Average Vehicle Speed (Highway) | 0.2% increase | impact not significant |
| Bus Passenger Kilometres | impact not significant | impact not significant |

6.52 Figures 6.5 to 6.8 show the impact of the Red and Orange routes on the highway network, both in terms of vehicle flow (Figures 6.5 and 6.7) and capacity utilisation (Figures 6.6 and 6.8).

6.53 Figures 6.5 and 6.6 indicate that the Red route relieves the congestion on the B3130 through Barrow Gurney, on the A370 and through Long Ashton and, as a result, a number of links are brought below the 85% capacity utilisation threshold. However, the scheme generates additional traffic on the A38 to the south of its junction with the Red route which pushes this section slightly above the 85% capacity threshold and hence some local measures may be required to solve the outstanding problems.

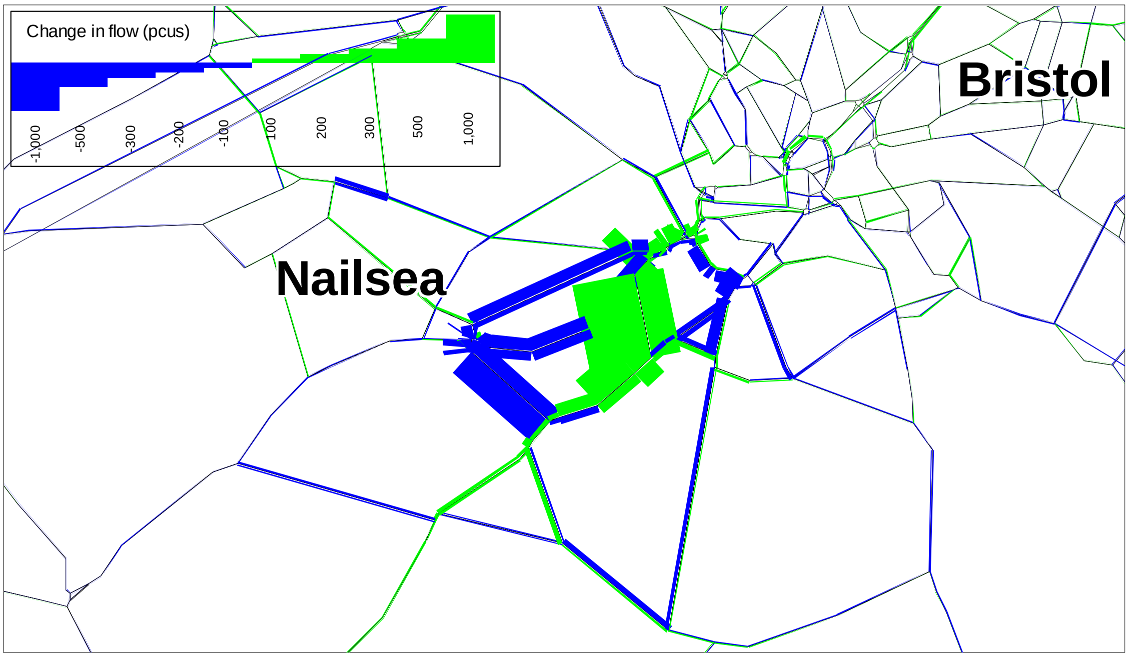
6.54 Figures 6.7 and 6.8 show the additional effects of implementing the Orange route, assuming the Red route is already in place. The joint scheme introduces some local re-routing from the Red to the Orange route. Although its impacts are local, the Orange route plays a role in providing some additional relief to the B3130 through Barrow Gurney.

6.55 Table 6.5 shows the effect of introducing the A38-A370 Red and Orange routes on journey times. As shown in the table, neither link on its own has a great impact on journey times to the airport, although both schemes contribute to reductions in orbital journey times, for example between Keynsham and Long Ashton.

**Table 6.5 – Impact of Red and Orange Routes on Journey Times (minutes in average morning peak hour)**

| Route | No A38-A370 Link | A38-A370 Red Route | A38-A370 Red and Orange Routes |
|---|---|---|---|
| Keynsham to Long Ashton | 42 | 41 | 40 |
| Bristol City Centre to Bristol International Airport | 22 | 22 | 22 |
| Thornbury to Bristol International Airport | 47 | 47 | 47 |
| Portishead to Bristol International Airport | 22 | 21 | 21 |

## Figure 6.5 – Difference in Flow as a Result of Implementing A38-A370 Red Route (average morning peak hour)




## Figure 6.6 – Difference in Capacity Utilisation as a Result of Implementing A38-A370 Red Route (average morning peak hour)

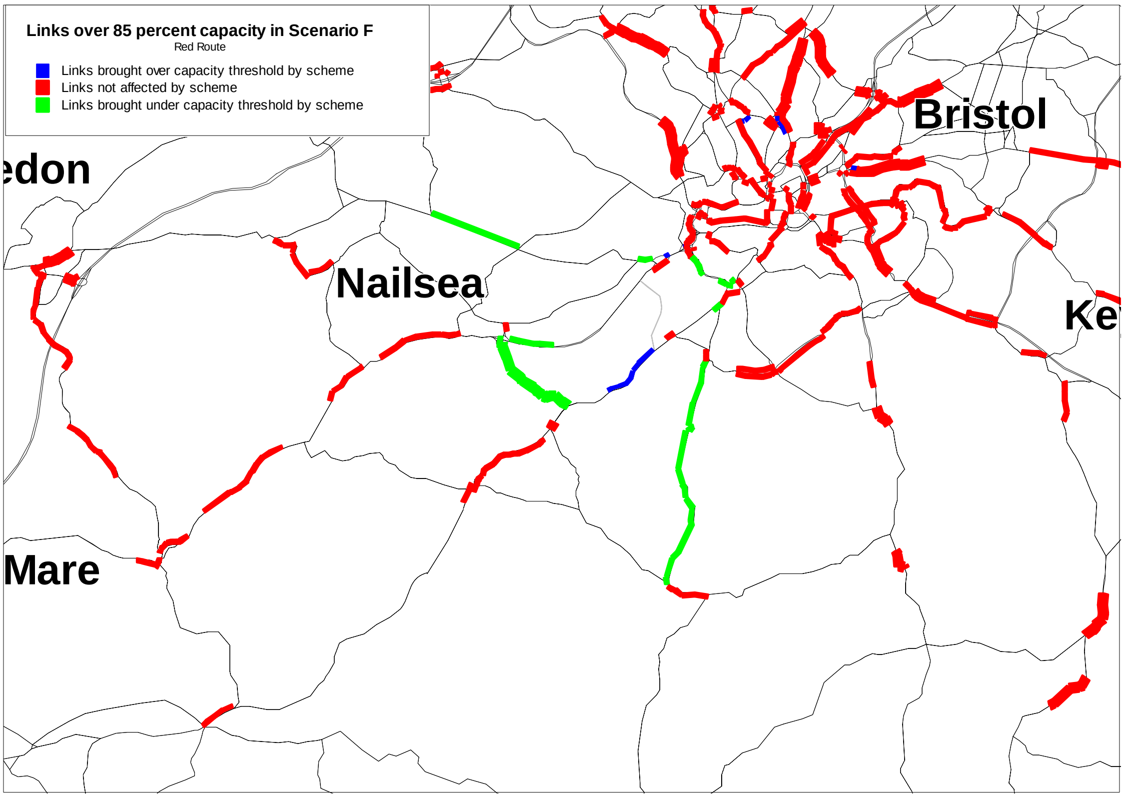


**Figure 6.7 – Difference in Flow as a Result of Implementing A38-A370 Orange Route (average morning peak hour)**

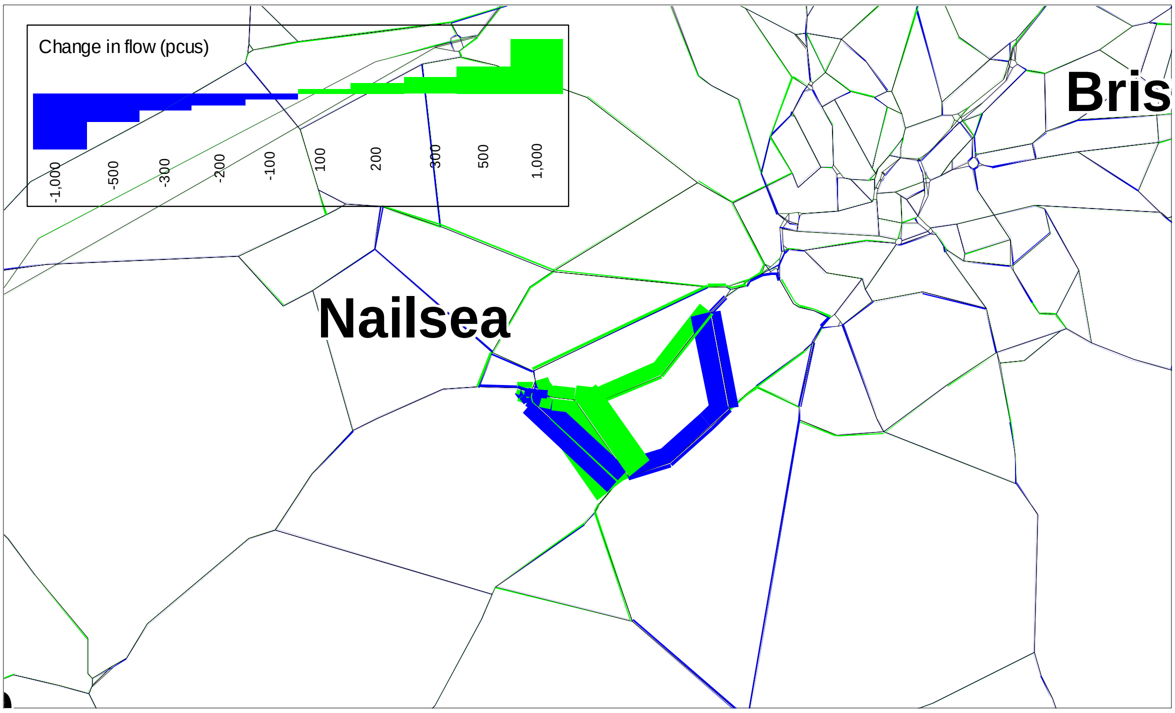
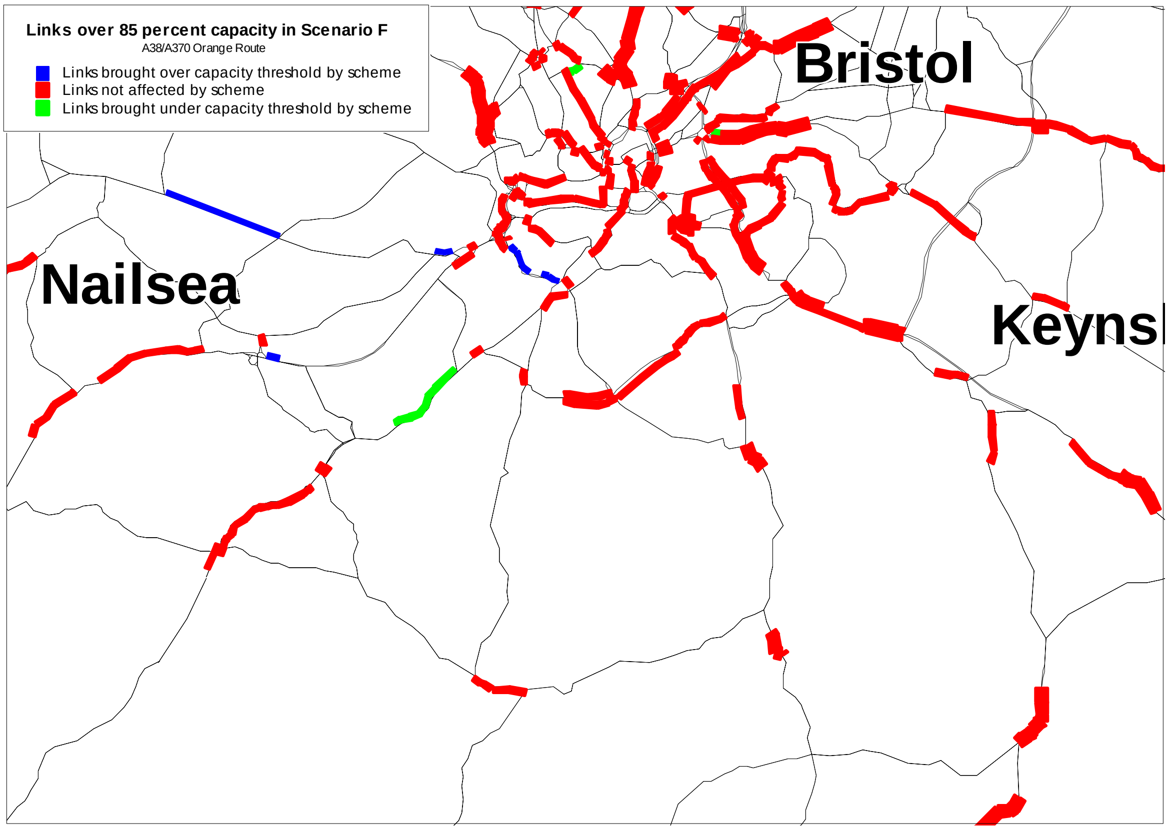



**Figure 6.8 – Difference in Capacity Utilisation as a Result of Implementing A38/A370 Orange Route (average morning peak hour)**



6.56 Table 6.6 summarises the economic performance of the two schemes, assuming that the rest of SBRR is in place between the A38 and the A4. The table shows that, while the impact of the Red route on the network as a whole is relatively modest, the journey time savings it generates considerably outweigh the scheme costs to produce an NPV of £70 million and a strong BCR of 8.5.

6.57 In contrast, assuming the Red route is already in place, the Orange route performs poorly at the strategic level. It has a negligible impact on journey times for strategic journeys and results in a negative NPV.

**Table 6.6 – Economic Performance of A38/ A370 Link Road Schemes**

| | Red Route | Orange Route |
|---|---|---|
| Cost (2005,Q1) £mill, inc Optimism Bias | £16 | £12 |
| Cost (2005,Q1) £mill, excl Optimism Bias | £11 | £8 |
| PVC (£ mill, 2002 prices & values) | £9 | £9 |
| PVB (£ mill, 2002 prices & values) | £80 | -£2 |
| NPV (£ mill, 2002 prices & values) | £70 | -£10 |
| BCR | 8.5 | -0.2 |

6.58 The Red route forms an element of the SBRR, has a strong economic justification in its own right, and is therefore included in the GBSTS strategy. The Orange route mainly provides local links, with relief to Barrow Gurney being the main benefit together with links to the new Ashton Vale development. Further analysis of the effects of implementing the Orange route in conjunction with a wider scheme to improve access to the airport is given in the section on airport links below.

### Link Road from A370 to M5 Junction 20

6.59 The construction of a link between the A370 at Long Ashton and Junction 20 of the M5 would provide a more direct connection between the motorway and south Bristol, replacing the range of existing routes from the M5, i.e. via Junction 19 and A369, Junction 20 and B3130 and Junction 21 and A38/A370. None of these routes represents a satisfactory link between the M5 and south Bristol due to a combination of limited capacity on rural single carriageway roads, passing through local communities with infrequent passing places and variations in gradient.

6.60 Although, in this section, the analysis concentrates on the link from M5 Junction 20, an alternative scheme between M5 Junction 21 and south Bristol via BIA is examined later in this chapter; this Airport Link Road scheme was not identified specifically in the study Brief and hence was considered separately, although its performance is compared with the A370 to M5 Junction 20 link.

6.61 The link between M5 Junction 20 and south Bristol would mainly follow a new alignment within the B3130 corridor and hence would also provide a bypass for a number of communities of differing sizes along its route, including Nailsea, Tickenham and Wraxall. The scheme would significantly increase traffic on the A370 between Cambridge Batch and Bristol and hence the widening of this section to dual carriageway standard would need to be included in the scheme definition.

6.62 Figures 6.9 and 6.10 indicate the impacts of the scheme, which include:

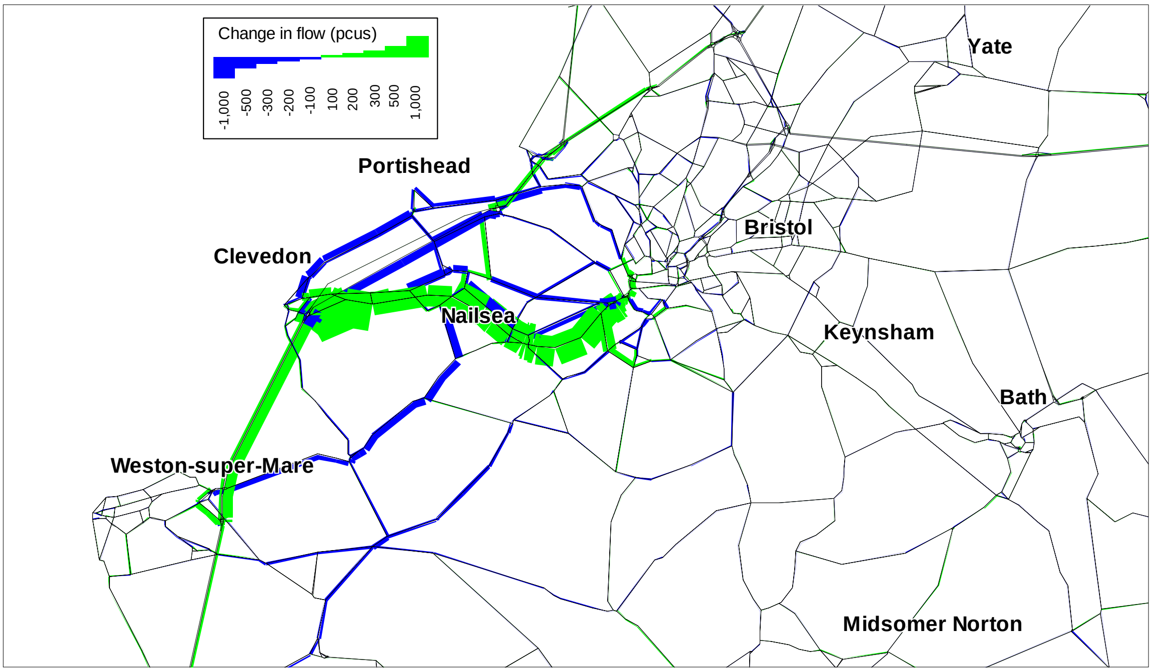
- new connection to the M5 from Nailsea and south Bristol, also providing both areas with enhanced links to Weston-super-Mare;
- some relief to the M5 between Junctions 19 and 20 and to Junction 19 itself; and
- transfer of some traffic from the A38 and A370 onto the M5 between Junctions 20 and 21, although the extent of the diversion is not sufficient to have a significant impact on the M5 capacity utilisation on this section of the motorway.

6.63 Table 6.7 summarises some of the overall impacts of the M5 Junction 20 Link Road scheme. It indicates that the scheme has a relatively small impact on the operation of the transport system across the study area.

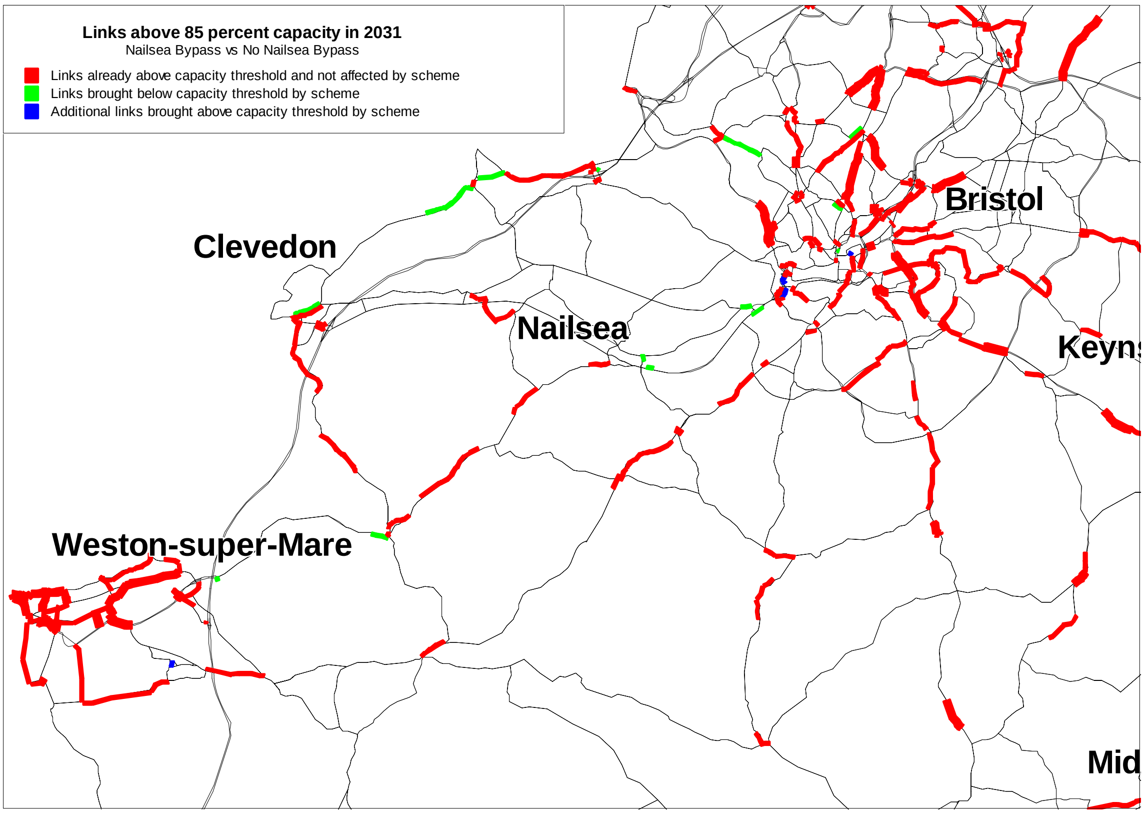
**Table 6.7 – Key Impact of M5 Junction 20 Link Road**

| Measure | M5 Junction 20 Link |
|---|---|
| Vehicle Trips | 0.1% increase |
| Vehicle Kilometres | 0.3% increase |
| Total Vehicle Delay on highway network | 1% reduction |
| Average Vehicle Speed (Highway) | 1% increase |
| Bus Passenger Kilometres | 1% increase |

## Figure 6.9 – Difference in Flow as a Result of Implementing M5 Junction 20 Link Road




## Figure 6.10 – Difference in Capacity Utilisation as a Result of Implementing M5 Junction 20 Link Road



6.64 The M5 Junction 20 Link Road produces some small journey time savings between Weston-super-Mare and Bristol city centre (about two minutes). The time savings are small because, although it raises the average speed for the journey, the scheme is indirect and hence increases the journey length.

6.65 Table 6.8 summarises the economic performance of the scheme. The time savings are mainly experienced by drivers whose origins or destinations lie close to the alignment; drivers for whom the link increases the journey length (e.g. between central Bristol and Weston-super-Mare) only gain small time benefits. In particular, 30% of the benefits are gained from savings (of 9 to 12 minutes per trip) occurring between Nailsea and Weston-super-Mare.

**Table 6.8 – Economic Performance of M5 Junction 20 Link Road**

| | M5 Junction 20 Link |
|---|---|
| Cost (2005,Q1) £mill, inc Optimism Bias | £98.4 |
| Cost (2005,Q1) £mill, excl Optimism Bias | £67.9 |
| PVC (£ mill, 2002 prices & values) | £77.7 |
| PVB (£ mill, 2002 prices & values) | £241.8 |
| NPV (£ mill, 2002 prices & values) | £164.1 |
| BCR | 3.1 |

6.66 The alternative scheme between Weston-super-Mare and south Bristol, via the BIA, is described later and includes a comparison with the M5 Junction 20 Link Road.

### Link Road from M4 to A4174

6.67 A number of options were examined in relation to the possible construction of a new Junction 18A on the M4 to the east of Junction 19 with the M32. If constructed, the new junction would be connected to the A4174 at Emersons Green with a new link as shown in Figure 6.11.

6.68 The operation of the new link is complicated by the inter-relationship between Junctions 18A and 19, M32 Junction 1 and the northern sections of the Avon Ring Road (A4174). Consequently, a number of options were considered for the Link Road. The alternatives included:

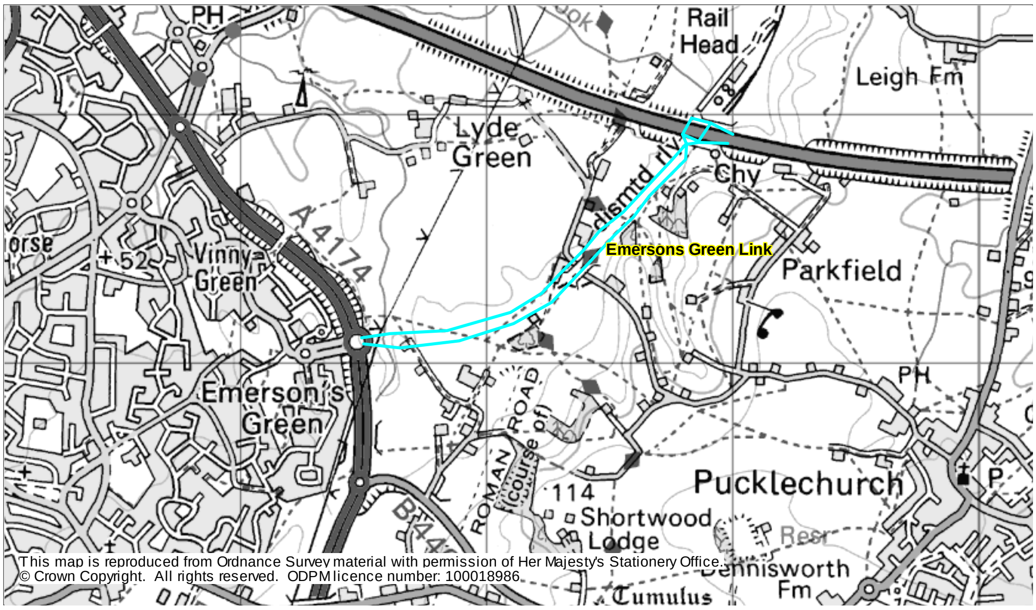
- full junction movements at M4 Junctions 18A and 19 so that at each junction traffic is able to enter and exit the motorway in both eastbound and westbound directions;
- full junction movements at M4 Junction 19 but Junction 18A restricted to only eastbound access to the M4 and westbound egress from the M4 i.e. ‘east-facing’ slip roads – such a configuration would remove the short-

distance trips between Junctions 18A and 19 which were a feature of the first alternative; and

- at Junction 19, only westbound access and eastbound egress would be permitted (i.e. west-facing slip roads) while at Junction 18A only eastbound access and westbound egress would be available (i.e. 'east-facing' slip roads) – however, this option produced extremely high levels of diversion onto the Avon Ring Road (A4174).

6.69 Of the three alternatives, the second one was the most operationally efficient and therefore formed the basis for the detailed appraisal.

**Figure 6.11 – Alignment of M4 to A4174 Link at Emersons Green**




Note: The schemes in this diagram are conceptual and defined for appraisal purposes.

6.70 Table 6.9 shows the main effects of the possible new M4 to A4174 Link. The scheme provides a more direct route for traffic to and from Emersons Green and other areas to the east of Bristol, reducing the average trip length by 0.5%. There is an associated reduction in congestion on alternative routes, leading to a fall in total vehicle delay across the study area of 1.5%.

**Table 6.9 – Key Impacts of M4 to A4174 Link at Emersons Green**

| Measure | Impact |
|---|---|
| Vehicle Trips | 0.1% increase |
| Vehicle Kilometres | 0.4% reduction |
| Total Vehicle Delay on highway network (hours) | 1.5% reduction |
| Average Vehicle Speed (Highway) | 0.6% increase |
| Mean Journey Length | 0.5% reduction |

6.71 Figures 6.12 and 6.13 show the impact of the scheme on highway flows and capacity utilisation. Figure 6.12 shows that the scheme provides some relief for M4 J19, although much of the released capacity is taken up by traffic making other movements, leading to an increase in flow on the M4 between J20 and J19.

6.72 There is also a substantial increase in flow on the north-eastern sections of the A4174 Avon Ring Road, and a corresponding reduction on the M4 between J19 and J18A as vehicles use the new junction when travelling to and from the east. This exacerbates capacity problems on the A4174. Furthermore, significant levels of additional traffic on the M4 to the east of the new junction pushes this section of the motorway (J18A-J18 eastbound) above the 85% capacity threshold (see Figure 6.13).

**Figure 6.12 – Difference in Flow as a Result of M4 to A4174 Link at Emersons Green**

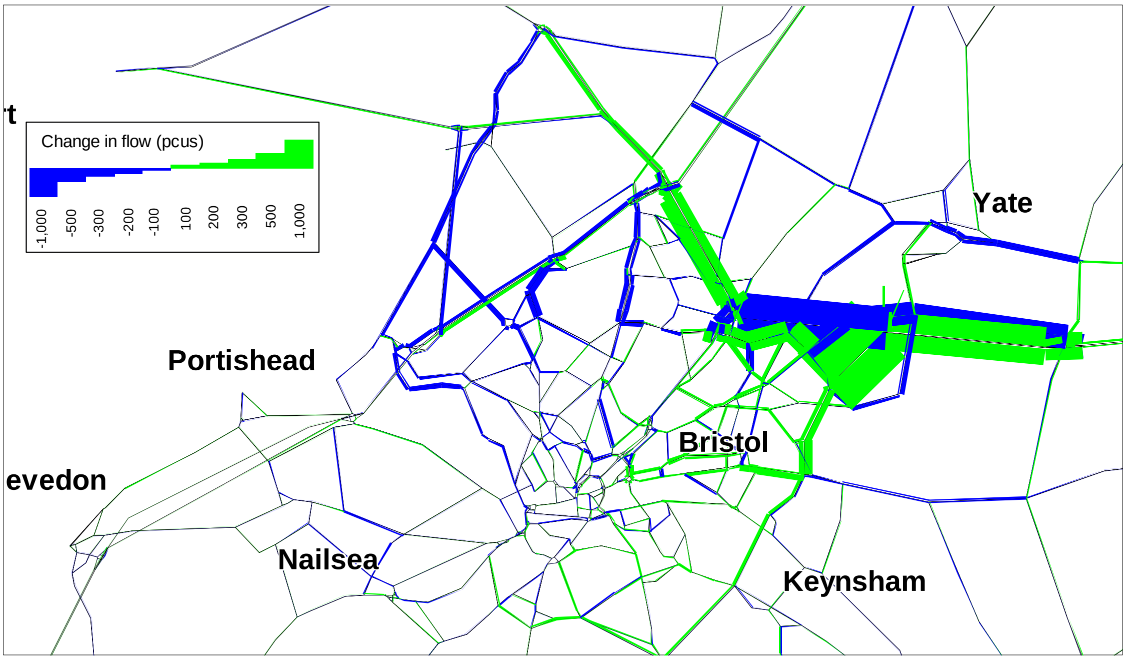
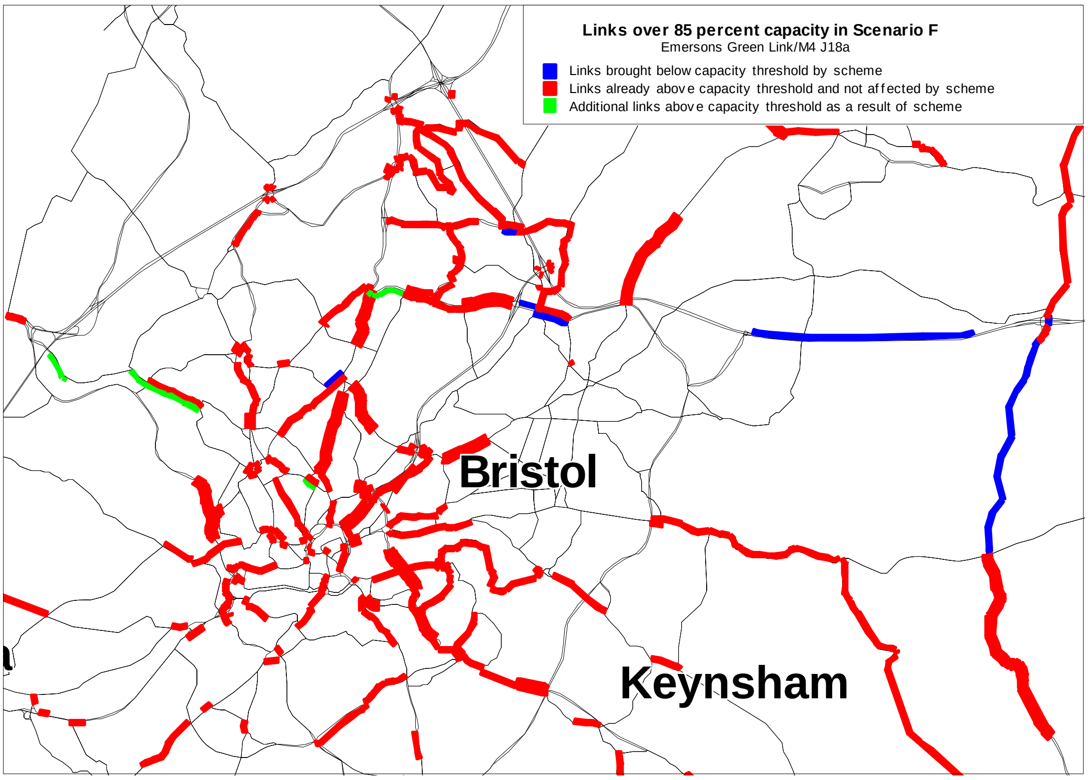


**Figure 6.13 – Difference in Capacity Utilisation as a Result of M4 to A4174 Link at Emersons Green**




6.73 Table 6.10 shows the significant journey time savings for trips from the east to Emersons Green – for example the journey time from Swindon is reduced by 7 minutes. However, there is little benefit for trips from the study area to Emersons Green or for trips from the east to central Bristol. Journeys between the North Fringe and Emersons Green take longer as a result of the scheme because of increased congestion on the A4174 ARR.

**Table 6.10 – Key Journey Times for M4 to A4174 Link at Emersons Green**

| Route | No scheme | M4 J18A and Emersons Green Link |
|---|---|---|
| Swindon to Emersons Green | 39 | 32 |
| Patchway to Emersons Green | 24 | 26 |
| Swindon to Bristol City Centre | 58 | 57 |
| Yate to Emersons Green | 13 | 13 |
| Bath to Emersons Green | 21 | 21 |

6.74 Almost all trips using the M4 to A4174 Link are travelling between the study area and the hinterland and external areas (see Table 6.11), because the scheme creates a new route into and out of the Bristol urban area from the east.

### Table 6.11 – Select Link Analysis for M4 to A4174 Link at Emersons Green

| | Emersons Green Link |
|---|---|
| ***Northeast-bound*** | |
| Total Flow (pcus) | 1491 |
| % Within Study Area | 1% |
| % Study Area to Hinterland | 40% |
| % External | 60% |
| ***Southwest-bound*** | |
| Total Flow (pcus) | 1231 |
| % Within Study Area | 0% |
| % Study Area to Hinterland | 30% |
| % External | 70% |

6.75 Table 6.12 summarises the economic performance of the M4 to A4174 Link. The overall economic performance is strong, with an NPV of £274 million and BCR of 12. The time savings are mainly derived from a large number of long distance trips saving typically 3 to 5 minutes on their journey by taking advantage of the quicker, more direct route between the A4174 and M4. Over 80% of the time savings accrue to trips starting or ending beyond the study area.

### Table 6.12 – Economic Performance of M4 to A4174 Link at Emersons Green

| | M4 to A4174 Link at Emersons Green |
|---|---|
| **Cost (2005,Q1) £mill, inc Optimism Bias** | £41.9 |
| **Cost (2005,Q1) £mill, excl Optimism Bias** | £28.8 |
| **PVC (£ mill, 2002 prices & values)** | £25.0 |
| **PVB (£ mill, 2002 prices & values)** | £299.4 |
| **NPV (£ mill, 2002 prices & values)** | £274.4 |
| **BCR** | 12.0 |

6.76 Although the new M4 to A4174 Link road scheme has a strong economic case, mainly derived from travel time savings for journeys from outside the study area, it is not being recommended by the study. The new link would alter flow patterns in the congested area between M4 J20 and M4 J19, M32 J1 and the northern stretch of the A4174 Avon Ring Road, putting additional strain on the A4174 and causing congestion problems on the M4 to the east of the new junction with the strong likelihood that the widening of the M4 between Junctions 18A and 18 would be necessary. The improved linkage to the M4 is likely to encourage long-distance commuting to and from developments in Emersons Green and Pucklechurch, which would go against the principles of sustainable development.

### M5 Junction 21

6.77 M5 Junction 21 currently experiences significant delays on the approaches from the A370 from the west (especially in the morning peak period) and also on the southbound exit slip road from the motorway (particularly in the evening peak period). A major influence on the level and location of the congestion is the conflict between traffic wishing to access/egress the motorway and through traffic travelling across the motorway on the A370 between Weston-super-Mare, Congresbury and south Bristol.

6.78 A major factor behind the congestion is the high level of out-commuting from Weston-super-Mare due to the imbalance between housing and employment in the town following the significant increases in the housing stock in recent years. The Weston Vision aims to resolve the imbalance through an employment-led strategy to develop Weston-super-Mare and to bring forward other developments. This is reflected in the emerging Area Development Framework which is being given development plan status through an Area Action Plan. It will be vital that the imbalance between housing and employment is corrected if further increases in out-commuting are to be avoided with consequent additional pressures at Junction 21.

6.79 The study has explored a wide variety of measures designed to improve the operation of the junction, in parallel with the significant increase in development in the Weston-super-Mare area. The initial analysis highlighted that the most effective schemes were ones that aimed to split the movements at the junction between the traffic wishing to access the motorway and the traffic seeking to cross the motorway on the A370. Measures designed to improve the operation of the junction without splitting the two movements resulted in significant continued congestion on the A370 distributor road to the west of M5 Junction 21 and did not resolve the underlying problem. These included additional flyover lanes and other improvements to M5 Junction 21.

6.80 The two alternatives which provided the most effective solutions to the problems were:

- the preferred alternative comprising the closure of the current Junction 21 and the construction of a new junction to the south near Woolvers Hill, with connections to the A370 at West Wick; or
- the construction of a new Junction 21A with the A371 together with the closure of the south-facing slip roads at the current Junction 21.

6.81 Both of the schemes performed well, producing high levels of benefits with reductions to journey times and reduced flows on the A370 Primary Distributor Road (PDR) to the west of the M5.

6.82 The separate work on the Weston Vision identified a third option involving the retention of the existing motorway junction and the construction of a new crossing over the motorway to the south of the junction and linking into the A370 to the east of the junction. The operation of this scheme will need to be included in the detailed assessment of the alternatives although there is the potential for it to encourage routeings which will not resolve the problems at the junction.

6.83 The key impacts of the preferred scheme to relocate the junction are given in Table 6.13.

**Table 6.13 – Key Impacts of M5 J21 Relocation (average morning peak hour)**

| Measure | Impact |
|---|---|
| Vehicle Trips | impact not significant |
| Vehicle Kilometres | 0.4% increase |
| Total Vehicle Delay on highway network | 1% reduction |
| Average Vehicle Speed (Highway) | 0.7% increase |
| Mean Highway Journey Length | 0.3% increase |

6.84 The scheme has a significant impact on congestion in the vicinity of the motorway junction, reducing total vehicle delay across the study area by around 1%. The changes to the road network result in some trips taking longer routes, producing a slight increase in the mean journey length.

6.85 Figures 6.14 and 6.15 show the effect of relocating Junction 21 on the highway network, in terms of vehicle flow and capacity utilisation.

**Figure 6.14 – Difference in Flow as Result of Relocating M5 J21 (average morning peak hour)**

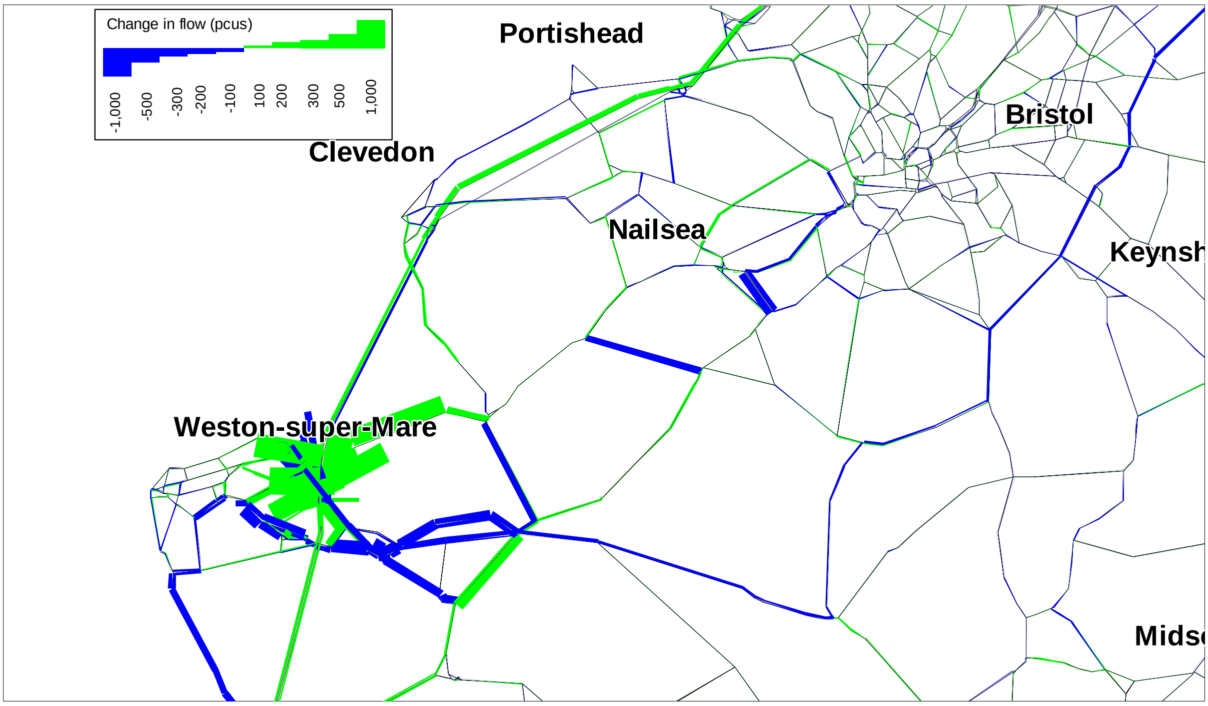
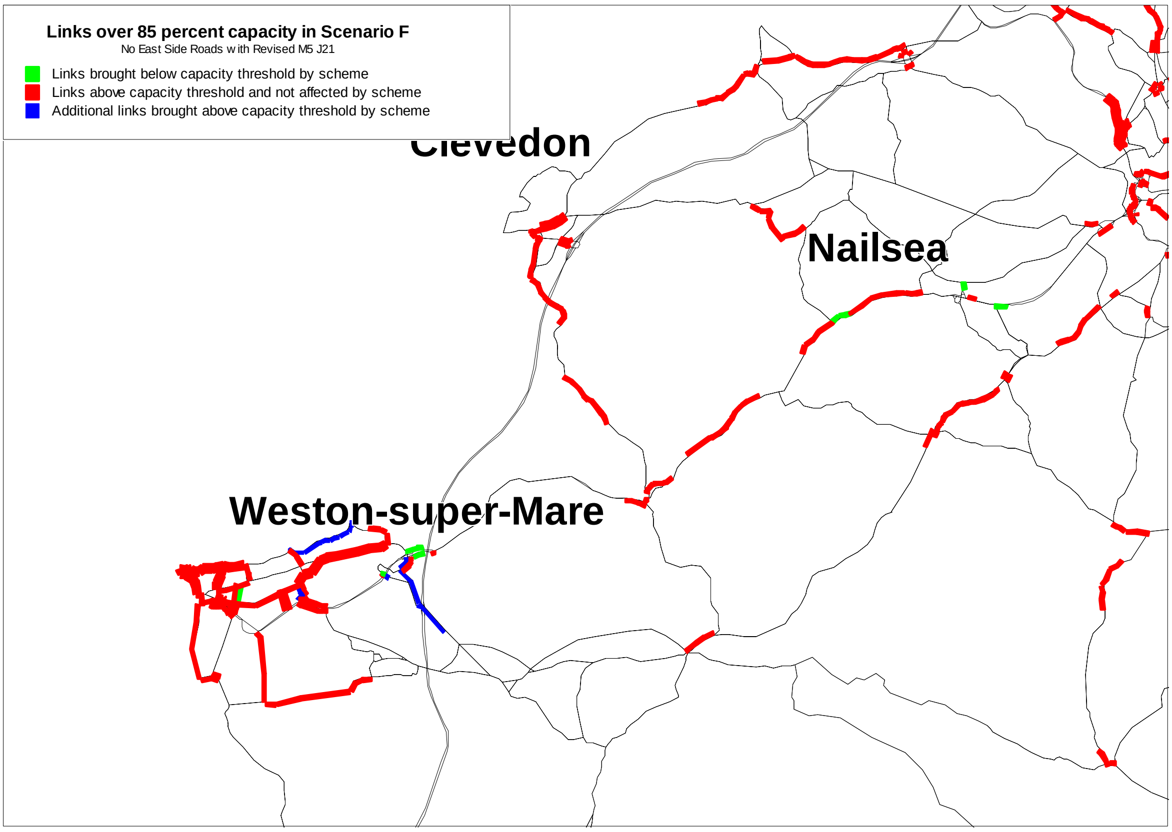


**Figure 6.15 – Difference in Capacity Utilisation as a Result of Relocating M5 J21 (average morning peak hour)**




6.86 Figure 6.15 shows that there is reduced congestion on the A370 PDR in Weston-super-Mare on the approach to the old J21 which brings all links in the immediate vicinity of the old junction below the 85% capacity utilisation threshold. Conversely, increases in flow on the Wolvershill Road and at the West Wick roundabout push some links in this area above the 85% capacity threshold.

6.87 Table 6.14 shows that relocating the junction reduces journey times to and from Weston-super-Mare. Hence, the scheme produces good journey time savings between Weston-super-Mare and central Bristol.

**Table 6.14 – Impact of M5 J21 Relocation on Journey Times (average morning peak period, in minutes)**

| Route | No Relocation | M5 J21 Relocation |
|---|---|---|
| Weston-super-Mare to Bristol City Centre | 66 | 64 |
| Weston-super-Mare to BIA | 37 | 35 |
| BIA to Weston-super-Mare | 41 | 40 |

6.88 Table 6.15 presents the main characteristics of the scheme's economic appraisal. This shows that the benefits associated with the relocated junction option outweigh the costs, resulting in an NPV of over £150 million and BCR of 3.2.

**Table 6.15 – Economic Performance of M5 J21 Relocation**

| | M5 J21 Relocation |
|---|---|
| Cost (2005,Q1 prices) £mill, inc Optimism Bias | £80 |
| Cost (2005,Q1 prices) £mill, excl Optimism Bias | £55 |
| PVC (£ mill, 2002 prices & values) | £70 |
| PVB (£ mill, 2002 prices & values) | £221 |
| NPV (£ mill, 2002 prices & values) | £151 |
| BCR | 3.2 |

6.89 Improvements at M5 J21 are essential to solve problems with the operation of the M5 motorway in this area, which will only be exacerbated with the additional development planned for Weston-super-Mare. As part of the new developments, it will be vital to resolve the current imbalance between housing and employment in Weston-super-Mare and hence cut the current levels of out-commuting. The junction relocation option would separate traffic crossing the motorway from that accessing it, which would resolve conflicts and hence reduce delays. The scheme is therefore included in the GBSTS strategy.

### Saltford Bypass

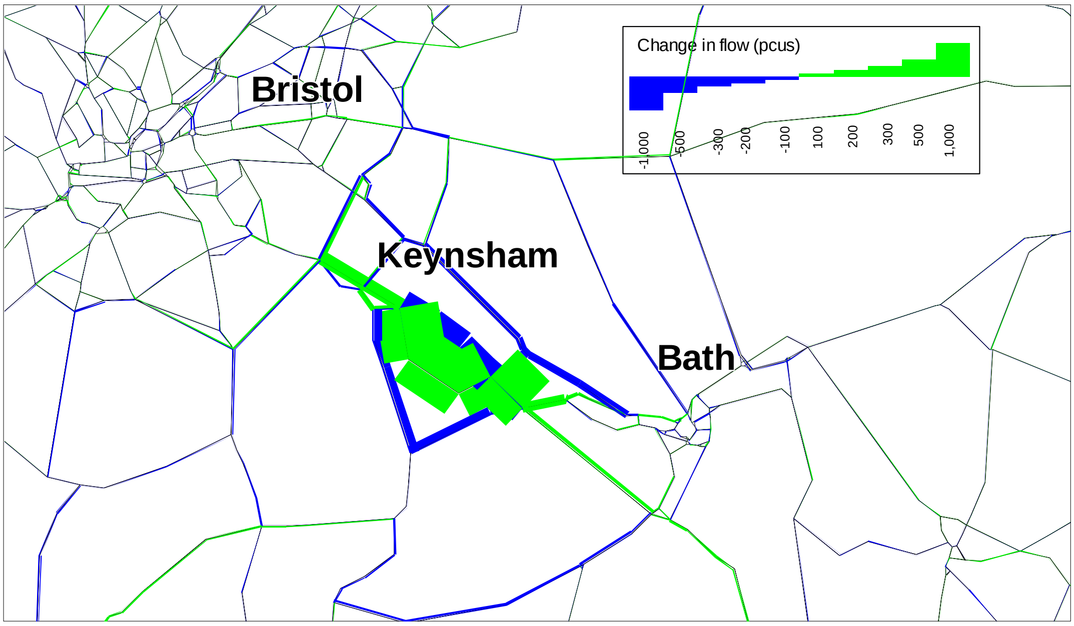
6.90 The scheme carries reasonable hourly traffic flows of 1100 pcus to the south-east and 700 to the north-west which, in the peak periods, would justify a single carriageway road. As shown in Figures 6.16 and 6.17, there would be relief to Saltford village with flows falling to 300 pcus per hour in each direction through the village, and modest travel time savings of 1-2 minutes for trips between Keynsham and Bath. The overwhelming majority of the traffic using the scheme is local, with around 90% of trips travelling wholly within the study area.

6.91 However, the scheme would have high construction costs due to the difficult terrain, and it does not produce an effective economic performance. Furthermore, as shown by Figures 6.16 and 6.17, the impact of the scheme on the highway network is of a local rather than strategic nature.

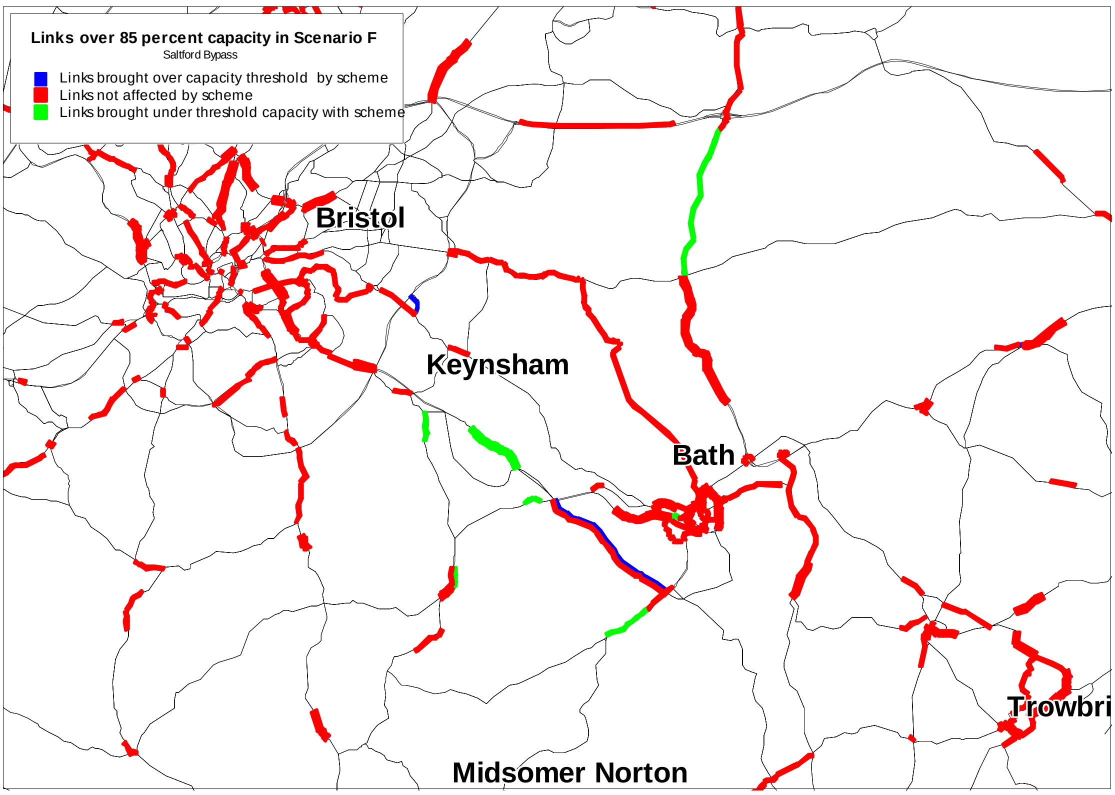
6.92 The scheme produces a net reduction in average journey costs, generating user benefits of £90 million (PVB). However, the high cost of the scheme (PVC = £72 million) means that the resulting NPV and BCR are moderate, at £17 million and 1.2 respectively. Time savings represent about 95% of the benefits and these savings are predominantly experienced by trips between areas to the south/east of Bristol and Bath. Bypassing the congested area in Saltford provides average savings of between 5 and 6 minutes for these trips. However, the release of the capacity constraint in Saltford creates additional traffic in Bath producing some further congestion and hence net disbenefits in this area.

6.93 Thus, although the scheme produces some local relief, it does not provide strategic benefits and hence is not taken forward to the GBSTS strategy.

## Figure 6.16 – Difference in Flow as a Result of Implementing the Saltford Bypass




## Figure 6.17 – Difference in Capacity Utilisation as a Result of Implementing the Saltford Bypass



### Whitchurch Bypass and Callington Road Link

6.94 The two schemes were tested in combination, although much of the impacts are local in nature. Figures 6.18 and 6.19 summarise the changes in traffic flows and capacity utilisation in the local network as a result of the schemes.

6.95 Both schemes provide some additional capacity and carry more than 800 pcus per hour in the morning peak in the dominant northbound direction. The Callington Road link provides some relief to the A37 but less relief to the more heavily congested A4 which is probably due to the longer routeing and the difficulty in negotiating the junctions to gain access to the new link from the A4. The majority of the traffic is local, with over 86% having both its origin and destination in the study area.

6.96 The impact of the Whitchurch bypass is very localised with traffic switching from the existing A37 through the village. Congestion remains at other locations along the A37 to the south, including through Pensford. There is some use of the road by non-local traffic with 25% of trips having either its origin or destination outside the study area.

6.97 Both schemes would provide additional capacity in relatively congested parts of south Bristol. The Callington Road link would provide some congestion relief, particularly to the A37, but in overall terms, the impact of the scheme is moderate.

**Figure 6.18 – Difference in Flow as a Result of Implementing the Callington Road Link and Whitchurch Bypass**

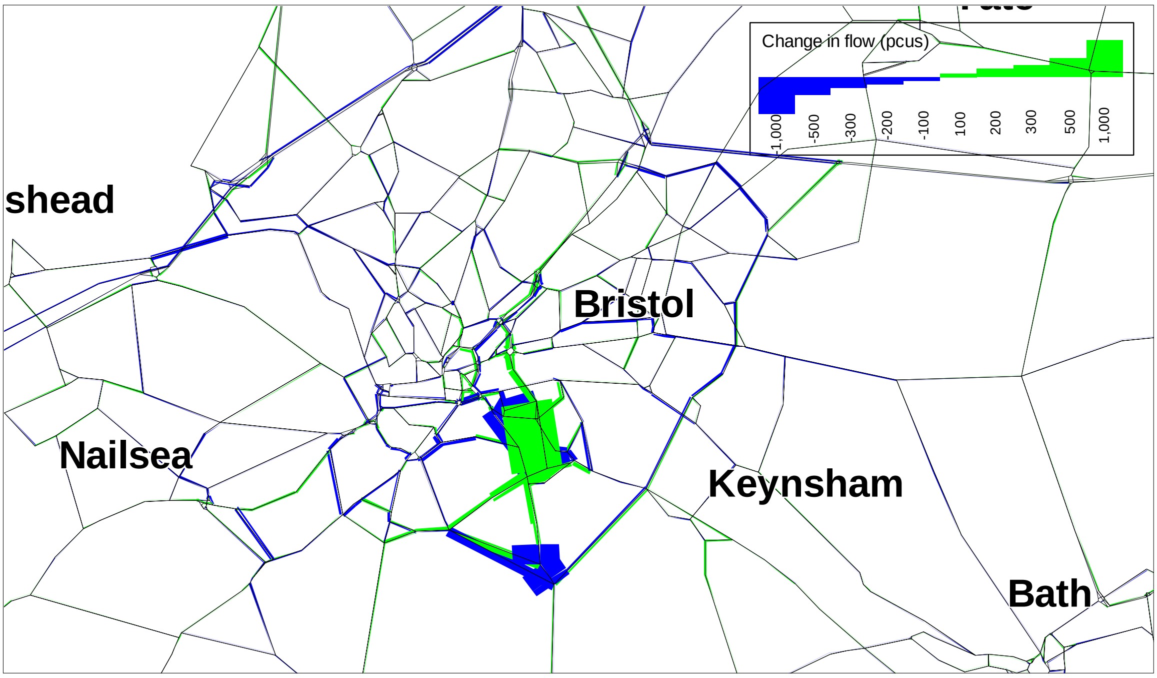
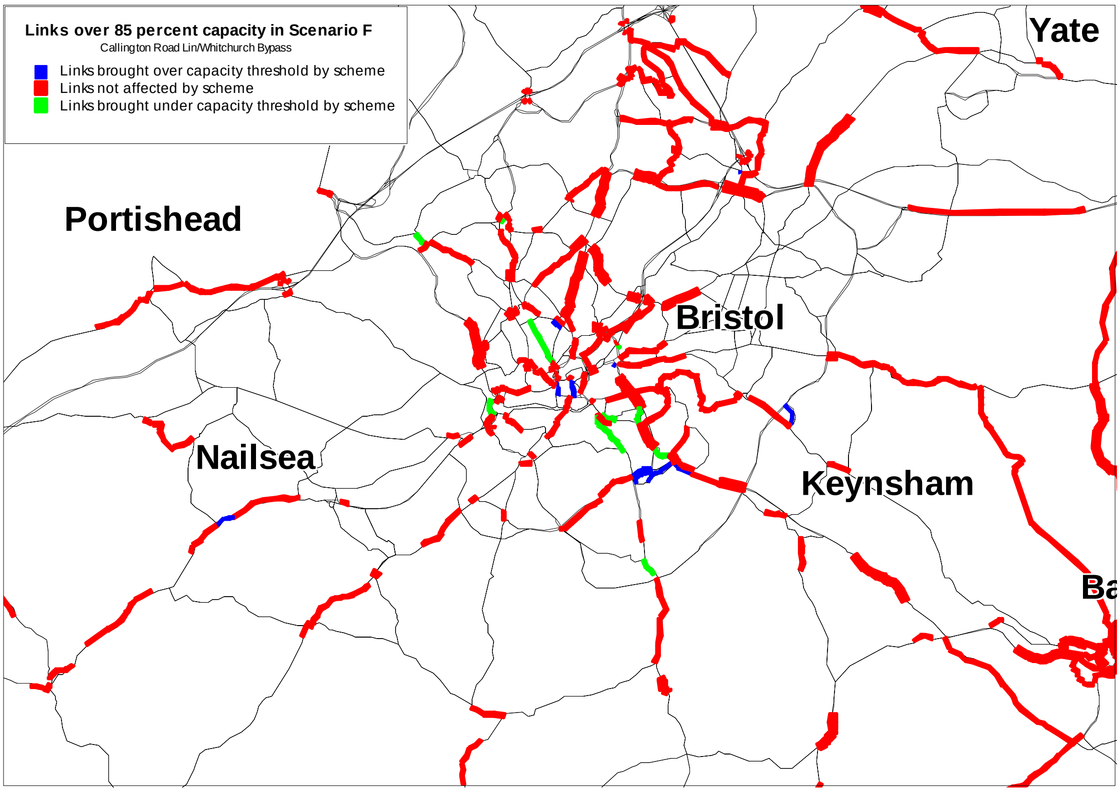


**Figure 6.19 – Difference in Capacity Utilisation as a Result of Implementing the Callington Road Link and Whitchurch Bypass**




6.98 The impact of the Whitchurch bypass is localised, simply allowing traffic to switch to the new route rather than travel through Whitchurch. The benefits are diminished by the serious problems that remain on other sections of the A37, particularly further south at Pensford. Nevertheless, it may be possible to incorporate a scheme that would provide a bypass of Whitchurch in the detailed design of the South Bristol Ring Road.

### Clutton/Temple Cloud Bypass

6.99 The two neighbouring villages on the A37 are bypassed by the scheme which provides local relief although there is little strategic impact as shown by Figures 6.20 and 6.21. The peak traffic levels on the new road are around 800 pcus per hour in each direction. There is limited relief to other roads in the area and no impact on other strategic routes or on the overall network. Since the scheme is near the edge of the study area, the majority of the traffic has its origin and/or destination outside the study area.

6.100 The schemes provide local benefits but have little strategic impact and hence are not included in the GBSTS strategy.

**Figure 6.20 – Difference in Flow as a Result of Implementing the Temple Cloud/Clutton Bypass**

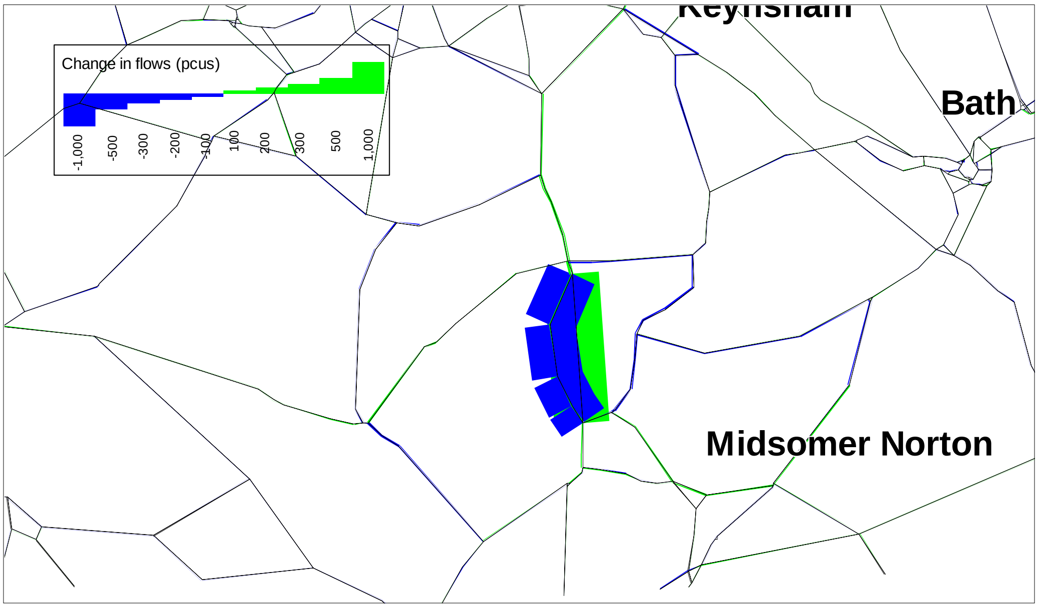
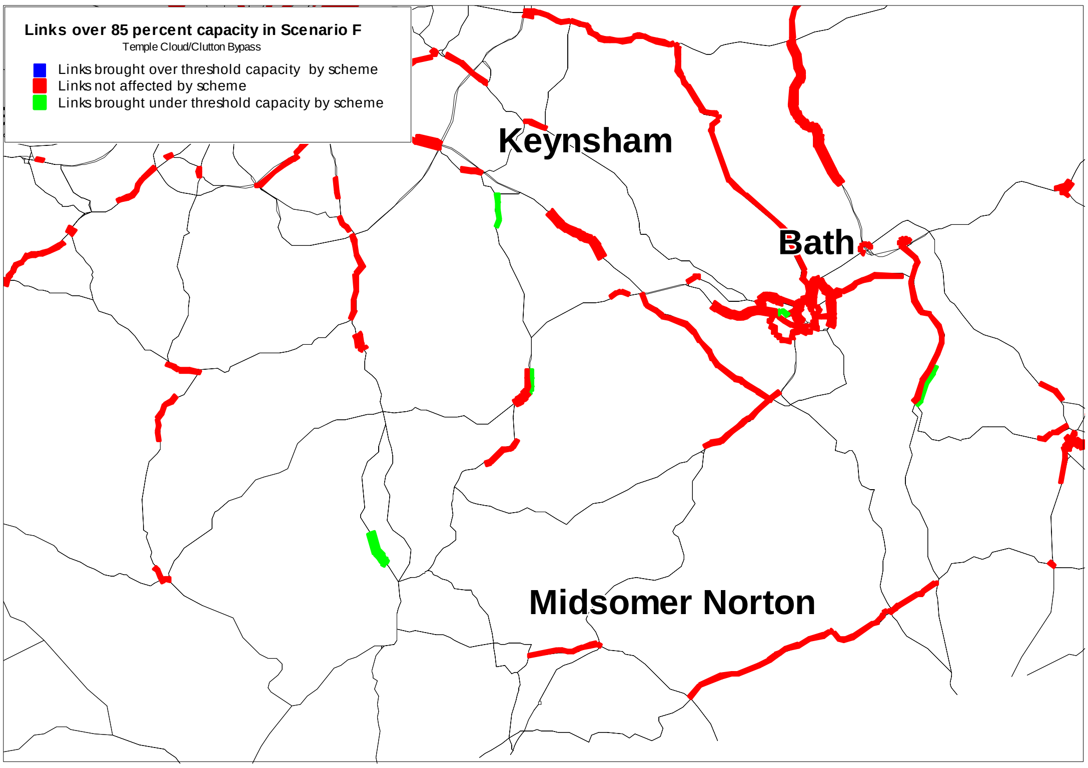



**Figure 6.21 – Difference in Capacity Utilisation as a Result of Implementing the Temple Cloud/Clutton Bypass**



### Banwell, Churchill and Sandford Bypasses

6.101 The three adjacent communities of Banwell, Sandford and Churchill experience significant levels of local congestion, due to the volumes of through traffic associated particularly with Weston-super-Mare, BIA and the Mendip Hills:

- Banwell – on the A371 with particular constraints within the centre of the village (especially in relation to goods vehicles) due to a very narrow section of road;
- Sandford – general traffic volumes on the A368; and
- Churchill – at the junction of the A368 and A38, the latter being a major route to BIA and south Bristol from M5 Junction 22 and the South West.

6.102 A linked series of bypasses was examined to establish the impact on traffic flows through the villages. Such bypasses would increase the length of journeys and hence forms of traffic calming within the villages were included in the schemes to ensure that traffic was deterred from continuing to travel through the villages. Figures 6.22 and 6.23 present the changes in traffic flows in the morning peak hour and the associated impact on the capacity utilisation of the local highway network.

6.103 The bypass carries hourly flows in the morning peak of around 800 pcus eastbound and 400 pcus westbound. There are variations in the characteristics of the traffic between the two directions. For the eastbound flow, less than a quarter (22%) of the traffic has both origin and destination in the study area, with 40% travelling between Somerset and the study area. In the westbound direction, there is a much higher level of local traffic, with around two-thirds (65%) having both origin and destination in the study area; this probably reflects the proximity to Weston-super-Mare and its attraction as a destination for work trips.

6.104 The overall economic performance of the scheme is poor, with the net user benefits produced by the scheme being small in scale (PVB of £40 million) and therefore not sufficiently large to offset the scheme costs (PVC of £42 million) resulting in a negative NPV of £2 million and a BCR of 0.96. The time savings experienced by drivers using the new road are limited because the road adds to travel distance, offsetting some of the improvements in average speed.

6.105 The introduction of the bypass has little impact on traffic movements apart from the relief of the three communities; Figure 6.22 highlights that there are negligible changes in traffic flows away from the communities. Hence, the scheme is considered to have a local rather than strategic importance and is not included in the GBSTS strategy.