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1. Introduction

1.1. Joint Spatial Plan and Joint Transport Study

The West of England authorities (Bath & North East Somerset Council, Bristol City Council, North Somerset Council and South Gloucestershire Council), supported by the West of England Partnership office, are in the process of preparing a Joint Spatial Plan (JSP) and Joint Transport Study (JTS). The Plan area covers the whole of the West of England, including Bath & North East Somerset, Bristol, North Somerset and South Gloucestershire.

The purpose of the JSP is to consider the long-term development needs in the West of England to 2036 and identify strategic locations for growth. This includes identifying overall requirements for housing and employment land, the most appropriate locations for housing and employment (the ‘strategic locations’), and transport and other infrastructure to support the planned growth. The JSP considers growth up to 2036 which is in addition to that planned for up to 2026 in the Local Plans for the authorities.

The purpose of the JTS is to provide a clear direction for the long-term development of the transport system in the West of England to 2036 and beyond. This will follow on from the current Joint Local Transport Plan (JLTP) which sets investment priorities to 2026. The JTS will also inform, and be informed by, the JSP and it has therefore facilitated work to inform the JSP process. The JTS has provided evidence on current and future transport issues to inform the assessment of potential strategic locations for future development.

This report focuses on the assessment of development suggested in the Emerging Spatial Strategy. It assumes that current Local Plans will have been implemented, with development incorporated into committed housing and employment growth to 2026. Background traffic growth has then been applied to generate a 2036 Base Test. The Emerging Spatial Strategy has then been compared against the 2036 Base Test to identify critical transport requirements to support the Emerging Spatial Strategy.

1.2. Purpose of this Report

This report discusses the transport issues associated with the Emerging Spatial Strategy and the mitigation that will be required. This report does not represent the level of detail required for Local Plans or Transport Assessment at Development Management stage.

The assessment has focused on strategic transport issues and impacts of the growth suggested in the Emerging Spatial Strategy. It focuses on addressing travel choice issues and strategic network impacts. It does not include other aspects of mitigation such as road safety and local walking and cycling schemes. Local impacts would also need to be addressed if areas are considered further.

This report should be considered alongside other evidence used to support the preparation of the JSP. It should also be considered alongside Towards the Emerging Spatial Strategy, which is available at the consultation website at https://www.jointplanningwofe.org.uk/consult ti.

The remainder of this report is structured as follows:

- Chapter 2 describes the Emerging Spatial Strategy developed by the JSP workstream, which is assessed in this report;
- Chapter 3 sets out the principles for developing a mitigation package designed to maximise the transport sustainability of the development options and mitigate the impacts of additional traffic on the network;
- Chapter 4 presents the assessment of the Emerging Spatial Strategy and describes the mitigation package;
- Chapter 5 provides a commentary on the impacts of the Emerging Spatial Strategy on the transport network and the estimated cost of the mitigation package; and
Chapter 6 sets out the conclusions from this work.

This report is supported by three appendices, which report the testing of different combinations of strategic locations:

- Appendix A explains the different stages of model testing used to inform the assessment of strategic locations and to inform the development of the Emerging Spatial Strategy; and

- Appendices B and C present the results from testing of the strategic locations in the two previous stages of testing that were used to inform the development of the Emerging Spatial Strategy.
2. Emerging Spatial Strategy

2.1. Introduction
This chapter describes the Emerging Spatial Strategy developed by the JSP workstream. Figure 2-1 shows the indicative locations for development suggested in the Emerging Spatial Strategy, together with a table showing indicative numbers of dwellings and employment land that were assumed for the purposes of transport model testing.

2.2. Strategic Locations
In South Gloucestershire, there would be a focus of development at settlements to the north of the M4 at Yate, Coalpit Heath, Charfield, Thornbury and the Buckover Garden Village to the east of Thornbury. In North Somerset, development would be focused on the A38/A368 corridor (Banwell and Churchill) and A370 corridor (Nailsea and Backwell). In Bath & North East Somerset, development would be focused to the south east of Bristol at Whitchurch and Keynsham.

2.3. Urban Living
The Emerging Spatial Strategy has assumed a total 14,600 dwellings for urban living. This would comprise 12,000 in Bristol, 1,300 in the Bristol Urban Fringe (North and East), 1,000 in Weston-super-Mare and 300 dwellings in Bath. At present there is limited information about the locations for urban living within these areas.

Urban living should, in general, benefit from the wider range of travel choices available in the urban areas. However, there could be significant impacts on congestion if action is not taken to minimise car use and encourage alternative travel choices as part of the mitigation packages. The preferable approach to urban living would be for high-intensity development to be located in places with good access by public transport, walking and cycling to jobs and local services. There could be opportunities for promoting largely car-free development to support high quality placemaking and encourage sustainable travel choices.
The numbers shown in this table are for the purposes of transport modelling only: they are not intended to be indicative of potential development capacities at these locations. The employment figures shown above are in hectares and assume that land areas would be 60% occupied by buildings.
3. **Approach to Mitigation**

### 3.1 Introduction

This chapter sets out the approach used to assess the impacts and develop the mitigation package for the Emerging Spatial Strategy. This represents a strategic assessment; it does not consider the level of detail required for Local Plans or Transport Assessment at the Development Management stage.

The approach is based on mitigating the transport impacts of the Emerging Spatial Strategy. It does not seek to address the current problems on the network, nor those that will emerge with current planned growth to 2026, which are addressed by the Transport Vision developed by the JTS. However, elements of the JTS Transport Vision are included where these are the most appropriate solutions to mitigating the impacts of additional development to 2036.

### 3.2 General Principles

There are two key components in addressing the transport issues associated with the Emerging Spatial Strategy:

- First, maximise the effectiveness of sustainable travel choices and encourage greater use of rail, MetroBus, Park & Ride, bus, cycling and walking. This aims to minimise car based travel to/from the development areas; and

- Then, mitigate the remaining impacts of additional traffic, including investigation of junction capacity improvements, upgrades, new highway connections and traffic restrictions.

Urban living will require a different, but complementary, approach. There are limited opportunities for significant highway capacity improvements in the Bristol urban area. The overall approach is therefore to reduce traffic to create the right conditions to support urban growth, intercepting traffic on radial routes into Bristol, Bath and Weston-super-Mare with Park & Ride, enabling roadspace to be restructured to support active travel and public transport.

### 3.3 Sustainable Travel Choices

The first principle for mitigation is to maximise sustainable travel choices through rail, MetroBus, Park & Ride, bus, cycling, and walking:

- Walking and cycling must take a central role for local trips – links to surrounding walking and cycling networks are assumed;

- Conventional bus services will be an important part of promoting sustainable travel on several corridors;

- MetroBus rapid transit services will be central to delivering mode shift at several locations, with a number of areas being beyond walking/cycling distance from key destinations;

- Park & Ride will help to intercept vehicles on the edge of the urban areas, which will reduce traffic in the urban areas and improve conditions for walking, cycling and public transport; and

- Rail will play an important role for access to urban centres, but improvements will be needed, including access to stations, new station(s), improved parking facilities, station environment and platforms.

There is a need to maximise the effectiveness of non-car modes for both urban living and new development outside existing urban areas.
3.4. Mitigation of Traffic Impacts
Highway improvements are needed to mitigate the remaining traffic impacts after maximising sustainable travel choices. Highway improvements should incorporate multi-modal infrastructure where possible, for example, creation or extension of MetroBus corridors.

In some cases, development options could result in increases in traffic on the motorway network (especially on the M5 between Weston-super-Mare and the North Fringe). In these cases, it will be necessary to include measures to minimise traffic impacts. This will include improvements to the local road network, to provide an attractive alternative to the motorway for local trips, and improvements to the motorway network itself.

3.5. Delivery Risks
In many cases, significant interventions will be required to deliver effective mitigation for the development that is proposed. There will be a number of challenges in delivering these interventions, including overcoming engineering constraints, providing sufficient roadspace for active modes and MetroBus rapid transit on congested urban corridors, and securing funding from different sources.

In some cases, there are significant underlying issues relating to the scale of development already proposed to 2026 and there are potential challenges in delivering transport infrastructure to mitigate this development. In some cases this could pose a risk to the ability to support further growth in these areas. These issues are highlighted, as appropriate, for each location in Chapter 5.
4. Impacts and Mitigation

4.1. Introduction
This chapter assesses the impacts of the Emerging Spatial Strategy on the transport network. The mitigation package has been developed to address the incremental impact of the additional development on the network. This chapter presents:

- The routings of traffic generated by the new housing and attracted by new employment in the morning peak period;
- A summary of impacts on the road network – locations with significant increases in delays to traffic; and
- The proposed transport mitigation package.

The overall network impacts of the Emerging Spatial Strategy and the estimated cost of the mitigation package are then discussed in the following chapter.

4.2. Traffic Routing and Impacts
The routings of the traffic generated by the Emerging Spatial Strategy in the morning peak hour – before mitigation – are shown in Figure 4-1. The widths of the coloured lines on the map are proportionate to the volumes of traffic generated by the strategic locations. Each colour represents a strategic location tested.

There are significant numbers of trips on key routes, for example the A370 and A371 (Weston-super-Mare), A38, B3130 (Clevedon-Nailsea-A370), A37, A39, A362, B3116 (Keynsham), A4 (East), A432 and B4058 (Winterbourne). There are high numbers of trips forecast along the A38 and A370 corridors to the south west of Bristol, A37, A39 and A4 to the south east of Bristol and the A432 and A38 to the north of Bristol.

Traffic from Nailsea and Backwell is forecast to use the M5 (via Junction 20 and Junction 19) to access Weston-super-Mare and the North Fringe. Traffic from Banwell and Churchill would use the A371, crossing the M5, to access Weston-super-Mare and the A368 and A38 to the east to access Bristol. Traffic from Whitchurch and Keynsham would use a number of routes to access key destinations, including radial routes into Bristol and routes around the south of the city. Traffic from Yate and Coalpit Heath is forecast to use the A432 and B4058 towards the North Fringe, and traffic from Thornbury and Buckover Garden Village is forecast to use the A38 towards the North Fringe. Traffic from Charfield is forecast to use the M5 (via Junction 14) and the B4058 towards Iron Acton and the North Fringe.

High volumes of traffic, and associated congestion on key corridors, are forecast to cause traffic to use secondary routes, for example Old Gloucester Road and Church Road (north of the M4 in South Gloucestershire). This is likely to impact on the quality of life for the settlements along these routes. It can also be seen that development traffic would use rural roads in parts of North Somerset and Bath & North East Somerset, including routes through the Chew Valley.

The impacts on the network resulting from this additional traffic are shown in Figure 4.2.
Figure 4-1  Emerging Spatial Strategy: Routings of Traffic Generated by New Development – Without Mitigation

© OpenStreetMap contributors, CC-BY-SA
Figure 4-2   Emerging Spatial Strategy: Impacts on Road Network – Without Mitigation

Key:
- Strategic Location
- Employment Location
- Urban Living
- Locations with significant additional delays
- Corridors impacted
Figure 4-2 shows increased delays on key corridors from the strategic locations. There are also delays on secondary corridors, some of which are caused by traffic taking more circuitous routes due to increased delays on the strategic and primary network.

On the M5 motorway, Junctions 14, 16, 19, 20 and 21 would be impacted, as well as on the Avonmouth Bridge. Many of these junctions are currently operating at capacity with queuing back onto the motorway observed at peak times.

In North Somerset, there would be increased delays in the Nailsea area, the B3130 through Tickenham, on the A370 (in particular at the Backwell signals) and on the A38 at Langford, Bristol Airport and Downside Road / West Lane. Due to the scale of development at Banwell and Churchill, it is assumed that a new distributor road will be required to provide access to the strategic locations, which would also act as a bypass to Banwell and Churchill. The scale of impact on the A371 / A368 corridor will therefore depend on the configuration of this distributor road. Failure to provide significant connectivity improvements to provide access to these strategic locations would cause significant problems on the A371 / A368 corridor.

In Bath & North East Somerset, some increases in delay are forecast on the A37 in Pensford and Whitchurch to the south of Bristol, on key routes in Keynsham (A4 and B3116) and A39 south of Keynsham and Bath.

In South Gloucestershire there would be increases in delay at M5 Junction 14, the B4058 and A432 in the Yate, Westerleigh and Winterbourne area, A4174 Ring Road and A38 corridor from Thornbury.

In Bristol, the combination of increases in traffic on radial routes, together with a general increase in traffic across the city resulting from urban living, are forecast to cause slight increases in delay across the network.

### 4.3. Mitigation for the Emerging Spatial Strategy

The proposed mitigation package for this scenario is shown in Figure 4-3.
Figure 4-3   Emerging Spatial Strategy: Proposed Transport Mitigation
4.3.1. Sustainable Travel Choices
Links to surrounding walking and cycling networks are assumed for each of the strategic locations. Strategic cycle corridors will encourage sustainable travel on key corridors into the Bristol urban area. The mitigation package also seeks to improve travel choices through expansion of the MetroBus network:

- Weston-super-Mare (Worle area to town centre);
- Nailsea to Bristol;
- Keynsham to Bristol;
- Bristol city centre to East Fringe via A420;
- Yate to Bristol (connecting into North Fringe to Hengrove Package infrastructure); and
- Buckover and Thornbury to Bristol via A38 (connecting into North Fringe to Hengrove infrastructure).

These interventions would be complemented by conventional bus services from the other strategic locations. Park & Ride sites would be served by dedicated conventional bus services, except where a proposed MetroBus service passes the Park & Ride site.

A ring of Park & Ride sites around the Bristol urban area is intended to intercept traffic on radial routes, reducing traffic to create conditions for urban growth and enabling roadspace to be reallocated. This forms a key part of the mitigation for urban living, as well as intercepting trips from the strategic locations outside of the Bristol urban area.

Rail improvements would comprise a relocated Keynsham station, on the basis of the scale of the existing settlement and development in the Emerging Spatial Strategy. A new station is proposed at Charfield on the Birmingham-Bristol mainline to serve both existing communities and new development: subject to further detailed assessment, a new station at Charfield appears to be feasible. However, the other strategic locations are unlikely to justify new railway stations based on expected levels of demand. Longer rolling stock from Weston-super-Mare, Nailsea & Backwell and Yate is proposed in conjunction with longer platforms to cater for increased rail demand.

4.3.2. Highway Improvements
Having maximised opportunities for sustainable travel, highway improvements would also be required:

- Improvements to M5 Junctions 14, 16, 20 and 21;
- A new M5 Junction 21A, together with a bypass for Banwell and Churchill on the A371/A368 corridor, with links into these strategic locations, and upgrades to the A38 corridor, including improvements to address capacity constraints in the vicinity of the Airport;
- A new road link from M5 Junction 20 to the A370 in the Nailsea and Backwell area;
- Winterbourne and Frampton Cotterell Bypass;
- Callington Road Link (connecting from A4320 St Philips Causeway to A4174 Callington Road);
- A new highway link from the A4 at Hicks Gate roundabout to the A37;
- Avon Mill Lane-A4 link in Keynsham;
- A new distributor road, at Whitchurch (to the east of the A37), providing access into the area, but which would also provide traffic relief for Whitchurch village; and
• A package of junction improvements on key corridors between the strategic locations and key destinations, for example the A38, A432 and A370.
5. **Commentary**

5.1. **Introduction**

This chapter discusses the estimated costs of mitigation and the impacts of the Emerging Spatial Strategy and the mitigation package, followed by a discussion about each strategic location. The overall objective of the mitigation package is to achieve no overall increase in average journey times across the West of England road network. However, as shown in the analyses that follow, there are different scales of impact across different parts of the West of England.

5.2. **Estimated Costs of Mitigation**

Table 5-1 presents the outturn mitigation costs for the Emerging Spatial Strategy. The total indicative cost for the mitigation package is approximately £1.8 billion.

For testing purposes a typical level of contribution for strategic transport infrastructure of £5,000 per dwelling was assumed, which would be equivalent to a total contribution of approximately £0.2 billion. This level of expected developer contribution per dwelling may itself be challenging to negotiate in many circumstances, given other requirements for affordable housing, starter homes, social and community infrastructure, open space, and onsite and local transport improvements.

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<td>Total Estimated Cost (Outturn Prices)</td>
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<tr>
<td>Potential Contribution from Development (£5,000/dwelling)</td>
<td>£0.2 billion</td>
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<tr>
<td>Balance of Funding Requirement</td>
<td>£1.6 billion</td>
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The package would cost significantly in excess of what is likely to be sourced from developer contributions, and would therefore require complementary funding from a range of other sources.

The proposed mitigation package is substantial, although proportionate to the scale of development impact, and represents a significant major scheme programme to address 10 years of housing growth. At present, the West of England is investing approximately £100 million per annum on capital schemes including MetroBus construction.

5.3. **Network Impacts**

This section considers the impacts of the Emerging Spatial Strategy on overall travel conditions on the road network. It first considers average travel times for journeys in the West of England, for a 2036 scenario but assuming no further development beyond 2026 (the ‘Base Test’). It then presents the changes in average journey times for the Emerging Spatial Strategy, first without mitigation, then including the impacts of the mitigation package.

The changes in average journey times presented reflect two factors:

- The distances between the strategic locations and key attractors (e.g. employment, in particular Bristol city centre and the North Fringe); and
- Congestion – traffic takes longer, more circuitous routes to avoid congestion.
5.3.1. **Performance of Base Test**
The average modelled journey time for trips in the network is forecast to be 23.6 minutes in the 2036 Base Test. This is based on modelled journey times for trips on the highway network in the transport model. This compares with a modelled average journey time of 22.5 minutes in 2016 and is equivalent to a rise of 5%. This takes into account future growth in travel demand but also incorporates the benefits of the planned capital investment programme in MetroBus and MetroWest.

5.3.2. **Emerging Spatial Strategy**
The impacts of the Emerging Spatial Strategy were first tested without any transport mitigation. The Emerging Spatial Strategy is forecast to result in an overall 3.1% increase in average journey times, without mitigation, on the road network across the West of England. This average masks significant differences across the sub-region. Reductions in average travel times are forecast for journeys to/from Bath & North East Somerset due to two factors. First, new development is located close to destinations: the strategic locations at Whitchurch and Keynsham are located close to the Bristol urban area. This results in relatively short journey times to key destinations, which contributes to an overall reduction in journey times. Second, infrastructure to provide access into development at Whitchurch would provide the opportunity to deliver wider benefits to other users of the road network in this area.

Increases in average travel times are forecast in North Somerset. These are due to the relatively long distances from the strategic locations at Nalisea, Backwell, Banwell and Churchill to key destinations including Weston-super-Mare and the Bristol urban area. The long distances would result in relatively long travel times, increasing overall travel times within North Somerset. Journey times are also forecast to increase in South Gloucestershire due to the relatively long travel distances from some strategic locations to key destinations including the North Fringe and Bristol city centre.

With the package of mitigation in place, it is estimated that there would be no overall increase in average journey times on the road network across the West of England compared to the case without development. In the context of the strategic modelling that has been undertaken, this shows that, overall, the package would mitigate the impacts of development. There are, however, likely to be significant localised issues in some areas, for example the A38 and A432 corridors north of Bristol, A38 and A370 corridors south of Bristol and parts of the A39 in Bath & North East Somerset.

5.4. **Commentary on Key Locations**
This section outlines the key transport issues, the mitigation package, and residual challenges for the strategic locations contained in the Emerging Spatial Strategy. It first covers urban living, followed by locations in North Somerset, Bath & North East Somerset and South Gloucestershire.

5.4.1. **Urban Living**
At present, there is limited information about the locations for urban living. The preferable approach would be to locate high-intensity development in places with good access by public transport, walking and cycling to jobs and local services. In the Emerging Spatial Strategy, urban living is planned in the Bristol urban area, Bristol Urban Fringe (South Gloucestershire), Weston-super-Mare and Bath.

For Bristol, and the Bristol Urban Fringe, the overall approach is to reduce traffic to create the right conditions to support urban growth, intercepting traffic on radial routes into Bristol with Park & Ride, enabling roadspace to be restructured to support active travel and public transport.

In Weston-super-Mare, interventions include encouraging mode shift through MetroBus, junction improvements on the A370, and improving the attractiveness of rail services. However, there are challenges due to the high levels of growth already planned to 2026 and challenges in the funding and delivery of the current infrastructure programme. The package to support further growth in Weston-super-Mare is dependent on the delivery of the existing infrastructure programme.

In Bath, due to the low level of proposed urban living, the approach is focused on continued improvements to active travel and the continued incremental improvement of bus services.
5.4.2. Banwell and Churchill

Banwell and Churchill currently have poor travel choices, with high levels of car dependence for travel to Weston-super-Mare and Bristol. They are located on the A371 / A368 connecting Weston-super-Mare to Bristol and suffer from high levels of through traffic. Due to the scale of development at Banwell and Churchill, it is assumed that a new distributor road will be required to provide access to the strategic locations, which would also act as a bypass to Banwell and Churchill.

The scale of impact on the A371 / A368 corridor will therefore depend on the configuration of the distributor road. Failure to provide significant connectivity improvements to access these strategic locations would cause significant problems on the A371 / A368 corridor. This would impact on the villages themselves and at key junctions on the route, including the A368 / A38 junction between Churchill and Langford. A comprehensive infrastructure solution is therefore required to meet the needs of the strategic locations. In addition, forecasts indicate that Junction 21 will be under severe strain. The provision of a new Junction 21A, connecting to the A371 east of Weston-super-Mare, would provide significant relief. An improved strategic route, connecting from Junction 21A to the A38 at Langford, would both bypass the existing communities and provide access into the new areas of development.

Failure to provide this strategic infrastructure would result in major delivery risks for these strategic locations. Piecemeal development in the area will result in further deterioration in traffic and environmental conditions along this corridor. A comprehensive solution, with integration of development and new highway infrastructure, will be required for these strategic locations.

5.4.3. Nailsea and Backwell

Parts of Nailsea are isolated, with poor travel choices in some parts of the town and poor road connectivity. The modelling has forecast high levels of development traffic on the A370 into Bristol, and development traffic using the M5 (via Junctions 19 and 20) to access Weston-super-Mare and the North Fringe. MetroBus is required to provide high quality travel choices to Bristol, although there are likely to be significant challenges in providing the scale of infrastructure needed to enable buses to bypass congestion hotspots and to provide sufficient penetration of the town.

Extension of the platform at Nailsea & Backwell railway station would facilitate provision of longer rolling stock, to address potential future crowding on rail services into Bristol. Improved road connectivity to M5 Junction 20 and the A370 is required, however there are likely to be challenges in delivering new road connections to serve development areas and to cross the railway line. A comprehensive infrastructure solution will be required to connect these strategic locations and address the congestion problems on the A370 corridor. This will require new bridge crossings over the railway, integration of the MetroBus route with new highway infrastructure, and careful integration of new infrastructure with development.

5.4.4. Whitchurch

Whitchurch is located on the southern edge of the Bristol urban area with potential to extend existing urban bus services and support active travel. The modelling has forecast high levels of development traffic on the A37 into Bristol, and on orbital routes including Whitchurch Lane towards Hengrove, and Stockwood Lane/Durley Hill towards the A4. To address significant traffic impacts on these routes, improved road connectivity is required around south east Bristol, with improved links from Whitchurch to Hicks Gate roundabout. To intercept trips into Bristol, a new Park & Ride site is required on the A37 near Whitchurch.

Effective integration of new transport infrastructure with development is required: masterplanning has the opportunity to deliver significant wider benefits to connectivity in this area. High quality walking and cycling facilities would be incorporated into new infrastructure connecting with the existing urban area. High quality bus services would serve the A37 Park & Ride site and penetrate the new development. However, this location will require significant infrastructure to support sustainable travel choices and mitigate the effects of traffic generated on orbital routes. Failure to provide adequate infrastructure to address these issues will pose a significant delivery risk to development at this location.

5.4.5. Keynsham

Development at Keynsham would result in high levels of development traffic on the A4 and A4174 Ring Road. Located on the A4 corridor, this strategic location could be served by MetroBus, providing high quality
rapid transit into Central Bristol and to Bath. Extension of the platform at Keynsham railway station (or, potentially, relocation of the station) would facilitate provision of longer rolling stock at this station.

New road capacity would be required to provide access to this strategic location and tackle congestion in Keynsham. This is likely to include the need to include new bridge crossings over the railway line, which could also provide wider connectivity benefits in the town. This would facilitate improved connections around the north of the town, connecting the A4 near the Broadmead roundabout to the A4175 via Avon Mill Lane. However, the provision of new or improved crossings over the railway will be critical to ensuring adequate connectivity to support new development. Failure to provide adequate access will be a significant delivery risk to development at this location.

5.4.6. Somer Valley (Employment)
At present, there are relatively limited employment opportunities in the Somer Valley, which means that there are high levels of out-commuting to Bath and Bristol. A greater focus on new employment in the Somer Valley could help to encourage more people to live and work in the area. However, it is also likely that new employment would also draw in commuting from surrounding rural areas, from both Bath & North East Somerset and the Mendip area. Although there would be opportunities to encourage sustainable travel choices within Midsomer Norton and Radstock, it is likely that there would be some car use from surrounding areas.

This would result in traffic impacts on several road corridors, including through villages. Overall it would be difficult to deliver substantial cost-effective mitigation to support access to employment opportunities in the Somer Valley by sustainable modes of travel outside Midsomer Norton and Radstock.

5.4.7. Yate/Chipping Sodbury
Traffic generated by development in the Yate area would use the A432 and B4058 towards Bristol, with impacts along the routes including at the A432/A4174 Ring Road junction, B4058 in Winterbourne and within Yate itself. The modelling has forecast high levels of development traffic on the A432 and B4058 into Bristol and the North and East Fringe. Congestion along the A432 and B4058 would result in traffic using inappropriate secondary routes if adequate mitigation is not in place.

A new MetroBus route from Yate to the North Fringe and Bristol is needed to improve public transport options. This would require complementary highway improvements on the A432 corridor, including junction improvements in Yate, and provision of the Winterbourne and Frampton Cotterell Bypass to provide capacity on the parallel route and relieve Winterbourne High Street and Beacon Lane. These schemes would incorporate improvements to provision for cyclists in the area. Park & Ride at Nibley (served by MetroBus) will intercept car trips into Bristol. Improved car parking and interchange with bus services at Yate railway station would further enhance the attractiveness of rail services. Extension of platforms at the station will facilitate provision of longer rolling stock to address potential future crowding on rail services into Bristol.

5.4.8. Coalpit Heath
Coalpit Heath is located on the A432 corridor and suffers from high levels of through traffic between Yate to Bristol, the North and East Fringe, and the M4. The modelling has forecast high levels of development traffic impacting on both the A432 and parallel B4058 through Winterbourne.

Development at Coalpit Heath should be served by MetroBus (from Yate) to improve public transport options and encourage sustainable travel. A new bypass will be required for Winterbourne and Frampton Cotterell to mitigate the impacts of development at Coalpit Heath and at Yate. The bypass would provide capacity on the parallel B4058 route and relieve Winterbourne High Street and Beacon Lane. These schemes would incorporate improvements to provision for cyclists in the area. Failure to provide this strategic infrastructure would result in delivery risks for these strategic locations. Piecemeal development in this area would result in further deterioration in traffic and environmental conditions along the A432 and B4058 corridors. A comprehensive solution will be required, with integration of development and new highway infrastructure and provision of MetroBus to serve the area.

5.4.9. Thornbury and Buckover Garden Village
The relatively long distance from Buckover Garden Village to key destinations is a factor in the forecast increase in average journey times in South Gloucestershire. Development at Thornbury and Buckover
Garden Village would result in high levels of development traffic via the A38, B4058 and M5 Junction 14. A new Metrobus service from Buckover and Thornbury to Bristol will be needed to encourage sustainable travel, in conjunction with a new Park & Ride facility on the A38. At present there are long bus journey times from Thornbury to Bristol, but this would be improved through the extension of MetroBus on this corridor. This would connect into the North Fringe to Hengrove Package infrastructure, providing connections to employment in the North Fringe.

M5 Junction 14 is an immediate constraint on the level of development – it is at capacity and there are safety issues due to queuing back onto the M5 carriageway. Failure to improve M5 Junction 14 would result in a major delivery risk for these strategic locations. M5 Junction 16 is also a significant constraint to growth on the A38 corridor. Providing high levels of additional capacity at M5 Junction 16 would result in the release of large volumes of additional traffic into adjacent junctions (e.g. Aztec West to the south), causing congestion problems elsewhere on the network. It would be preferable to control flows of traffic into the junction, and encourage use of the proposed Park & Ride site on the A38.

Analyses indicate that there is unlikely to be a strong case for reopening of the railway line from Yate to Thornbury. Significant works would be required to extend the line to a new terminus in Thornbury and reinstate the line to the standard required for passenger services. The level of demand generated from Thornbury and Buckover Garden Village is unlikely to justify the high costs that would be required.

5.4.10. Charfield
The relatively long distance from Charfield to key destinations is a key factor in the forecast increase in average journey times in South Gloucestershire. Charfield currently has limited travel choices. Relatively high levels of traffic are therefore forecast, with traffic impacts on the B4058 corridor, M5 Junction 14 and the A38 corridor. M5 Junction 14 is an immediate constraint: the junction is at capacity and there are safety issues due to queuing back onto the M5 carriageway. Failure to improve M5 Junction 14 would result in a major delivery risk for this strategic location.

A new station is proposed at Charfield on the Birmingham-Bristol main line to serve both existing communities and new development, which would improve travel choices in the area. Subject to further detailed assessment, a recent study has shown that there is likely to be a positive business case for a new station at Charfield. Improved bus services would also be needed to improve accessibility for local journeys to Thornbury and Yate.
6. Conclusions

6.1. Emerging Spatial Strategy: Conclusions

The Emerging Spatial Strategy has strengths and weaknesses in transport terms. The urban extensions at Whitchurch and Keynsham will reduce travel distances but improvements to travel choices will be needed. However, development in Nailsea and Backwell, Banwell and Churchill, Coalpit Heath, Buckover, Charfield, Yate and Thornbury will increase travel distances and improvements will be required to travel choices from these locations. Banwell and Churchill are particularly problematic in transport terms, but the proposed infrastructure will enable improvements to conventional bus and Metrobus feeder services to be considered. Overall, the mitigation package is estimated to cost around £1.8 billion.

At present there is limited information about the locations for urban living. The preferable approach in transport terms would be to locate high-intensity development in places with good access by public transport, walking and cycling to jobs and local services. This would provide the opportunity for car-free development and high-quality place-making.

It is recognised that other planning policy considerations will need to be taken into account in the development of the Emerging Spatial Strategy.

6.2. Guiding the JSP Process

It has been shown that strategic locations closer to the urban area are, in general, easier to serve with good quality public transport options. This is confirmed in the testing for the following strategic locations considered in the Emerging Spatial Strategy:

- Whitchurch is adjacent to the Bristol urban area. It would require a new or improved highway link between the A37 and A4, new public transport (MetroBus services) and provision of an A37 Park & Ride site;
- Keynsham can be served by MetroBus but will require new road capacity to serve the proposed development areas and to tackle congestion in the town;
- Yate would be served by MetroBus but will require highway improvements on key corridors; and
- Coalpit Heath could be served by MetroBus (from Yate) but will also require significant highway infrastructure.

Many of the areas located beyond the Green Belt have relatively poor travel choices and therefore pose challenges in improving travel choices and mitigation of their impacts:

- Parts of Nailsea are isolated, with poor travel choices and poor road connectivity: this would require new MetroBus connections and improved road links – it will be challenging to provide new highway infrastructure to cross the railway line, serve new development in this area and relieve congestion on the A370;
- Banwell and Churchill have poor travel choices and serving these sites by public transport will be challenging. The scale of development at these locations means that a bypass would be required to provide access to the development. Forecast impacts on M5 Junction 21 indicate that a new junction on the M5 (new Junction 21A) is required to accommodate the scale of development;
- The relatively long distance from Buckover Garden Village to key destinations is a factor in the forecast increase in average journey times in South Gloucestershire. Buckover and Thornbury would be served by MetroBus and Park & Ride on the A38, but will also require highway improvements on the A38 and other nearby corridors. M5 Junctions 14 and 16 are constraints to development on the A38 corridor; and
• The relatively long distance from Charfield to key destinations is a key factor in the forecast increase in average journey times in South Gloucestershire. Charfield currently has limited travel choices and development at this location will result in traffic impacts on the A432, B4058 and at M5 Junction 14. With its location on the mainline between Bristol and Birmingham, there is the opportunity to reopen Charfield railway station which would improve travel choices in the area.
Appendix A. Introduction to Testing

A.1. Background

Alternative development patterns were provided by the JSP workstream for transport modelling and testing. The data provided were only indicative for the purposes of testing the transport implications of options, which formed part of the wider technical work undertaken to support the Emerging Spatial Strategy. They do not represent appropriate alternative strategies or capacities at the respective locations.

A three stage testing process was adopted, as shown in Figure A-1. The results from the transport testing have been used, along with information from other non-transport disciplines, to inform the development of the Emerging Spatial Strategy.

Figure A-1 Testing Stages

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Model Testing Process

The Stage 1 tests, reported in Appendix B, emerged from the previous Issues and Options stage of the JSP, and were provided by the JSP workstream for testing:

- Test 1 focused on development options that avoid the Green Belt but include strategic locations within Flood Risk Zone 3A;

- Test 2 focused on supporting economic growth through sustainable urban extensions to the Bristol urban area, together with housing and employment development along the A38 corridor; and

- Test 3 focused on maximising sustainability objectives and making best use of the transport network by focusing development mainly in urban extensions and along railway corridors, together with employment.

The Stage 2 tests, reported in Appendix C, were provided by the JSP workstream for testing:

- Test 4 was broadly a hybrid of the Stage 1 tests provided by the JSP workstream, and a further Sensitivity Test explored different options for development in South Gloucestershire; and

- Test 1 (from Stage 1) was included for comparison purposes. This test avoided the Green Belt but included strategic locations within Flood Risk Zone 3A.

Finally, Stage 3 focused on the testing of the Emerging Spatial Strategy, which is presented in the main body of this report.

As already noted, the housing and employment figures in this report are only indicative for the purposes of testing the transport implications of options, which formed part of the wider technical work undertaken to support the Emerging Spatial Strategy. They do not represent appropriate alternative strategies or capacities at the respective locations.
A.2. Purpose of Appendices

The remainder of Appendix A outlines the approach to developing mitigation packages for each test. Appendices B and C then describe the findings from the first two stages of testing. The assessments focus on strategic transport issues and impacts of the growth suggested in each test. They focus on addressing travel choice issues and strategic network impacts, but do not include other aspects of mitigation such as road safety and local walking and cycling improvements.

A.3. Approach to Mitigation

This section sets out the approach used to assess the impacts and develop the mitigation package for each test. This represents a strategic assessment; it does not consider the level of detail required for Local Plans or Transport Assessment at the Development Management stage.

The approach is based on mitigating the transport impacts of each test. It does not seek to address the current problems on the network, nor those that will emerge with current planned growth to 2026, which are addressed by the Transport Vision developed by the JTS. However, elements of the JTS Transport Vision are included where these are the most appropriate solutions to mitigating the impacts of additional development to 2036.

There are two key components in addressing the transport issues associated with each test:

- First, maximise the effectiveness of sustainable travel choices and encourage greater use of rail, MetroBus, Park & Ride, bus, cycling and walking. This aims to minimise car based travel to/from the development areas; and
- Then, mitigate the remaining impacts of additional traffic, including investigation of junction capacity improvements, upgrades, new highway connections and traffic restrictions.

Urban living will require a different, but complementary, approach. There are limited opportunities for significant highway capacity improvements in the Bristol urban area. The overall approach is therefore to reduce traffic to create the right conditions to support urban growth, intercepting traffic on radial routes into Bristol, Bath and Weston-super-Mare with Park & Ride, enabling roadspace to be restructured to support active travel and public transport.

Sustainable Travel Choices

The first principle for mitigation is to maximise sustainable travel choices through rail, MetroBus, Park & Ride, bus, cycling, and walking:

- Walking and cycling must take a central role for local trips – links to surrounding walking and cycling networks are assumed;
- Conventional bus services will be an important part of promoting sustainable travel on several corridors;
- MetroBus rapid transit services will be central to delivering mode shift at several locations, with a number of areas being beyond walking/cycling distance from key destinations;
- Park & Ride will help to intercept vehicles on the edge of the urban areas, which will reduce traffic in the urban areas and improve conditions for walking, cycling and public transport; and
- Rail will play an important role for access to urban centres, but improvements will be needed, including access to stations, parking, station environment and platforms.

There is a need to maximise the effectiveness of non-car modes for both urban living and new development outside existing urban areas.
Mitigation of Traffic Impacts

Highway improvements are needed to mitigate the remaining traffic impacts after maximising sustainable travel choices. Highway improvements should incorporate multi-modal infrastructure where possible, for example, creation or extension of MetroBus corridors.

In some cases, development options could result in increases in traffic on the motorway network (especially on the M5 between Weston-super-Mare and the North Fringe). In these cases, it will be necessary to include measures to minimise traffic impacts. This will include improvements to the local road network, to provide an attractive alternative to the motorway for local trips, and improvements to the motorway network itself.

Delivery Risks

In many cases, significant interventions will be required to deliver effective mitigation for the development that is proposed. There will be a number of challenges in delivering these interventions, including overcoming engineering constraints, providing sufficient roadspace for active modes and MetroBus rapid transit on congested urban corridors, and securing funding from different sources.

In some cases, there are significant underlying issues relating to the scale of development already proposed to 2026 and the ability to deliver transport infrastructure to mitigate this development. This poses a risk to the ability to support further growth in these areas. These issues are highlighted, as appropriate, for each location.
Appendix B. Stage 1 Tests

B.1. Description of Stage 1 Tests

Overview
This section describes the three initial tests undertaken to inform the JSP workstream as part of the Stage 1 testing (see Figure A-1). For each test, a map is provided to show the broad locations for development, together with a table with indicative numbers of dwellings and employment land assumed for the purposes of transport modelling for this work.

The testing compares each of the three tests with a ‘Base Test’. In the Base Test, the numbers of people living and working in the West of England would be those assumed in the current Core Strategies to a 2026 forecast year. It then assumes growth in the propensity to travel (reflecting forecast growth in incomes and continued growth in demand for travel) between 2026 and 2036 from the people living and working in the area. This provides a forecast of the total amount of travel in 2036, based on the numbers of houses and jobs in 2026. This therefore provides a mechanism for the comparing of the impacts of the new houses and jobs delivered in the three tests between 2026 and 2036.

The description of locations in this appendix was provided for transport assessment at a preliminary assessment stage. Changes to the numbers of dwellings or employment land at a particular location could change the forecast traffic impacts and potential mitigation requirements.

Urban Living
It was assumed that urban living in Tests 1-3 would comprise:

- Bristol – 10,000 dwellings;
- Bristol Urban Fringe (South Gloucestershire) – 1,000; and
- Weston-super-Mare – 1,000.

Test 1
Test 1 comprised strategic locations that avoid the Green Belt but include strategic locations within Flood Risk Zone 3A. The strategic locations are shown in Figure B-1.

Test 2
Test 2 focused on supporting economic growth through sustainable urban extensions to the Bristol urban area, together with housing and employment development along the A38 corridor. The strategic locations are shown in Figure B-2.

Test 3
Test 3 focused on maximising sustainability objectives and making best use of the transport network by focusing development mainly in urban extensions and along railway corridors, together with employment along the A38 corridor at Bristol Airport. The strategic locations are shown in Figure B-3.
Figure B-1  Test 1

The numbers shown in this table are for the purposes of transport modelling only: they are not intended to be indicative of potential development capacities at these locations. The employment figures shown above are in hectares and assume that land areas would be 60% occupied by buildings.
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The numbers shown in this table are for the purposes of transport modelling only; they are not intended to be indicative of potential development capacities at these locations. The employment figures shown above are in hectares and assume that land areas would be 60% occupied by buildings.
B.2. Results of Testing

B.2.1. Introduction
This section presents the assessment of the three tests. For each test the following maps and commentary are provided:

- Routings of traffic generated by the new development in the morning peak period, together with impacts on the transport network; and
- The proposed transport mitigation package for the test.

The costs and quantified impacts of the tests and the mitigation packages are then discussed in the following section.

B.2.2. Test 1

B.2.2.1. Traffic Routing and Impacts
The routings of traffic generated by this test – before mitigation – are shown in Figure B-4. The widths on the map are proportionate to the volumes of traffic generated by the strategic locations.

Figure B-4  Test 1: Routings of Traffic Generated by New Development

Figure B-4 shows traffic routings from the strategic locations during the morning peak. This test generates significant long distance travel, including traffic on the M5, which will be difficult to mitigate. There are significant numbers of trips on key routes, for example A370, A371, A38, A37, A39, A362, A367, B3116, A4 (East), A432 and B4058. The M5 is used by traffic from Yatton/Congresbury and Clevedon via Junctions 20 and 21. Traffic from Charfield/Wickwar uses the M5 via Junction 14. These routes would experience increased traffic delays, particularly at junctions, which would need to be addressed in future mitigation proposals.
B.2.2.2. Test 1: Mitigation

The proposed mitigation package for this test is shown in Figure B-5.

Figure B-5  Test 1: Proposed Transport Mitigation

Test 1: Sustainable Travel Choices

Test 1 will require a package of comprehensive transport improvements to maximise sustainability for the strategic locations located beyond the Green Belt. Some of these sites can be served by MetroBus, however other sites (including those in the Somer Valley) are more challenging. Overall, the traffic impacts of this test will be difficult to fully mitigate due to the long travel distances to key destinations.

Links to surrounding walking and cycling networks are assumed for all sites. At Weston-super-Mare and Clevedon, bridges over the M5 for pedestrians, cyclists and buses will improve connectivity for the two sites on the opposite side of the motorway. This is essential to reduce severance by the M5. Strategic cycle corridors will help encourage sustainable travel on key corridors into Bristol, and the North and East Fringe.

The mitigation package seeks to improve sustainable travel choices through expansion of the MetroBus network:

- Weston-super-Mare (East of Weston urban extension to town centre);
- Clevedon/Nailsea to Bristol MetroBus;
- Thornbury to Bristol MetroBus (connecting into North Fringe to Hengrove Package infrastructure); and
- Yate to Bristol MetroBus (connecting into North Fringe to Hengrove Package infrastructure).

This would be supported by conventional bus services from other strategic locations. Park & Ride sites would be served by dedicated conventional bus services, except where a proposed MetroBus service passes the site.
A ring of Park & Ride sites is proposed around the Bristol urban area, which is intended to intercept traffic on radial routes, reducing traffic to create conditions for urban growth and enabling roadspace to be restructured. This forms a key part of the mitigation for urban living, as well as intercepting trips from the strategic locations outside of the Bristol urban area. Further expansion of the Odd Down Park & Ride site in Bath is required for the area of search at Midsomer Norton/Radstock. A new Park & Ride site to the east of Weston-super-Mare is required to support urban living in Weston and the East of Weston urban extension.

Rail improvements are assumed to comprise longer rolling stock from Weston-super-Mare, Yatton, Nailsea & Backwell and Yate with longer platforms to cater for increased rail demand. This could prove to be challenging to deliver because the specification of rolling stock and works to the railway are currently controlled by investment processes in the rail industry.

**Test 1: Highway Improvements**

Having maximised opportunities for sustainable travel, the following highway improvements would be required:

- A requirement to upgrade the M5 to Smart Motorway standard, to accommodate the large increases in flows generated from the North Somerset area (notably the strategic location to the east of Weston, Yatton and Clevedon);
- Upgrades to M5 Junctions 14, 16, 20 and 21;
- Comprehensive highway upgrade at the Airport, including potential realignment to significantly increase capacity at major bottlenecks at Downside Road and the Airport entrance;
- A new road link from M5 Junction 20 to the A370, with a distributor road into the Nailsea area;
- New M5 Junction 21A incorporating a bypass for Banwell and Churchill, with links into the development areas;
- Second railway crossing in Yatton, providing a distributor road for the area;
- A new eastern bypass for Keynsham, connecting the B3116 south of the town with the A4 to the east, to address the impacts of increased traffic from the Midsomer Norton area heading towards Bristol;
- A bypass for Pensford, to address the impacts in the village of large volumes of additional traffic generated from Temple Cloud/Clutton and Midsomer Norton heading towards Bristol;
- A bypass for Whitchurch village to address the impacts of large volumes of traffic generated from Temple/Cloud and Midsomer Norton; and
- A package of junction improvements on the A38(S), A370, A38(N), A432 and a number of other locations.

Whilst Test 1, without mitigation, would result in more traffic through Chew Magna (B3130), it is proposed that this route is not upgraded. The increase in traffic through Chew Magna is due to congestion on the radial routes, resulting in traffic taking longer, more circuitous routes. The focus is therefore on addressing congestion on these routes, to encourage traffic to take more appropriate (shorter) routes. Otherwise there is the risk of promoting the B3130 for longer distance, sub-regional journeys.

**B.2.3. Test 2**

**B.2.3.1. Traffic Routing and Impacts**

The routings of traffic generated by this test – before mitigation – are shown in Figure B-6. The widths on the map are proportionate to the volumes of traffic generated by the strategic locations.
Figure B-6 shows traffic routings from strategic locations during the morning peak. Test 2 has less long-distance traffic than Test 1, but major impacts concentrated in some areas. The large number of houses at Keynsham result in high volumes of traffic and the routings would depend on the configuration of the individual development sites within the strategic locations (in this case it is forecast that large volumes of traffic would route via the B3116 to the south east of Keynsham, A4 towards Bristol, A4174 towards the North Fringe and A4175 towards Warmley). The South West Urban Extension is forecast to generate relatively short trips through south west Bristol. Major employment development at Bristol Airport would generate increased traffic on the A38 corridor to the south-west of the city.

The area of search to the north of the M4/M5 interchange and Almondsbury/Hortham would generate significant volumes of traffic into the North Fringe: traffic would take a number of different routes to avoid congestion on the A38, M5 Junction 16 and in the Bradley Stoke area (for example via Over Lane and M5 Junction 17). A small volume of traffic would use the M5 between Weston and the North Fringe, but significantly less than in Test 1.

**B.2.3.2. Test 2: Mitigation**

The proposed mitigation package for this test is shown in Figure B-7.
Test 2: Sustainable Travel Choices

Links to surrounding walking and cycling networks are assumed for each of the strategic locations. Strategic cycle corridors will encourage sustainable travel on key corridors into Bristol.

The mitigation package seeks to improve sustainable travel choices through expansion of the MetroBus network:

- Bristol Airport to Bristol;
- Orbital MetroBus (Whitchurch to Emersons Green, connecting with the East Fringe leg of the North Fringe to Hengrove route);
- Thornbury to Bristol via M4/M5 site (connecting into North Fringe to Hengrove Package infrastructure); and
- Bath to Bristol, including options to serve Keynsham/Saltford sites.

This would be supported by conventional bus services from the other strategic locations. Park & Ride sites would be served by dedicated conventional bus services, except where a proposed MetroBus service passes the site.

A ring of Park & Ride sites around the Bristol urban area is intended to intercept traffic on radial routes, reducing traffic to create conditions for urban growth and enabling roadspace to be restructured. This forms a key part of the mitigation for urban living, as well as intercepting trips from the strategic locations outside of the Bristol urban area. A new Park & Ride site is proposed to intercept trips into Weston-super-Mare, together with further expansion of Newbridge Park & Ride to intercept trips from Keynsham into Bath.

Rail improvements would comprise a new station at Saltford on the basis of the scale of existing settlement and potential development areas. Apart from Saltford, none of the locations justify new railway stations.
Longer rolling stock from Weston-super-Mare is proposed in conjunction with longer platforms to cater for increased rail demand.

**Test 2: Highway Improvements**

Having maximised opportunities for sustainable travel, the following highway improvements would be required:

- Upgrade to M5 Junctions 14, 16, 17, 19 and 21;
- Comprehensive highway upgrade at the Airport, including realignment to significantly increase capacity at major bottlenecks at Downside Road and the Airport entrance;
- A bypass for Banwell and Churchill, with links into the strategic locations;
- Upgrade to Trench Lane and Old Gloucester Road, forming part of M4/M5 site distributor roads;
- A new distributor road to the south of Keynsham and Saltford, to connect key development sites within this strategic location, but which would also provide increased traffic routing options in the area and provide bypasses for both Saltford and Keynsham town centre;
- A new highway link from the A4 at Hicks Gate to the A37; and
- A package of junction improvements on the A38(S), A370, A38(N), A432 and a number of other locations.

Whilst Test 2, without mitigation, would result in more traffic through Chew Magna (B3130), it is proposed that this route is not upgraded. The increase in traffic through Chew Magna is due to congestion on the radial routes, resulting in traffic taking longer, more circuitous routes. Therefore the focus is on addressing congestion on these routes, to encourage traffic to take more appropriate (shorter) routes. Otherwise there is the risk of promoting the B3130 for longer distance, sub-regional journeys.

**B.2.4. Test 3**

**B.2.4.1. Traffic Routing and Impacts**

The routings of traffic generated by this test – before mitigation – are shown in Figure B-8. The widths on the map are proportionate to the volumes of traffic generated by the strategic locations.
Figure B-8 shows traffic routings from strategic locations during the morning peak. Test 3 generates less long-distance traffic than Test 1, with impacts distributed across the sub-region. Development at Yatton would result in significant volumes of traffic using the M5, although to a lesser extent that in Test 1. Traffic from sites at Nailsea would use the B3130 through Tickenham, B3128 through Wraxall and A370, while traffic from the South West Urban Extension would be focused in south west Bristol. Traffic from the Keynsham/Saltford area would use similar routes to Test 2 but volumes would be lower. Traffic from development at Warmley would make strong use of the A4174 Ring Road and A4175 towards Keynsham. Traffic from Winterbourne and Yate would use a number of different routes to access Bristol and the North Fringe, due to the capacity constraints on both the A432 and B4058 junctions in the centre of Winterbourne. Major employment development at Bristol Airport would generate increased traffic on the A38 corridor to the south-west of the city.

B.2.4.2. Test 3: Mitigation
The proposed mitigation package for this test is shown in Figure B-9.
Test 3: Sustainable Travel Choices

Links to surrounding walking and cycling networks are assumed for each of the strategic locations. Strategic cycle corridors will encourage sustainable travel on key corridors into Bristol, and the North and East Fringe.

The mitigation package for Test 3 seeks to improve sustainable travel choices through expansion of the MetroBus network:

- Clevedon/Nailsea to Bristol;
- Bristol Airport to Bristol;
- Orbital MetroBus (Whitchurch to Emersons Green, connecting with the East Fringe leg of the North Fringe to Hengrove route);
- Yate to Bristol (connecting into North Fringe to Hengrove Package infrastructure); and
- Bath to Bristol, including options to serve Keynsham/Saltford sites.

This would be supported by conventional bus services from the other strategic locations. Park & Ride would be served by a dedicated conventional bus service, except for where a proposed MetroBus service passes the site.

A ring of Park & Ride sites around the Bristol urban area is intended to intercept traffic on radial routes, reducing traffic to create conditions for urban growth and enabling roadspace to be restructured. This forms a key part of the mitigation for urban living, as well as intercepting trips from the strategic locations outside of the Bristol urban area. A new Park & Ride site is proposed to intercept trips into Weston-super-Mare, together with further expansion of Newbridge Park & Ride to intercept trips from Keynsham into Bath.
Rail improvements comprise a new station at Saltford on the basis of the scale of the existing settlement and new development. Longer rolling stock from Weston-super-Mare, Yatton, Nailsea & Backwell and Yate is proposed, in conjunction with longer platforms to cater for increased rail demand.

**Test 3: Highway Improvements**

Having maximised opportunities for sustainable travel, the following highway improvements would be required:

- Upgrade to M5 Junctions 14, 19 and 21;
- A new road link from M5 Junction 20 to the A370, with a distributor road into the Nailsea sites;
- Second railway crossing in Yatton, providing a distributor road for the site;
- Comprehensive highway upgrade at the Airport, including realignment to significantly increase capacity at major bottlenecks at Downside Road and the Airport entrance;
- A bypass for Banwell and Churchill, with links into the strategic locations;
- A new distributor road to the south of Saltford and east of Keynsham, to connect key development sites, within this strategic location, but which would also provide increased traffic routing options in the area and provide bypasses for both Saltford and Keynsham town centre;
- A new highway link from the A4 at Hicks Gate to the A37;
- A new distributor road to the north of Winterbourne, providing access into new development, but which would also provide traffic relief for Winterbourne village; and
- A package of junction improvements on the A38(S), A370, A432 and a number of other locations.

Whilst Test 3, without mitigation, would result in more traffic through Chew Magna (B3130), it is proposed that this route is not upgraded. The increase in traffic through Chew Magna is due to congestion on the radial routes, resulting in traffic taking longer, more circuitous routes. Therefore the focus is on addressing congestion on these routes, to encourage traffic to take more appropriate (shorter) routes. Otherwise there is the risk of promoting the B3130 for longer distance, sub-regional journeys.

**B.3. Commentary**

**B.3.1. Introduction**

This section discusses the estimated costs of mitigation and the impacts of the Stage 1 tests. The objective of the mitigation packages is to achieve no overall increase in journey times across the West of England road network. However, as shown in the analyses that follow, the overall impacts of each mitigation package reflect a balance of different scales of impact across different parts of the West of England.

**B.3.2. Estimated Costs of Mitigation**

Table B-1 presents the estimated mitigation costs for each test in outturn prices, with the costs ranging from ~£1.4 billion to ~£2.0 billion. The costs for Test 1 are higher because significant infrastructure is needed to improve travel choices and mitigate the impacts of longer distance traffic. The development locations in Tests 2 and 3 are generally concentrated along corridors and/or closer to the urban area.

If a typical level of contribution for strategic transport infrastructure of £5,000 per dwelling is assumed, this would be equivalent to approximately £0.2 billion. This level of expected developer contribution per dwelling may itself be challenging to negotiate in many circumstances, given other requirements for affordable housing, starter homes, social and community infrastructure, open space, and onsite and local transport improvements.
All of the packages would cost significantly in excess of what is likely to be sourced from developer contributions. These packages would therefore require complementary funding from a range of other sources.

The proposed mitigation packages are substantial, although proportionate to the scale of development impact, and represent a significant major scheme programme to address 10 years of housing growth. This is particularly the case for Test 1. At present, the West of England is investing approximately £100 million per annum on capital schemes including MetroBus construction.

Table B-1 Mitigation Costs by Test

<table>
<thead>
<tr>
<th></th>
<th>Test 1</th>
<th>Test 2</th>
<th>Test 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Estimated Cost (£ Million, Outturn Prices)</td>
<td>£2.0 billion</td>
<td>£1.4 billion</td>
<td>£1.8 billion</td>
</tr>
<tr>
<td>Potential Contribution from Development (£5k/dwelling)</td>
<td>£0.2 billion</td>
<td>£0.2 billion</td>
<td>£0.2 billion</td>
</tr>
<tr>
<td>Balance of Funding Requirement</td>
<td>£1.8 billion</td>
<td>£1.2 billion</td>
<td>£1.6 billion</td>
</tr>
</tbody>
</table>

B.3.3. Impacts of Tests

This section considers the impacts of the tests on overall travel conditions on the road network. It first presents the average travel times for journeys in the West of England, for 2036 but assuming no further development beyond 2026. It then presents the changes in average journey times for the three tests, first without mitigation, then including the impacts of the mitigation packages.

The analysis of journey times is based on modelling, using SATURN software, of vehicle journeys on the road network and the figures quoted are for vehicle trips. Average journey times for buses will be higher than the figures quoted in these tables. It is expected the journey times would also increase for buses, without mitigation in place, but significant reductions would be achieved following the implementation of the MetroBus schemes.

The changes in average journey times presented reflect two factors:

- The distances between the strategic locations and key attractors (e.g. employment, in particular Bristol and the North Fringe); and
- Congestion – traffic takes longer more circuitous routes to avoid congestion.

The average modelled journey time for trips in the network is forecast to be 23.6 minutes in the 2036 Base Test. This compares with an average of 22.5 minutes in 2016 and is equivalent to a rise of 5%. This takes into account future growth in travel demand but also incorporates the benefits of the planned capital investment programme in MetroBus and MetroWest.

The changes in average journey times across the West of England for each test compared to the 2036 Base Test are provided below.

Table B-2 Change in Average Journey Times for each Test compared to 2036 Base Test

<table>
<thead>
<tr>
<th></th>
<th>Test 1</th>
<th>Test 2</th>
<th>Test 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Mitigation</td>
<td>+6.5%</td>
<td>+1.7%</td>
<td>+2.8%</td>
</tr>
<tr>
<td>With Mitigation</td>
<td>+1.0%</td>
<td>-0.2%</td>
<td>-0.5%</td>
</tr>
</tbody>
</table>

Note: based on 12 hour average, from combination of GBATS4 model outputs for AM, Inter and PM Peak periods.

Table B-2 shows important differences between the tests. Test 1 showed the largest increase in journey times across the network before mitigation is applied. This is due to the relatively long distances between new housing and key destinations, together with significant congestion impacts on the network. Tests 2 and
3 showed much lower increases in journey times before mitigation is applied. This is due to shorter distances between new housing and key destinations and more concentrated congestion impacts. In all cases, the mitigation packages would help to reduce the impacts of the traffic generated by new development. In the case of Tests 2 and 3, the transport packages would mitigate the impacts, with overall average journey times across the West of England equivalent to those in the 2036 Base Test without development. However, in the case of Test 1, it was not possible to fully mitigate the impacts and overall journey times would be slightly higher than the 2036 Base Test without development.

B.4. Conclusions from Stage 1 Testing

Test 1 has fundamental challenges. Locating development beyond the Green Belt results in large volumes of travel on sub-regional corridors, with poor travel choices in many cases. The road network has a number of capacity constraints, causing serious congestion problems at a number of locations. Particular problems are forecast at Yatton, Nailsea, Bristol Airport and routes from the Somer Valley to Bristol. In particular, the testing has forecast high volumes of traffic using M5, which will be difficult to mitigate. It is possible to implement measures to promote good travel choices and mitigate impacts, but the fundamental challenges of longer-distance travel remain. The mitigation package for Test 1 is estimated to cost ~£2.0 billion: this is the most expensive of the three tests, and even then the mitigation package cannot fully address the journey time impact of the developments in this test.

Test 2 has strengths and weaknesses. Focusing development on urban extensions will reduce travel distances, but many of the locations have relatively poor travel choices and major improvement will be needed. The road network has a number of capacity constraints. There are particular problems at Bristol Airport, the Keynsham area and the approaches to the North Fringe, all of which will require major intervention. It is possible to implement measures to promote good travel choices and mitigate impacts, although some challenges would remain. The mitigation package for Test 2 is estimated to cost ~£1.4 billion: fewer, more focused strategic allocations would present economies of scale for the investment packages.

Test 3 also has strengths and weaknesses. It comprises a mix of urban extensions and development beyond Green Belt. This results in a greater balance of travel demands across the area, but again there are relatively poor travel choices at some of these locations. The road network has a number of capacity constraints. There are particular problems at Yatton, Nailsea, Bristol Airport, Keynsham, the East Fringe and the Winterbourne area, all of which will require major intervention. It is possible to implement measures to promote good travel choices and mitigate impacts, although challenges would remain. The mitigation package for Test 3 is estimated to cost ~£1.8 billion, with multiple interventions needed to serve the different strategic locations.

Two key guiding principles were identified from the Stage 1 technical work:

Firstly, sites closer to the urban area are, in general, easier to serve with good quality transport options (with the following caveats):

- The South West Urban Extension is close to central Bristol and can be easily served by MetroBus – this would also enhance the business case for a MetroBus or other rapid transit extension to the Airport;
- Whitwick is adjacent to the Bristol urban area. It would require a new highway link between the A37 and A4, which would also facilitate an orbital MetroBus route to the East Fringe and North Fringe, together with provision of an A37 Park & Ride site;
- Keynsham / Saltford and Hicks Gate can be served by MetroBus but will require significant new road capacity to serve the proposed development areas and to tackle congestion in the town;
- Coalpit Heath could be served by MetroBus (from Yate) but will also require significant highway infrastructure;
- Almondsbury / Hortham could be served by MetroBus (from Thornbury). M5 Junction 16 is a constraint to development on the A38 corridor. There are limited options to improve this junction: it would be preferable to control flows of traffic into the junction and encourage traffic to transfer onto Park & Ride services from a new site on the A38;
The M4/M5 site would be difficult to serve by sustainable transport options. Severance caused by the M4 and M5 reduces the scope to link into existing bus routes and cycle networks. The cost of providing crossings over/under the M4 (or widening existing structures) would be very expensive, and making use of existing structures results in less direct routes; and

Sites on the East Fringe are difficult to serve by effective public transport options: these would require significant investment in new public transport to connect to central Bristol.

Secondly, many of the sites located beyond Green Belt have relatively poor travel choices and therefore pose challenges in improving travel choices and mitigation of their impacts:

- Parts of Nailsea are isolated, with poor travel choices and poor road connectivity: this would require new MetroBus connections and improved road links – it will be challenging to provide new infrastructure to cross the railway, serve the housing sites in this area and relieve congestion on the A370;

- Yatton is reliant on its rail service; travel choices are otherwise poor, and large volumes of traffic are likely to use the M5 to access Bristol and the North Fringe;

- Significant new employment development at Bristol Airport would require major investment (MetroBus) to improve public transport connectivity and major highway investment to mitigate impacts on the A38 corridor between the Airport and Bristol;

- Settlements along the A371/A368/A38 corridor between Weston-super-Mare and Bristol are affected by a number of bottlenecks which would need to be addressed by a series of significant highway capacity improvements;

- Temple Cloud and Norton Radstock are particularly problematic: there is no realistic prospect of serving these areas by rail or MetroBus, with resulting traffic impacts on the A37, A39 and A367 corridors;

- Yate could be served by MetroBus but will require highway improvements on key corridors;

- Thornbury can be served by MetroBus and Park & Ride at M5 Junction 16 but will also require highway improvements on the A38 and other nearby corridors. M5 Junctions 14 and 16 are constraints to development on the A38 corridor; and

- Other potential locations identified as options for growth (e.g. Wickwar) would be difficult to serve with sustainable travel options, which would result in high levels of car dependency and impacts on the wider sub-regional road network.
Appendix C. Stage 2 Tests

C.1. Description of Stage 2 Tests

Overview
This section describes the Stage 2 testing, which focused on Test 4 and a Sensitivity Test, compared with Test 1 which was previously assessed. For each test, a map is provided to show the broad locations for development, together with a table with indicative numbers of dwellings and employment land assumed for the purposes of transport modelling for this work.

Test 4 was a hybrid of Tests 1, 2 and 3 provided by the JSP workstream for testing. The Test 4 Sensitivity Test reduced the level of development in the East Fringe and Pucklechurch, with higher levels of development at Almondsbury / Hortham, Alveston, and Wickwar. The comparator, Test 1, from Stage 1, was focused on development options that avoid the Green Belt but include strategic locations within Flood Risk Zone 3A.

Urban living
Urban living features in all tests. In Test 4 and the Sensitivity Test, urban living totals 14,500 dwellings, which would comprise 12,000 in Bristol, 1,000 in the Bristol Urban Fringe, 1,000 in Weston and 500 in Bath. In the comparator, Test 1, urban living was assumed to total 12,000 dwellings, comprising 10,000 in Bristol, 1,000 in the Bristol Urban Fringe in South Gloucestershire and 1,000 in Weston-super-Mare.

Urban living should, in general, benefit from the wider range of travel choices available in the urban areas. However, there could be significant impacts on congestion if action is not taken to minimise car use and encourage alternative travel choices as part of the mitigation packages. At present there is limited information about the locations for urban living. The preferable approach to urban living would be for high-intensity development in places with good access by public transport, walking and cycling to jobs and local services. There could be opportunities for promoting largely car-free development to support high quality placemaking and encourage sustainable travel choices.

Test 4
Test 4 was a hybrid of Tests 1, 2 and 3 provided by the JSP workstream for testing. In South Gloucestershire there would be a stronger focus of development in the East Fringe, with an assumed 5,700 dwellings in total at East Fringe and Pucklechurch. In North Somerset, there would be no development at Banwell/Churchill and Yatton, with the focus instead at Nailsea/Backwell and South West Bristol. In Bath & North East Somerset, there would be a lower level of development at Keynsham/Saltford, with development also proposed at Midsomer Norton and Radstock. In Bristol, in addition to the increased urban living, there would also be development at Hicks Gate, which would cross the boundary with Bath & North East Somerset, and some development inside South Bristol Link. The locations for development in Test 4 are shown in Figure C-1.

Test 4 Sensitivity Test
The Test 4 Sensitivity Test would reduce the level of development in the East Fringe and Pucklechurch, with higher levels of development proposed at Almondsbury / Hortham, Alveston and Wickwar. The locations for development in the Sensitivity Test are shown in Figure C-2.

Test 1
Test 1, which was previously tested in Stage 1, is focused on development options that avoid the Green Belt but include strategic locations within Flood Risk Zone 3A. The locations for development in Test 1 are shown in Figure C-3.
The numbers shown in this table are for the purposes of transport modelling only: they are not intended to be indicative of potential development capacities at these locations. The employment figures shown above are in hectares and assume that land areas would be 60% occupied by buildings.
The numbers shown in this table are for the purposes of transport modelling only: they are not intended to be indicative of potential development capacities at these locations. The employment figures shown above are in hectares and assume that land areas would be 60% occupied by buildings.
The numbers shown in this table are for the purposes of transport modelling only: they are not intended to be indicative of potential development capacities at these locations. The employment figures shown above are in hectares and assume that land areas would be 60% occupied by buildings.
C.2. Results of Testing

C.2.1. Introduction
This section presents the results of testing: for each test the following maps and commentary are provided:

- Routings of traffic generated by the new development in the morning peak period, together with impacts on the transport network; and
- The proposed transport mitigation package for the test.

The costs and quantified impacts of the test and the mitigation packages are then discussed in the following section.

C.2.2. Test 4

C.2.2.1. Traffic Routing and Impacts
The routings of traffic generated (during the morning peak) by this test – before mitigation – are shown in Figure C-4. The widths on the map are proportionate to the volumes of traffic generated by the strategic locations.

Figure C-4  Test 4: Routings of Traffic Generated by New Development

There are significant numbers of trips on key routes, for example the A370, A38, B3130, A37, A362, A367, B3116, A4 (East), A432 and B4058. There are also significant numbers of trips in the area around Warmley and Pucklechurch, resulting from the large scale of development in this area. Traffic from Nailsea/Backwell uses the M5 (via Junction 20) to access Weston-super-Mare and the North Fringe.
High volumes of traffic, and associated congestion on key corridors, are forecast to result in traffic using secondary routes, for example Old Gloucester Road and Church Road, north of the M4 in South Gloucestershire. This is likely to impact on the quality of life for the settlements along these routes. Similarly, the Pucklechurch site results in traffic using rural roads – this site is further from the urban area and traffic therefore takes these routes to avoid congestion on the A420 and Ring Road. It can also be seen that development traffic would use rural roads in parts of North Somerset and Bath & North East Somerset, including routes through the Chew Valley.

C.2.2.2. Test 4: Mitigation

The proposed mitigation package for this test is shown in Figure C-5.

**Figure C-5  Test 4: Proposed Transport Mitigation**

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**Test 4: Sustainable Travel Choices**

Links to surrounding walking and cycling networks are assumed for each of the strategic locations. Strategic cycle corridors will encourage sustainable travel on key corridors into Bristol.

The mitigation package seeks to improve sustainable travel choices through expansion of the MetroBus network:

- Weston-super-Mare (Worle area to town centre);
- Nailsea to Bristol;
- Bristol Airport to Bristol;
- Bath to Bristol, including options to serve the Keynsham/Saltford area of search;
• City Centre to East Fringe via A420;
• Yate to Bristol (connecting into North Fringe to Hengrove Package infrastructure); and
• Thornbury to Bristol via A38 (connecting into North Fringe to Hengrove Package infrastructure).

The options for provision of rapid transit to connect the city centre to the East Fringe have been reviewed. In order to mitigate the impacts of the development proposed in the East Fringe, it is considered that a bus-based rapid transit (MetroBus) solution would be appropriate in supporting the level of public transport mode split to adequately mitigate the impacts of the new development. However, there would be a number of challenges in delivering a MetroBus scheme between the city centre and East Fringe. This would require high levels of segregation and/or measures to significantly reduce traffic flows on the A420 corridor, which, in practice, is likely to present significant delivery challenges.

These interventions would be complemented by conventional bus services from the other strategic locations. Park & Ride sites would be served by dedicated conventional bus services, except where a proposed MetroBus service passes the area.

A ring of Park & Ride sites around the Bristol urban area is intended to intercept traffic on radial routes, reducing traffic to create conditions for urban growth and enabling roadspace to be restructured. This forms a key part of the mitigation for urban living, as well as intercepting trips from the strategic locations outside of the Bristol urban area. The expansion of the Odd Down Park & Ride site is proposed to intercept trips from Midsomer Norton / Radstock into Bath.

Rail improvements would comprise a new station at Saltford on the basis of the scale of the existing settlement and potential future growth in this area. None of the other strategic locations justify new railway stations. Longer rolling stock from Weston-super-Mare and Nailsea & Backwell is proposed in conjunction with longer platforms to cater for increased rail demand.

**Test 4: Highway Improvements**

Having maximised opportunities for sustainable travel, the following highway improvements would be required:

• Upgrade to M5 Junctions 14, 16, 19, 20 and 21;
• A new road link from M5 Junction 20 to the A370 in the Nailsea and Backwell area (with a new junction on the A370);
• A comprehensive highway upgrade at the Airport, including realignment to significantly increase capacity at major bottlenecks at Downside Road and the Airport entrance;
• A new distributor road to the south of Keynsham and Saltford, to connect key development areas, but which would also provide increased traffic routing options in the area and provide bypasses for both Saltford and Keynsham town centre;
• A new highway link from the A4 at Hicks Gate to the A37;
• A new distributor road, at Whitchurch (to the east), providing access into the area, but which would also provide traffic relief for Whitchurch village;
• A new distributor road at Coalpit Heath, providing access into this strategic location; and
• A package of junction improvements on key corridors between the strategic locations and key attractors.

The need for a new motorway connection on the M4 between Junctions 18 and 19 (Junction 18A) was reviewed. In terms of mitigating the level of development in the East Fringe proposed in this test, M4 Junction 18A would not be required.
C.2.3. **Test 4 Sensitivity**

C.2.3.1. **Traffic Routing and Impacts**

The routings of traffic generated by this test – before mitigation – are shown in Figure C-6. The widths on the map are proportionate to the volumes of traffic generated by the strategic locations.

In most areas, the scale of housing and employment is identical to Test 4. However, the sensitivity test reduces the level of development in the East Fringe and Pucklechurch. Higher levels of development are instead proposed at Almondsbury / Hortham, Alveston and Wickwar.

**Figure C-6 Test 4 Sensitivity Test: Routings of Traffic Generated by New Development**

In most cases, the traffic routings are similar to those identified for Test 4. However, the changes in the scale of development in different parts of South Gloucestershire would result in differences in the volumes of development traffic around Pucklechurch, on the A4174 Ring Road in the East Fringe, and the A38 (north) approach to M5 Junction 16. Junction 16 currently acts as a constraint to high levels of growth on the A38 corridor. There is a risk that providing increased capacity at Junction 16 could release traffic into other congested parts of the network in the surrounding area, exacerbating congestion problems in these areas.

The higher levels of development at Almondsbury would result in traffic using a number of different routes to access the North Fringe and Bristol, including the unclassified road through Over Village to reach M5 Junction 17 and roads in the Cribbs Causeway area.

C.2.3.2. **Test 4 Sensitivity: Mitigation**

The proposed mitigation package for this test is shown in Figure C-7.
The mitigation for the Test 4 Sensitivity Test is similar to that proposed for Test 4, although there would be important differences, which relate to the scale of mitigation required for the major sites in the East Fringe, Pucklechurch and Almondsbury / Hortham:

- The MetroBus corridor between the North Fringe and Thornbury, proposed in Test 4 (and identified in the JTS Transport Vision) could be routed to serve Almondsbury / Hortham and provide higher levels of priority to bypass the congested A38 corridor; and

- Additional highway mitigation would be required to address the impacts of higher levels of development at Almondsbury / Hortham, including management of access onto the A38 through Almondsbury, traffic management through Over village and improvements to M5 Junction 17.

C.2.4. Test 1

C.2.4.1. Traffic Routing and Impacts

The routings of traffic generated by this test – before mitigation – are shown in Figure C-8. The widths on the map are proportionate to the volumes of traffic generated by the strategic locations.
Figure C-8 shows traffic routings from strategic locations during the morning peak. It generates significant long distance travel, including traffic on the M5, which will be difficult to mitigate. There are significant numbers of trips on key routes, for example A370, A371, A38, A37, A39, A362, A367, B3116, A4 (East), A432, and B4058. The M5 is used by traffic from the Yatton/Congresbury and Clevedon areas via Junctions 20 and 21. Traffic from the Charfield/Wickwar areas uses the M5 via Junction 14.

C.2.4.2. Test 4: Mitigation
The proposed mitigation package for this test is shown in Figure C-9.
Test 1: Sustainable Travel Choices

Test 1 will require a package of comprehensive transport improvements to maximise sustainability for areas located beyond the Green Belt. Some of these areas can be served by MetroBus, however other areas (including those in the Somer Valley) are more challenging. Overall, the traffic impacts of this test will be difficult to fully mitigate due to the long travel distances to key destinations.

Links to surrounding walking and cycling networks are assumed for all areas. At Weston-super-Mare and Clevedon, bridges over the M5 for pedestrians, cyclists and buses will improve connectivity for the two areas on the opposite side of the motorway. This is essential to reduce severance by the M5. Strategic cycle corridors will help encourage sustainable travel on key corridors into Bristol, and the North and East Fringe.

The mitigation package seeks to improve sustainable travel choices through expansion of the MetroBus network:

- Weston-super-Mare (East of Weston urban extension area to town centre);
- Clevedon/Nailsea to Bristol MetroBus;
- Thornbury to Bristol MetroBus (connecting into North Fringe to Hengrove Package infrastructure); and
- Yate to Bristol MetroBus (connecting into North Fringe to Hengrove Package infrastructure).

This would be supported by conventional bus services from other development areas. Park & Ride sites would be served by dedicated conventional bus services, except where a proposed MetroBus service passes the area.
A ring of Park & Ride sites is proposed around the Bristol urban area, which is intended to intercept traffic on radial routes, reducing traffic to create conditions for urban growth and enabling roadspace to be restructured. This forms a key part of the mitigation for urban living, as well as intercepting trips from the development areas outside of the Bristol urban area. The expansion of the Odd Down Park & Ride site in Bath is specifically required to mitigate the impacts of the Midsomer Norton/Radstock area of search. A new Park & Ride site to the east of Weston-super-Mare is required to support urban living in Weston and the East of Weston urban extension.

Rail improvements are assumed to comprise longer rolling stock from Weston-super-Mare, Yatton, Nailsea & Backwell and Yate with longer platforms to cater for increased rail demand. This could prove to be challenging to deliver because the specification of rolling stock and works to the railway are currently controlled by investment processes in the rail industry.

**Test 1: Highway Improvements**

Having maximised opportunities for sustainable travel, the following highway improvements would be required:

- A requirement to upgrade the M5 to Smart Motorway standard, to accommodate the large increases in flows generated from the North Somerset area (notably the areas to the east of Weston, Yatton and Clevedon);
- Upgrades to M5 Junctions 14, 16, 20 and 21;
- Comprehensive highway upgrade at the Airport, including potential realignment to significantly increase capacity at major bottlenecks at Downside Road and the Airport entrance;
- A new road link from M5 Junction 20 to the A370, with a distributor road into the Nailsea area;
- New M5 Junction 21A incorporating a bypass for Banwell and Churchill, with links into the development areas;
- Second railway crossing in Yatton, providing a distributor road for the area;
- A new eastern bypass for Keynsham, connecting the B3116 south of the town with the A4 to the east, to address the impacts of increased traffic from the Midsomer Norton area heading towards Bristol;
- A bypass for Pensford, to address the impacts in the village of large volumes of additional traffic generated from Temple Cloud/Clutton and Midsomer Norton heading towards Bristol;
- A bypass for Whitchurch village to address the impacts of large volumes of traffic generated from Temple/Cloud and Midsomer Norton; and
- A package of junction improvements on the A38(S), A370, A38(N), A432 and a number of other locations.

Whilst Test 1, without mitigation, would result in more traffic through Chew Magna (B3130), it is proposed that this route is not upgraded. The increase in traffic through Chew Magna is due to congestion on the radial routes, resulting in traffic taking longer, more circuitous routes. Therefore the focus is on addressing congestion on these routes, to encourage traffic to take more appropriate (shorter) routes. Otherwise there is the risk of promoting the B3130 for longer distance, sub-regional journeys.

**C.3. Commentary**

**C.3.1. Introduction**

This section discusses the estimated costs of mitigation and the impacts of the Stage 2 tests and the mitigation packages. The overall objective of the mitigation packages is to achieve no overall increase in journey times across the West of England road network. However, as shown in the analyses that follow, the
overall impacts of each mitigation package reflect a balance of different scales of impact across different parts of the West of England. Finally this section sets out the conclusions from the testing.

C.3.2. Estimated Costs of Mitigation

Table C-1 presents the estimated mitigation costs for each test in outturn prices, with costs ranging from ~£1.8 billion to ~£2.0 billion.

If a typical level of contribution for strategic transport infrastructure of £5,000 per dwelling is assumed, this would be equivalent to approximately £0.2 billion. This level of expected developer contribution per dwelling may itself be challenging to negotiate in many circumstances, given other requirements for affordable housing, starter homes, social and community infrastructure, open space, and on-site and local transport improvements.

<table>
<thead>
<tr>
<th>Test 4</th>
<th>Test 4 Sensitivity</th>
<th>Test 1</th>
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<tbody>
<tr>
<td>Total Estimated Cost (£ Million, Outturn Prices)</td>
<td>£1.8 billion</td>
<td>£1.8 billion</td>
</tr>
<tr>
<td>Potential Contribution from Development (£5k/dwelling)</td>
<td>£0.2 billion</td>
<td>£0.2 billion</td>
</tr>
<tr>
<td>Balance of Funding Requirement</td>
<td>£1.6 billion</td>
<td>£1.6 billion</td>
</tr>
</tbody>
</table>

All of the packages would cost significantly in excess of what is likely to be sourced from developer contributions. These packages would therefore require complementary funding from a range of other sources.

The proposed mitigation packages are substantial, although proportionate to the scale of development impact, and represent a significant major scheme programme to address 10 years of housing growth. At present, the West of England is investing approximately £100 million per annum on capital schemes including MetroBus construction.

C.3.3. Impacts of Tests

This section considers the impacts of the tests on overall travel conditions on the road network. It first presents the average travel times for journeys within and between the four authorities in the West of England, for a 2036 scenario but assuming no further development beyond 2026. It then presents the changes in average journey times for the three 2036 tests, first without mitigation, then including the impacts of the transport packages.

The changes in average journey times presented reflect two factors:

- The distances between the strategic locations and key attractors (e.g. employment, in particular Bristol and the North Fringe); and

- Congestion – traffic takes longer more circuitous routes to avoid congestion.

The average modelled journey time for trips in the network is forecast to be 23.6 minutes in the 2036 Base Test. This compares with an average of 22.5 minutes in 2016 and is equivalent to a rise of 5%. This takes into account future growth in travel demand but also incorporates the benefits of the planned capital investment programme in MetroBus and MetroWest.

The changes in average journey times across the West of England for each test compared to the 2036 Base Test are provided in Table C-2. The first row shows the changes in average journey times on the road.
network with no mitigation, and the second row shows the changes in average journey times including the mitigation package developed for each test.

<table>
<thead>
<tr>
<th>Without Mitigation</th>
<th>Test 1</th>
<th>Test 4</th>
<th>Test 4 Sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>With Mitigation</td>
<td>+6.5%</td>
<td>+3.2%</td>
<td>+3.0%</td>
</tr>
<tr>
<td></td>
<td>+1.0%</td>
<td>+0.1%</td>
<td>-0.5%</td>
</tr>
</tbody>
</table>

Note: based on 12 hour average, from combination of GBATS4 model outputs for AM, Inter and PM Peak periods.

As in Stage 1, this shows important differences between the tests. Test 1 showed the largest increase in journey times across the network before mitigation is applied. This is due to the relatively long distances between new housing and key destinations and significant congestion impacts on the network. Test 4 and the Sensitivity Test showed lower increases in journey times before mitigation is applied. This is due to shorter distances between new housing and key destinations and more concentrated congestion impacts.

In all cases, the mitigation packages would help to reduce the impacts of the traffic generated by new development. In the case of Test 4 and the Sensitivity Test, the transport packages would mitigate the impacts, with overall average journey times across the West of England broadly equivalent to those in the 2036 Base Test without development. However, in the case of Test 1, it was not possible to fully mitigate the impacts and overall journey times would be slightly higher than the 2036 Base Test without development.

C.4. Conclusions from Stage 2 Testing

Test 4 (and the Sensitivity Test) perform better than Test 1: they are both lower cost (but still require significant investment) and more effective. Overall the performance of Test 4 and the Sensitivity Test are similar, but with differences in the scale of impacts in the North Fringe and East Fringe.

Test 4: Conclusions

Test 4 has strengths and weaknesses. The focus on urban extensions at South West Bristol, Whitchurch, Hicks Gate, Keynsham and the East Fringe would reduce travel distances but improvements to travel choices would be needed. However, development in Nailsea/Backwell, Midsomer Norton/Radstock, Pucklechurch, Coalpit Heath, Yate and Thornbury would increase travel distances and improvements would also be required to travel choices from these locations. Midsomer Norton and Radstock are particularly problematic, with no realistic prospect of serving by rail or MetroBus. Overall, the mitigation package is estimated to cost around £1.8 billion.

Sensitivity Test: Conclusions

The Sensitivity Test also has strengths and weaknesses. It shares most of the characteristics of Test 4 itself, with the distinction of reduced development at Warmley and Pucklechurch and development instead located at Almondsbury / Hortham, Alveston and Wickwar. M5 Junction 16 is a constraint to high levels of growth on the A38 corridor. It would be preferable to control flows of traffic into the junction and encourage Park & Ride use; large-scale capacity improvements at the junction would have potential to release traffic into adjacent congested junctions, with implications for the performance of the wider network.

Development at Almondsbury / Hortham would require a strong balance of public transport penetrating the strategic location, and traffic management to control flow into Junction 16. The site would be served by the new MetroBus route connecting to Thornbury (part of the Test 4 mitigation), but would also require significant intervention at M5 Junctions 16 and 17, and potentially traffic management on Over Lane. Overall, the mitigation package is similar to that proposed for Test 4 (but with additional mitigation at M5 Junctions 16 and 17), with a total cost of around £1.8 billion.

Test 1: Conclusions

Test 1 has fundamental challenges. Locating development beyond the Green Belt results in large volumes of travel on sub-regional corridors, with poor travel choices in many cases. The road network has a number of capacity constraints, causing serious congestion problems at a number of locations. Particular problems are forecast at Yatton, Nailsea, Bristol Airport and routes from the Somer Valley to Bristol. In particular, the
testing has forecast high volumes of traffic using M5, which will be difficult to mitigate. It is possible to implement measures to promote good travel choices and mitigate impacts, but the fundamental challenges of longer-distance travel remain. The mitigation package is estimated to cost around £2.0 billion, and the mitigation package cannot fully address the journey time impact of the developments in this test.

**Urban living: Conclusions**

Urban living featured in all three tests, and the potential capacity for urban living increased since technical work on Test 1 took place. At present there is limited information about the locations for urban living. The preferable approach would be to locate high-intensity development in places with good access by public transport, walking and cycling to jobs and local services. This would provide the opportunity for car-free development and high-quality place-making.

**Guiding the JSP Process**

The testing undertaken in Stage 2 confirmed that the guiding principles identified during Stage 1 remain relevant. First, it was previously shown that areas closer to the urban area are, in general, easier to serve with good quality public transport options. This was confirmed in the testing for most of the strategic locations considered in the testing for Test 4 and the Sensitivity Test:

- The South West Urban Extension is close to central Bristol and can be easily served by MetroBus – this would also enhance the business case for a MetroBus or other rapid transit extension to the Airport;
- Whitchurch is adjacent to the Bristol urban area. It would require a new highway link between the A37 and A4, and provision of an A37 Park & Ride site;
- Keynsham / Saltford and Hicks Gate can be served by MetroBus but would require significant new road capacity to serve the proposed development areas and to tackle congestion in the town;
- Coalpit Heath could be penetrated by MetroBus (from Yate) but would also require significant highway infrastructure;
- Almondsbury / Horham could be penetrated by MetroBus (from Thornbury). M5 Junction 16 is a constraint to development on the A38 corridor. There are limited options to improve this junction, it would be preferable to control flows of traffic into the junction and encourage traffic to transfer onto Park & Ride services from a new site on the A38; and
- Sites on the East Fringe are difficult: any significant development in the East Fringe area would require major investment to transform public transport connectivity to central Bristol, including rapid transit and Park & Ride on the A420. Pucklechurch is difficult to serve by effective public transport options.

Second, many of the areas located beyond the Green Belt have relatively poor travel choices and therefore pose challenges in improving travel choices and mitigation of their impacts:

- Parts of Nailsea are isolated, with poor travel choices and poor road connectivity: this would require new MetroBus connections and improved road links – it will be challenging to provide new infrastructure to cross the railway, serve the housing sites in this area and relieve congestion on the A370;
- Employment development at Bristol Airport would require major investment (MetroBus) to improve public transport connectivity and major highway investment to mitigate impacts on the A38 corridor between the Airport and Bristol;
- Midsomer Norton has challenges: there is no realistic prospect of serving by rail or MetroBus, with resulting traffic impacts on the A37, A39 and A367 corridors. The lower levels of development in Test 4 and the Sensitivity Test would reduce the required scale of mitigation (compared with Test 1), but this would still be substantial;
- Yate would be served by MetroBus but will require highway improvements on key corridors;
• Thornbury and Alveston would be served by MetroBus and Park & Ride at M5 Junction 16 but will also require highway improvements on the A38 and other nearby corridors. M5 Junctions 14 and 16 are constraints to development on the A38 corridor;

• Other potential locations identified as options for growth (e.g. Wickwar) would be particularly difficult to serve with sustainable travel options, which would result in high levels of car dependency and impacts on the wider sub-regional road network. Wickwar in particular would contribute to impacts on M5 Junction 14; and

• Yatton (included in Test, 1 but not Test 4 of the Sensitivity Test) is reliant on its rail service: travel choices are otherwise poor, and large volumes of traffic would be likely to use M5 to reach Bristol and North Fringe.