Bath and North East Somerset Council

Core Strategy

Transport Evaluation

REP/037/13

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ARUP

Executive Summary

Bath and North East Somerset Council ('B&NES') Planning Service has appointed Ove Arup and Partners Limited ('Arup') to undertake a Transportation Evaluation of ten greenfield locations identified by the authority for consideration for inclusion within the core strategy (set out in Table A).

Table A: Locations Considered Within this Report

Location	Location
Land adjoining Weston	**Bath**
Land adjoining Odd Down	
Extension to MOD Ensleigh	
Land to the West of Twerton	
Land adjoining East Keynsham	**Keynsham**
Land adjoining South West Keynsham (South of Local Plan allocation K2)	
Uplands, South East Keynsham	
West of Keynsham	
Hicks Gate, Keynsham	**South-East edge of Bristol**
Land at Whitchurch	

The evaluation has considered each location in terms of opportunities to promote sustainable transport and potential highway impacts associated with development. Locations have been considered favourably if they are located adjacent to established sustainable transport networks which provide good access to employment destinations and local amenities and if the highway impacts are considered to be manageable through mitigation measures. The converse has been considered if development locations are isolated or are adjacent to congested highway links with little scope for mitigation without costly infrastructure provision.

Location Evaluations

Each of the ten locations has been reviewed to assess current and future access on foot, by bicycle and by public transport with journey times reviewed using ACCESSION modelling.

Vehicular trip generation has been calculated for each location based on an indicative land use schedule issued by B&NES with these trips assigned using 2001 census journey to work data. Traffic growth has been calculated for assessment years of 2021 and 2029 and this data used to assess future highway traffic volumes, impact of development and highway link capacity. Potential for mitigation of traffic impacts has been assessed based on high-level analysis and engineering judgement. Estimates have also been made as to the total mileage, CO_2 and contribution to road traffic accidents resulting from development of each location.

Based on this information the ten locations have been split into three categories:

Best Performing Locations: Land adjoining Weston, Extension to MOD Ensleigh, Land adjoining Odd Down.

Average Performing Locations: Land to the West of Twerton, Land adjoining East Keynsham, Hicks Gate, Land at Uplands

Worst Performing Locations: Land at Whitchurch, West of Keynsham, Land adjoining South West Keynsham.

Scenario Testing

Three scenarios, comprising of the different development location and land use mixes have been produced by B&NES.

Table B: Scenarios Developed by B&NES for Evaluation

Location	Scenario 1	Scenario 2	Scenario 3
Land adjoining Odd Down	300 dwellings	0 dwellings	0 dwellings
Land adjoining Weston	300 dwellings Primary school	300 dwellings Primary school	200 dwellings Primary school
Extension to MOD Ensleigh	120 dwellings	120 dwellings	120 dwellings
Land adjoining South West Keynsham	200 dwellings	450 dwellings	0 dwellings
Land adjoining East Keynsham	250 dwellings, 25,000m² employment	500 dwellings, 25,000m² employment, Primary School	25,000m² employment
Land at Whitchurch	200 dwellings	0 dwellings	800 dwellings, primary school
Somer Valley	300 dwellings	300 dwellings	400 dwellings
Rural Areas of B&NES	200 dwellings	200 dwellings	250 dwellings

Note: the Somer Valley and Rural Areas of B&NES are outside the scope of the study, but the differences between each scenario are not considered to be significant.

The sustainable transport merits of each scenario have been evaluated based on the information gathered in the individual appraisals. The cumulative impacts of traffic have also been examined with reference to highway capacity and potential for mitigation through highway capacity improvements and/or modal shift.

Scenario 1 is considered the most sustainable combination of development locations. The locations identified in Scenario 1 offers the best access to walking, cycling and public transport facilities/services. Scenario 1 locations also forecast to result in the lowest net increase in commuter car travel, CO_2 emissions and road traffic accidents. Highway impacts associated with Scenario 1 have the most scope for mitigation through modal shift, park and ride and highway capacity improvements.

Scenario 2 and Scenario 3 include development at locations which are less sustainable than development at Bath on the Land adjoining Odd Down included in Scenario 1. Scenario 3 provides better potential access to sustainable transport facilities as Land at Whitchurch is connected to the NCN and well served by buses operating on the A37. However the development area is isolated from major employment areas and the ward exhibits higher car dependency. Scenario 2 is

forecast to result in less additional commuter mileage, CO_2 emissions and road traffic accidents. Overall scenario 2 is considered marginally preferable to Scenario 3 as the dispersal of development across locations reduces the impact at any one location offering better scope for local highway capacity improvements and demand management measures. In addition to dispersion, the potential for greater in-commuting to Bath from the east (Wiltshire) needs to be considered as with Scenario 3 there will be a greater imbalance between jobs and housing within the Bath Travel to Work Area (BTWA). Whitchurch lies outside the BTTWA, but parts of west and north Wiltshire lie within the BTTWA.

Scenario 1 is therefore recommended for adoption with Scenario 2 the preferred alternative.

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1 Introduction

1.1 Background

Bath and North East Somerset Council ('B&NES') Planning Service has appointed Ove Arup and Partners Limited ('Arup') to undertake a Transportation Evaluation of ten greenfield locations within the authority that are being considered for promotion through the Core Strategy. The ten locations, selected by the Council, have previously been assessed through the Sustainability Appraisal and the Strategic Housing Land Availability Assessment (SHLAA). These locations would, if taken forward, provide urban extensions to Bath, Keynsham or south-east Bristol.

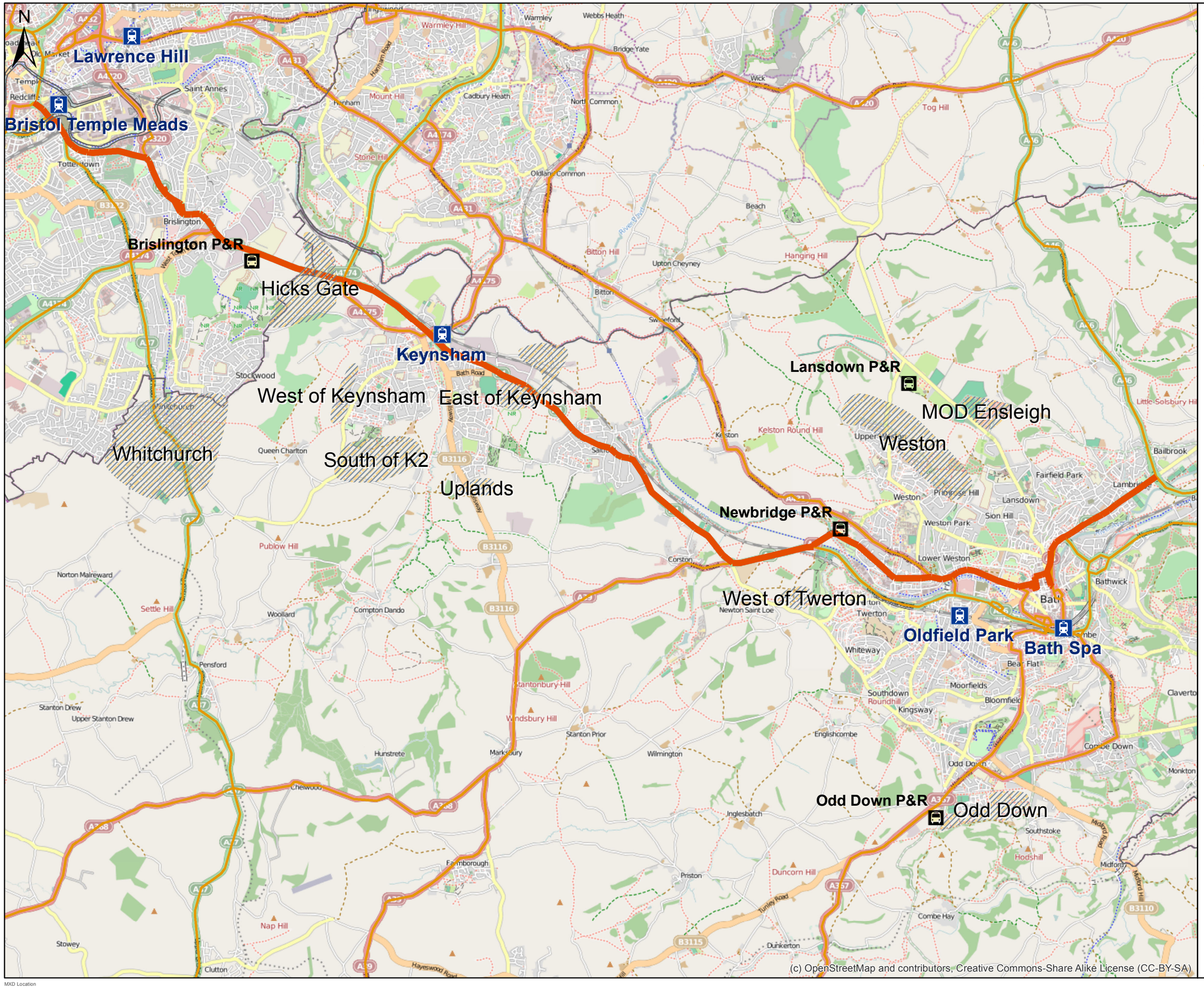
A transport evaluation is required to inform the choice of locations and scale of development, which will be promoted within the Core Strategy, as well as the key requirements that would be set out in the Core Strategy. The analysis considers the 'pros and cons' of each location in terms of opportunities to promote sustainable transport and potential highway impacts associated with development. This will inform the conclusions about which locations should be developed as part of a comprehensive strategy.

The ten locations considered are listed below in **Table 1**. A plan identifying each location is included as **Figure 1**.

Table 1: Potential Greenfield Development Locations Evaluated

Location	**Location**
Land adjoining Weston	**Bath**
Land adjoining Odd Down	
Extension to MOD Ensleigh	
Land to the West of Twerton	
Land adjoining East Keynsham	**Keynsham**
Land adjoining South West Keynsham (South of Local Plan allocation K2)	
Uplands, south east Keynsham	
West of Keynsham	
Hicks Gate, Keynsham	**South-East edge of Bristol**
Land at Whitchurch	

A3



Legend

- Park & Ride Sites
- Rail Stations
- Site Locations
- District Boundaries
- A4 Trunk Road
- A-Roads

Issue	Date	By	Chkd	Appd
P0	Feb 2013	HH	DW	AJ

Metres
0 700 1,400 2,800

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Bath & North East Somerset

Job Title

B&NES Core Strategy - Transport

Figure 1
B&NES - Transport Overview

Scale at A3

1:55,000

Job No	Drawing Status
229042-00	**Preliminary**

Drawing No	Issue
002	**P0**

MXD Location

1.2 Planning Strategy

The Core Strategy, when adopted, will guide future development; there is a need to rule out those locations which are unsuited to development. Within the strategy B&NES is planning for 12,700 additional homes between 2011 and 2029. It is estimated that around 10,800 can be accommodated on locations identified within the Strategic Housing Land Availability Assessment (predominantly brownfield land) with the shortfall to be provided at greenfield locations. All of the locations being assessed in this study lie within the existing Green Belt, except for the extension to MOD Ensleigh, which lies outside but adjoining the Green Belt.

In the interests of promoting sustainable travel and reducing vehicular mileage, there is a desire to locate future housing close to prime employment growth areas in the authority: Bath and Keynsham.

As Bath is the primary location within the authority for employment and retail opportunities, it is preferable to allocate housing adjacent to Bath in general planning terms.

It is understood that Bristol City Council (BCC) has already identified, and is planning for, sufficient housing to meet its needs through its adopted Core Strategy and as such there is no unmet need arising from Bristol that is required to be met on the south eastern edge of the city. BCC are also seeking to regenerate south Bristol.

The Keynsham locations lie between Bath and Bristol. Keynsham is well linked to both Bath and Bristol with the town's population primarily looking towards the two cities for employment opportunities.

Each location has been evaluated separately based on the maximum development potential of the location. The evaluation has reviewed:

- Walking catchments;
- Cycling catchments and infrastructure;
- Access to public transport services;
- Trip generation; and
- Highway infrastructure and potential mitigation.

This information has then been used to inform an evaluation of three development scenarios comprising of different development locations and land use schedules.

1.3 Structure of this Report

This report has been structured into the following sections:

- Section 2 presents the study methodology.
- Section 3 identifies the key highways in the study area based on vehicular speed and journey time analysis.

- Sections 4 provides comparison of the ten locations in terms of sustainable transport and highways impacts based on individual evaluations provided in Appendices A-J.
- Section 5 summarises the transport opportunities and forecast cumulative impacts associated with development of each of three scenarios.
- Section 6 looks at the range of transport measures which could be adopted to facilitate development.
- Section 7 presents conclusions and recommendation.

2 Study Methodology

Due to the challenging project programme the agreed approach was to undertake a high level evaluation of locations and cumulative impacts informed by existing data sources and mapping software. The analysis forms an initial test which will help to inform the identification of greenfield development locations in the Core Strategy.

The evaluation will seek to:

- Generate the likely number of trips for each location;
- Consider walking and cycling opportunities;
- Consider public transport opportunities;
- Derive the impact of proposed development on highway key links;
- Indicate likely high-level mitigation proposals where appropriate; and
- Summarise the transport context for development at each location.

Having considered each location individually a series of scenarios has been defined by B&NES which will allow consideration of cumulative effects.

A summary review of the cumulative impacts associated with each scenario will be presented.

2.1 Data Utilised

To inform the evaluation a range of data has been provided by B&NES and BCC:

- Automatic Traffic Counts;
- Manual Classified Count data;
- Whitchurch Park and Ride Report;
- Journey Time Isochrones;
- B&NES Cycle Network map;
- B&NES Public Transport Network; and
- Journey time data provided by B&NES.

2.2 Walking and Cycling Evaluation

A review of walking and cycling opportunities forms the initial consideration as these are the most sustainable modes of transport.

Consideration has also been given to the existing footway and cycle network provisions i.e. are there established connections and what is the standard of infrastructure?

The proximity of each potential development area to established walking and cycle networks has been considered and subsequently 20 minute walk and cycle time isochrones have been plotted using ACCESSION software. The output map indicates how far someone could travel in 20 minutes on foot or by cycle. Should

the isochrones include opportunities to travel to work and areas of retail then the location will be considered positively.

Walking and cycling ACCESSION analysis undertaken for each location is provided within the individual evaluations in Appendices A-J.

2.3 Public Transport Evaluation

The evaluation of each location in public transport terms considers proximity to established public transport services. This includes proximity to bus routes and to rail stations.

The number of bus services serving stops within 400m of each development location has been examined. School specific services and services with a frequency less than one bus every 30 minutes have been excluded from analysis.

Consideration has been given to opportunities for extension, diversion or creation of new services with reference to diversion routes and likely demand resulting from development.

Rail capacity has not been considered a potential issue due to proposed changes in local and regional rail services outlined later in this report.

Public transport analysis for each location is provided within the individual evaluations in Appendices A-J.

2.4 ACCESSION

The following assumptions have been made in the development of ACCESSION analysis. These assumptions determine the model parameters in terms of how fast people walk, how far they are likely to walk and the propensity to change between public transport modes.

- Average walk speed 4.8km/hr.
- Straight line walk distance factor 1.5. Routes from within the developmental area to existing routes are drawn using a straight line, however this length is multiplied by a factor of 1.5 to account for a less direct route being provided in practice.
- Maximum connection distance 0.8km. The furthest a resident would walk to access a public transport service from their home.
- Maximum interchange distance 0.5km. The furthest a passenger would walk to interchange with another public transport service.
- First wait time included.

2.5 Evaluating Highways Implications of Development

The construction of new residential developments leads to additional demands for transport associated with new residents undertaking journeys to work, education, retail and leisure facilities. While every effort should be made to encourage such trips to be undertaken through sustainable modes, it is inevitable that urban extensions will result in additional vehicular trips, particularly journeys to work.

Programme and budget considerations precluded the use of the GBATH and GBATS strategic models (SATURN based). In the absence of an available multi-modal transport model, a spreadsheet model has been produced to calculate the number of trips and assignment of traffic resulting from development at each of the locations.

This model has calculated trips based on an indicative land use schedule for each location with trip generation based on 2011 Census journey to work data and assignment based on 2001 Census journey to work data (the latest available for assignment). While the model lacks reassignment or modal shift to account for future congestion, it provides an initial evaluation of trip patterns and traffic volumes suitable for engineering judgements to be made as to the relative suitability of each location for development, in terms of highways access and impacts.

2.5.1 Trip Generation

2.5.1.1 Trip Rates

Trip generation to/from each development area has been estimated using peak hour trip rates obtained from the TRICS database for comparable land uses elsewhere in the UK. Trip rates are summarised in Table 2.

Table 2: Trip Generation Rates, TRICS

Land Use	Unit	AM Peak Hour		PM Peak Hour	
		Inbound	Outbound	Inbound	Outbound
Private Housing	Per dwelling	0.151	0.471	0.446	0.251
Affordable Housing	Per dwelling	0.069	0.237	0.301	0.185
Primary School	Per pupil	0.395	0.274	0.016	0.029
Industrial Estate	Per 100m² GFA	0.616	0.300	0.133	0.484

An indicative land use schedule was produced for each location by B&NES. These land use schedules specified a primary school for 220 pupils within each area with the exception of "Land to the West of Twerton" and employment space at "Land adjoining East Keynsham" and "Hicks Gate". It is therefore appropriate to apply discounts to account for "internal capture" whereby people live and work in the development, or escort their child to work as part of a journey to work.

TRICS output reports are provided in Appendix M.

2.5.1.2 Internal Trip Capture

To account for internal trip capture associated with people living and working on the same neighbourhood, a reduction of 10% was made to employment vehicular arrivals with the corresponding number of trips discounted from the number of residential departures.

To calculate the reduction in primary school trips the following methodology was adopted:

- Staff trips were calculated by assuming the difference between vehicular arrivals and departures is due to staff trips (i.e. no children drive). All remaining trips are assumed to relate to pupil escort.
- The number of children living on each development was calculated based on 0.3 children per dwelling.
- The proportion of children living on-site as a total of all school children was calculated.
- Car trips were then disaggregated into staff, pupil (living on-site) and pupil (living off-site).
- Based on UK travel survey data it is estimated that 60%[1] of drivers return home after escorting their child to education. These trips were therefore discounted from the residential departures and school arrivals as they never enter or exit the development (they are an internal trip). The remaining 40% of trips are assumed to travel off-site for employment, retail or leisure purposes (i.e. the parent drops off their child at school and continues on to work).

2.5.2 Modal Share Normalisation

Using the TRICS data, each development location generates the same number of car trips per household regardless of location within the local authority. Within B&NES there is significant variation in travel behaviour attributable to a variety of factors including:

- The number of shops and services within walking/cycling distance;
- Access to public transport services;
- Car ownership;
- On-street parking controls; and
- Distance to employment centres.

To account for this variation, the car modal share for trips generated by each location was normalised to that of a representative ward within B&NES, typically the ward the area is located within. Mode share for each ward has been taken from Census 2011 journey to work data with the normalisation values calculated in Table 3. Mode share tables for wards in Bath are provided in Appendix N.

Through application of the normalisation factors to vehicular trip generation each development area more closely models the neighbourhood it will join. This process was adopted in order for trip generation to reflect the location of development and was considered valid given the high-level nature of this study.

[1] Transport Statistics Bulletin, National Travel Survey:2005, Department for Transport, 2006

Table 3: Car Modal Share, Normalisation Factors

Location	Representative Ward	Veh Mode Share: TRICS	Veh Mode Share[2]:	Normalisation Factor
Land adjoining Weston, Bath	Weston	72%	53%	74%
Land adjoining Odd Down, Bath	Odd Down[3]		61%	85%
Extension to MOD Ensleigh, Bath	Lansdown		43%	59%
Land to the West of Twerton, Bath	Bathavon West		69%	96%
Land adjoining East Keynsham	Keynsham East		72%	100%
Land adjoining South of Keynsham	Keynsham South		68%	94%
West of Keynsham	Keynsham North		64%	90%
Land at Uplands, Keynsham	Keynsham East		72%	100%
Hicks Gate, Keynsham	Keynsham North		64%	90%
Land at Whitchurch	Publow and Whitchurch		81%	112%

Application of these normalisation factors to the trip rates shown in Table 2 produces the location specific trip rates shown in Table 4 for private housing.

Table 4: Location Specific Trip Generation Rates for Private Housing

Location	Unit	AM Peak Hour		PM Peak Hour	
		Inbound	Outbound	Inbound	Outbound
TRICS Rate		0.151	0.471	0.446	0.251
Land adjoining Weston	0.74	0.112	0.349	0.330	0.186
Land adjoining Odd Down	0.85	0.128	0.400	0.379	0.213
Extension to MOD Ensleigh	0.59	0.089	0.278	0.263	0.148
Land to the West of Twerton	0.96	0.145	0.452	0.428	0.241
Land adjoining East Keynsham	1.00	0.151	0.471	0.446	0.251
Land adjoining South of Keynsham	0.94	0.142	0.443	0.419	0.236

[2] Vehicle mode share is calculated based on the sum of "car as driver", "taxi" and "motorcycle" as all three modes result in vehicular trips from the development area.
[3] Development area is located within Bathavon South but Odd Down was considered more representative.

Location	Unit	AM Peak Hour		PM Peak Hour	
		Inbound	Outbound	Inbound	Outbound
West of Keynsham	0.90	0.136	0.424	0.401	0.226
Land at Uplands	1.00	0.151	0.471	0.446	0.251
Hicks Gate, Keynsham	0.90	0.136	0.424	0.401	0.226
Land at Whitchurch	1.12	0.169	0.528	0.500	0.281

These trip rates were benchmarked against AM peak hour trip rates for all "edge of town" and "edge of town" and "suburban" locations in the TRICS database (refer to Appendix O for copies of these tables).

As a result it was agreed with B&NES officers that the trip rates calculated for the Lansdown location were disproportionately low, especially given the location of the development area. It was therefore agreed that the trip rates for Odd Down would be used to calculate vehicular trips from the Extension to MOD Ensleigh area as this provided a more robust case for evaluation. The Odd Down ward was selected as it is a similar distance from Bath city centre with similar topographic constraints.

It was agreed with B&NES officers that the trip rates calculated for other locations broadly reflected the general pattern of behaviour in Bath and were suitable for use in the study.

Vehicular trip generation and distribution for each location based on location specific trip rates is provided in Appendix P. The number of peak hour journeys to/from each development area by public transport, walking and cycling has also been estimated by application of census 2011 mode share data for J2W.

2.5.3 Trip Distribution

Vehicular trip distribution has been undertaken based on Year 2001 Census journey to work data[4], issued in Appendix Q.

For the purposes of identifying primary destinations trip distribution has been grouped into eight areas for each ward:

- Bath;
- Keynsham;
- Midsomer Norton, Radstock, Westfield;
- Other B&NES;
- Bristol;
- South Gloucestershire;
- Somerset;

[4] Journey to work distribution is not available at ward level for Year 2011 Census.

- Wiltshire; and
- Other.

2.5.4 Trip Assignment

Trip assignment was undertaken based on three local area assignment models:

- Western and Central Bath – Land adjoining Weston, Land adjoining Odd Down, Lansdown and Land to the West of Twerton.
- Keynsham – Land adjoining East Keynsham, South of Keynsham, West of Keynsham and Land at Uplands.
- South-East Bristol Urban Extensions – Hicks Gate and Land at Whitchurch.

Trips from each location have been distributed onto these local area networks. The number of trips on key links outside of a model – for example the A4 through Saltford – has also been calculated. Trip assignment within Keynsham has been determined using the distribution of year 2001 census journeys to work for car drivers amongst wards in the town. Ward maps are provided in Appendix N.

Table 5: Distribution within Keynsham[5]

Ward	Distribution: Census 2001	
	Car as Driver Only	All Modes
Keynsham North	40%	40%
Keynsham South	31%	31%
Keynsham East	29%	29%
Total	100%	100%

Trip Assignment within Bath has been determined using the distribution of Year 2001 Census journey to work data for car drivers amongst wards in the city.

Table 6: Distribution within Bath[6]

Ward	Distribution: Census 2001	
	Car as Driver Only	All Modes
Abbey	19%	30%
Bathwick	9%	7%
Combe Down	5%	4%
Kingsmead	9%	10%
Lambridge	3%	3%
Lansdown	8%	6%
Lyncombe	5%	4%
Newbridge	14%	11%
Odd Down	2%	2%

[5] Distribution of all journeys originating within B&NES destined for Keynsham wards.
[6] Distribution of all journeys originating within B&NES destined for Bath wards.

Ward	Distribution: Census 2001	
	Car as Driver Only	All Modes
Oldfield	3%	2%
Southdown	2%	2%
Twerton	3%	3%
Walcot	3%	3%
Westmoreland	5%	4%
Weston	2%	2%
Widcombe	8%	7%
Total	100%	100%

Trip Assignment within Bristol has been determined using the distribution of Year 2001 Census journeys to work for car drivers amongst wards in the city. For the purposes of assignment Bristol wards were grouped into four categories as required to identify the most likely route on the road network.

Table 7: Distribution within Bristol[7]

Ward	Distribution: Census 2001	
	Car as Driver Only	All Modes
Brislington Ward	12%	11%
City Centre/Inner City	58%	64%
Northern/Eastern Wards	15%	12%
Southern Wards	15%	13%
Of which:		
Bishopsworth	*2%*	*2%*
Filwood	*2%*	*3%*
Hartcliffe	*2%*	*1%*
Hengrove	*4%*	*3%*
Knowle	*1%*	*1%*
Stockwood	*1%*	*1%*
Whitchurch Park	*3%*	*2%*

Link traffic forecasts are provided for each development location in Appendix T.

2.5.5 Background Traffic

2.5.5.1 Base Year Data

Background traffic volumes have been taken from data provided by B&NES and BCC in the form of Automatic Traffic Counts and Junction Turning Counts.

The majority of traffic count data provided is for year 2012. Older count data has been used at a few locations (six of the 41 links examined) where more up-to-date information was not available. As this data was typically gathered prior to the recent economic downturn (2007-2009) growth factors have not been applied as

[7] Distribution of all journeys originating within B&NES destined for Bristol wards.

local and national patterns suggest that traffic levels have fallen due to a reduction in economic activity. The older data therefore provides a worst-case assumption. At one location (Lansdown Lane) count data was from year 2003 and this has been factored up to a year 2012 base using Tempro factors.

Traffic count and speed data issued by B&NES is provided in Appendix R.

2.5.5.2 Traffic Growth

Growth factors have been applied to factor baseline traffic count data to the study horizon year of 2029 and an interim assessment year of 2021. These growth factors have been calculated using the methodology prescribed in TAG Guidance 3.15.2 "Use of TEMPRO data".

Tempro V6.2 is the latest version of the Department for Transport (DfT) approved software which takes account of short term reductions in growth rates as a result of the economic slowdown in recent years.

Growth factor calculations are provided in Appendix S.

Table 8: Peak Hour Growth Factors

Growth Period	**2012-2021**	**2012-2029**
Growth Factor	1.170	1.310

Tempro growth factors have not been adjusted to account for individual development locations as any change resulting from the modification of future housing forecasts is not significant.

Brownfield development locations identified within the core strategy have not been explicitly modelled with Tempro growth rates assumed to reflect growth associated with all residential development over the study period. "Background traffic growth" therefore accounts for increases in traffic resulting from development associated with implementation of the Core Strategy.

It should be noted that in practice traffic growth will occur at different rates depending on the exact area, highway classification/location and scope for development in the area. For consistency a general factor for B&NES has been calculated and applied. Furthermore the spreadsheet model has no facility to reassign or limit traffic to the capacity on approach roads – it is therefore possible for links to be shown as overcapacity when in practice the surrounding links and junctions will limit the scope for growth.

2.5.6 Highway Capacity

Highway link capacity has been calculated for key local and strategic highways using the "Determination of Urban Road Capacity" methodology specified in the Design Manual for Roads and Bridges (DMRB). Carriageway width has been measured using OS mapping data with road classification based on engineering judgement informed by site visits, OS mapping and satellite photography. The carriageway link capacity calculations are set out in Appendix U.

It should be noted that the link capacity calculations produced by DMRB are design values not an absolute values. Highways can operate above the DMRB

link capacity but such highways are likely to experience erratic driver behaviour resulting in queues and delays.

It should also be noted that in urban environments, such as central Bath, Keynsham or south-east Bristol, that junction capacity is often the key constraint rather than highway link capacity. The analysis presented therefore gives an indication of the relative impacts of each location, but the full extent of queues and delays can only be quantified as part of a full Transport Assessment.

2.5.7 Evaluating the Impact of Development

To provide an initial indication as to the highway implications of development the following indicators are examined for key links within the study area:

- Percentage increase in traffic resulting from development.
- Percentage of highway link capacity required to accommodate development traffic.
- Total traffic volumes as a percentage of highway link capacity.

Where information is available, reference has also been made to journey time data available from traffic models or measurement.

To assess the potential for highway improvement works, a site visit has been undertaken supported by mapping analysis. This information has been used to categorise which highways and junctions have potential for improvement. A detailed assessment of factors (land ownership, topography, junction modelling) is beyond the remit of this study and would be required as part of a Transport Assessment.

2.6 Additional Analysis

2.6.1 Mileage Calculations

The additional mileage generated by development has been calculated by assigning commuting trips to each of the wards within B&NES and key destination outside of the authority (for example Bristol). Journey distances have been calculated using online journey estimating tools.

Mileage calculations are for two-way peak hour commuter trips only and do not include vehicular trips made for other purposes. These values are not absolute, but provide a means of assessing the relative merits of each location.

2.6.2 CO_2 Calculations

The amount of additional CO_2 generated by commuter car trips to/from each location has been calculated at 2001 Census wards origin-destination pairs level. The calculation uses the following equation:

$$\boldsymbol{ODCO_2 = OD_{trip} \times OD_{distance} \times CO_2/km}$$

where:

- OD_{trip} is the number commuter trips for each origin-destination pair (vehicle trip)
- $OD_{distance}$ is the road distance for each origin-destination pair (km)
- CO_2/km a standard factor of 0.128 is the amount of CO_2 emitted every km travelled (unit = kg/km)

These values are not absolute, but provide a means of assessing the relative merits of each location.

2.6.3 Accident Calculations

The number of additional road traffic accidents which could rise from development at each location has been calculated according to traffic flow and default accident rates for different road classifications (COBA Manual Table 4/1). The formula assumed in calculations is:

$$Link_{VEH} \times 365 \times Link_{km} \times A_N$$

Where:

- $Link_{VEH}$ is the daily traffic on road (vehicle)
- 365 is the number of days in a year
- $Link_{km}$ is the length of the road (km)
- A_N is the accident rate or number of casualties per accident (Pia/mvkm)

The calculations assume the accident rates by road type for year 2013 shown below.

Table 9: Assumed Accident Rate by Road Type

Road speed	Road type	Accident per year
50/60/70 mph	D2 Roads	0.100
	S2 Roads	0.146
30/40 mph	D2/S2 Roads	0.245

The calculation looked at accidents on journeys from the development locations to four key destinations in the area: Bath, Keynsham, Bristol and South Gloucestershire (NE of Bristol).

2.7 Data Limitations

The approach undertaken has resulted in a broad analysis for each location, and has allowed the calculation of demand versus capacity for the main highway links on the network.

The spread sheet model does not allow for the impact of every link to be considered, nor does it allow for redistribution of traffic on congested links. Furthermore highway capacity in urban environments is typically governed by junction rather than link capacity. The analysis presented therefore provides for high-level consideration as to the routing and potential implications associated with development for the purposes of comparative evaluation. This approach is considered adequate to inform initial evaluation, particularly given the programme

constraints. More detailed evaluation should be undertaken for each location as part of a Transport Assessment submitted alongside any planning application.

Public transport evaluation is informed by professional experience and judgement and a broad overview of the likelihood of transport service provision. No consultation has been undertaken with bus or rail operators.

3 Highway Speeds & Journey Time

3.1 Introduction

B&NES has provided *Strat-e-gis* average journey time and average speed information for highway links within the authority. This data has been used to identify existing congestion and long journey times with a view to highlighting the key links where additional traffic resulting from development should be avoided where possible.

3.2 South-East Bristol Highways

Table 10 provides this data for key links in and around south-east Bristol. This shows that five of the 16 links listed have an average speed below 15mph in the AM and PM peak hours:

- A37 Staunton Ln to A4/A37 3 Lamps Jct - northbound
- A4/A37 3 Lamps Jct to A37 Staunton Ln - southbound
- A4/A37 3 Lamps Jct to A4 Stockwood Rd - eastbound
- A4174/A37 Jct to A4174/A4 Jct (Callington Rd) -eastbound
- A4 Hicks Gate Rbt to A4/Stockwood Rd - westbound

The A4 Stockwood Rd to A4/A37 3 Lamps Jct, westbound has an average speed below 15mph in the AM peak hour and an average speed of 17 mph in the PM peak hour. Inter-peak journey speeds are slightly higher at an average of 19mph, but still result in a journey time of seven minutes.

The data shows the importance of avoiding additional traffic volumes along the A4 and the A37 in particular, with the A37 having average speeds below 10mph in peak hours.

Journey times and speeds along the A4174 Ring Road are generally good.

Average speeds along the A4 Keynsham bypass are significantly slower in the AM peak hour, but remaining acceptable compared to other links in the area with a minimum average speed of 26mph recorded.

Table 10: Speed and Journey Time, South-East Bristol Highways

Route	Time-Minutes (Average Speed Mph)		
	AM Peak 0800-0900	PM Peak 1700-1800	Off-Peak 1100-1200
A37 Staunton Ln to A37 Hursley Ln (SB)	1.9 (35)	1.9 (34)	1.9 (33)
A37 Hursley Ln to Staunton Ln (NB)	2 (19)	2.3 (29)	2.3 (29)
A37 Staunton Ln to A4/A37 3 Lamps Jct (NB)	21.5 (8)	12.7 (13)	11.5 (15)
A4/A37 3 Lamps Jct to A37 Staunton Ln (SB)	12.7 (13)	16.4 (10)	10.1 (17)
A4 Stockwood Rd to A4/A37 3 Lamps Jct (WB)	12.8 (10)	7.9 (17)	6.9 (19)
A4/A37 3 Lamps Jct to A4 Stockwood Rd (EB)	10.7 (12)	15.1 (9)	8.3 (16)
A4174/A37 Jct to A4174/A4 Jct (Callington Rd) (EB)	6.1 (9)	5.3 (10)	3.5 (15)
A4174/A4 Jct to A4174/A37 Jct (Callington Rd) (WB)	3.1 (17)	3.1 (17)	2.8 (19)
A4/Stockwood Rd to A4 Hicks Gate Rbt (EB)	1.8 (32)	2.2 (26)	1.8 (33)
A4 Hicks Gate Rbt to A4/Stockwood Rd (WB)	5 (12)	4.2 (14)	2.4 (25)
A4174 Kingsfield Rbt to A4 Hicks Gate Rbt (SB)	2.8 (37)	2.7 (38)	2.4 (43)
A4 Hicks Gate Rbt to A4174 Kingsfield Rbt (NB)	2.1 (50)	2.1 (49)	2.1 (48)
A4 Hicks Gate Rbt to A4 Broadmead Rbt (EB)	3.2 (32)	2 (51)	1.9 (53)
A4 Broadmead Rbt toA4 Hicks Gate Rbt (WB)	4 (26)	2.5 (41)	2.1 (49)

3.3 Keynsham and Saltford Highways

Table 11 provides data for key links in and around Keynsham, including the A4 through Saltford. This shows that four of the ten links listed have an average speed below 15mph in the AM and PM peak hours:

- Bristol Rd/Station Rd Rbt to High/Temple St Rbt - southbound
- High/Temple St Rbt to Bristol Rd/Station Rd Rbt - northbound
- High/Temple St Rbt to Bath Hill/B3116 Rbt - eastbound
- Bath Hill/B3116 Rbt to High/Temple St Rbt - westbound

The above highways are all located in central Keynsham and illustrate that traffic heading into the town centre is likely to experience significant delays. There is also little difference between peak and inter-peak hour speeds, indicating that congestion is not confined to peak hours. Traffic from the east or west of the town is therefore more likely to use the bypass than travel through the centre.

Journey times and average speeds on approaches into Keynsham (Bath Road, Durley Hill) are considered acceptable given speed limits and character of these routes.

Average speeds along the A4 through Saltford are slowest eastbound in the AM peak (18mph), and westbound in the PM peak (21mph). The route is a combination of 30mph, 40mph and national speed limit sections and average speeds in the minor direction of travel are 27mph in peak hours, suggesting some peak hour congestion in the primary direction of travel.

Table 11: Speed and Journey Time, Keynsham Highways

Route	Time-Minutes (Average Speed Mph)		
	AM Peak 0800-0900	PM Peak 1700-1800	Off-Peak 1100-1200
A4 Broadmead Rbt to A4/A39 Globe Rbt (EB)	9.9 (18)	6.6 (27)	6 (30)
A4/A39 Globe Rbt to A4 Broadmead Rbt (WB)	6.6 (27)	8.4 (21)	6.1 (29)
Hicks Gate Rbt to Bristol Rd/Station Rd Rbt (EB)	2.5 (24)	2.5 (24)	2.4 (25)
Bristol Rd/Station Rd Rbt to Hicks Gate Rbt (WB)	3.6 (16)	2.8 (21)	2.5 (24)
Bristol Rd/Station Rd Rbt to High/Temple St Rbt (SB)	1 (13)	1.2 (10)	1.3 (10)
High St//Temple St Rbt to Bristol Rd/Station Rd Rbt (NB)	1.2 (11)	1.5 (8)	1.9 (6)
High St./Temple St Rbt to Bath Hill/B3116 Rbt (EB)	1.1 (14)	1.2 (14)	1 (16)
Bath Hill/B3116 Rbt to High St/Temple St Rbt (WB)	1.1 (14)	1.1 (15)	1 (16)
Bath Hill/B3116 Rbt to A4 Broadmead Rbt (EB)	1.4 (20)	1.4 (20)	1.4 (20)
A4 Broadmead Rbt to Bath Hill/B3116 Rbt (WB)	1.4 (20)	1.4 (16)	1.4 (20)

3.4 Bath Highways

Table 12 provides data for key links in and around Bath. This shows that three of the ten links listed have an average speed below 15mph in the AM and PM peak hours:

The slowest average speeds are recorded on the A4/A36 Twerton Fork to A4/A3604 Windsor Br Rd which is likely to experience additional traffic demand along its eastern section if development at Land adjoining Weston proceeds.

Two other sections of highway experience average journey speeds below 15mph in just the AM peak hour, but have PM peak hour speeds equivalent to that of the inter-peak indicating significantly less congestion between 1700 and 1800:

- A367 Wellsway/Frome Rd Rbt to Churchill Br. (NB)
- A3062 Bradford/Southstoke Rd to Claverton St (NB)

These two locations would potentially be affected by development at Land adjoining Odd Down.

Overall the analysis identifies east-west routes into Bath, in particular those in north-west Bath as key links sensitive to the traffic impacts of additional development.

Table 12: Speed and Journey Time, Bath Highways

Route	Time-Minutes (Average Speed Mph)		
	AM Peak 0800-0900	PM Peak 1700-1800	Off-Peak 1100-1200
A4/A39 Globe Rbt to A4/A36 Twerton Fork (EB)	1 (43)	0.9 (47)	0.9 (47)
A4/A36 Twerton Rbt to A4/A39 Globe Rbt (WB)	1.1 (43)	1.3 (37)	1.1 (41)
A4/A36 Twerton Fork to A4/A3604 Windsor Br Rd (EB)	7.7 (12)	6.1 (15)	4.4 (21)
A3604 Windsor Br Rd to A4/A36 Twerton Fork (WB)	4.2 (21)	6 (15)	3.8 (24)
A431/Combe Pk Rbt to A3604 Windsor Br Rd (EB)	3.6 (6)	2.7 (8)	1.7 (13)
A3604 Windsor Br Rd to A431`/Combe Pk Rbt (WB)	1.5 (14)	1.6 (14)	1.3 (17)
A367 Wellsway/Frome Rd Rbt to Churchill Br. (NB)	10.7 (10)	5.3 (21)	4.9 (22)
Churchill Br. to A367 Wellsway/Frome Rd Rbt (SB)	5.8 (19)	7.5 (15)	4.4 (25)
A3062 Bradford Rd /Southstoke Rd to Claverton St (NB)	9 (13)	5.9 (20)	5.1 (23)
Claverton St to A3062 Bradford Rd/Southstoke Rd (SB)	6.8 (17)	6.1 (19)	4.8 (25)

3.5 Conclusions

The journey time and average speed data has identified a number of highway links particularly sensitive to changes in traffic demand due to existing low journey speeds indicating congestion. The majority of these links are in south-east Bristol (A37, A4) and north-west Bath (A4, A431) with Keynsham town centre identified as a constraint to cross town travel.

4 Comparison of Individual Locations

4.1 Introduction

The purpose of this section is to provide comparative evaluation of the locations based on access and opportunities for sustainable behaviour and highways impacts. This section has been based on the findings of the individual evaluations presented in Appendices A to J.

Within each section is a summary table with each location given a colour corresponding to development potential; green for locations performing well, yellow for average, red for poor. Supporting narrative for each location is provided within the table.

4.2 Sustainable Transport

4.2.1 Walking

Based on the analysis undertaken for each location the Land adjoining Weston and Odd Down areas are believed to be the most conducive to walking due to existing infrastructure and proximity to local centres. Four locations (Land to the West of Twerton, Land adjoining South West Keynsham, Uplands and Hicks Gate) score poorly due to their relative isolation, which would result in greater car dependent behaviour for access to employment, retail and leisure facilities.

Table 13: Comparative Evaluation of Locations: Potential for Walking

Location	Ward Modal Share[8]	Comments
Land adjoining Weston	22%	Close proximity to amenities. Opportunities to tie into existing networks and established walking culture.
Land adjoining Odd Down	12%	Close to Odd Down amenities and opportunities to tie in established walking networks in the area.
Extension to MOD Ensleigh	32%[9]	Somewhat detached from local amenities but ward walking culture and opportunities to tie into established networks.
Land to the West of Twerton	9%	Isolated with journey distances deterring walking. No established networks/amenities.
Land adjoining East Keynsham	8%	Opportunities to tie into existing networks along Bath Rd and A4. Distance to town centre could deter walking.
Land adjoining South West Keynsham	12%	Isolated location and detached from local amenities. No established networks, but K2 development could establish routes.
Land at Uplands	8%	Isolated location with relatively long walk distances into Keynsham. No local amenities.

[8] Ward model share based on journey to work data for year 2011. Excludes those not in employment but includes those working from home.
[9] The Lansdown value show is considered an overestimate given the location of the developmental area and the values for the Odd Down ward are therefore considered more appropriate to this location.

Location	Ward Modal Share[8]	Comments
West of Keynsham	12%	Opportunities to link into existing networks. Closer to town centre than other locations, but distance could deter walking.
Hicks Gate, Keynsham	12%	Isolated location detached from local amenities.
Land at Whitchurch	5%	Close to Whitchurch village but too far from existing and future employment centres for walking to be a major mode of commuter travel.

4.2.2 Cycling

Based on the analysis undertaken for each location the Land to the West of Twerton area is considered to be the least conducive to encouraging cycling due to its distance from the centre of Bath.

The two Bristol extensions (Land at Whitchurch and Hicks Gate, Keynsham) have good access to the National Cycle Network (NCN) and are therefore considered well served for facilities. Furthermore cycling provides a means of accessing major employment areas within a 20-minute commute (Hengrove Park and Brislington respectively) and Bristol city centre is within a 25-minute commuter cycle. Land adjoining Weston, Land adjoining Odd Down, MOD Ensleigh and Land adjoining East Keynsham are also considered well placed to facilitate journeys by cycle into central Bath.

Table 14: Comparative Evaluation of Locations: Potential for Cycling

Location	Ward Modal Share[10]	Comments
Land adjoining Weston	5%	Trips to central Bath possible in < 20 min
Land adjoining Odd Down	3%	Trips to central Bath possible in < 20 min
Extension to MOD Ensleigh	3%	Trips to central Bath possible in < 20 min
Land to the West of Twerton	2%	Isolated, trips to central Bath > 20min
Land adjoining East Keynsham	3%	Trips to Bath and Bristol possible ~ 20 min Possibility of linking development to NCN4
Land adjoining South West Keynsham	2%	Trips to Bath and Bristol possible ~ 20 min
Land at Uplands	3%	Trips to Bath and Bristol possible ~ 20 min
West of Keynsham	3%	Trips to Bath and Bristol possible ~ 20 min
Hicks Gate, Keynsham	3%	Trips to central Bristol possible in < 20 min.
Land at Whitchurch	1%	Trips to central Bristol possible in < 20 min. Possible to cycle to Hengrove Park. On NCN.

[10] Ward model share based on journey to work data for year 2011. Excludes those not in employment but includes those working from home.

4.2.3 Access to Public Transport

All of the locations are considered to be outside of regular walking distance of a train station and day-to-day public transport use is therefore dependent on bus services (either in isolation or combined bus/train travel).

The table shows that the Land to the West of Twerton and Land adjoining South West Keynsham locations are considered the least conducive to encouraging public transport, due to their distance from existing and/or frequent bus services.

Whilst there are four buses per hour serving a stop within 400m of Land to the West of Twerton; the stop is situated to the east of the developmental area and therefore much of the development would be outside of the 400m threshold. Diversion of the number 5 bus service to this location is unlikely to be commercially supported by the quantum of development at this location.

The Land adjoining South West Keynsham location is adjacent to bus services operating along Charlton Road. The quantum of development should be sufficient to support commercial diversion of services; however the east-west alignment of the development area would make it less feasible to divert bus services into the centre of the location. Buses are therefore likely to remain at the periphery of any development.

Both Land to the West of Twerton and Land adjoining South West Keynsham locations are relatively isolated making for longer public transport journey times into major employment areas making journey times less attractive in comparison with private car use.

Land at Uplands and West Keynsham are close to established bus services, with both locations being within 400m of established bus stops. However, on account of the low frequencies currently in operation, additional services per hour would be required to encourage modal shift away from private car use. Both locations could theoretically offer a quantum of development (500 dwellings) sufficient to commercially increase service frequencies and the orientation of the development area would make it feasible to bring services into any development.

The remaining locations, namely; Land adjoining Western Slopes, Land adjoining Odd Down, MOD Ensleigh, Land adjoining East Keynsham, Hicks Gate and Land at Whitchurch all have established, frequent bus services in the vicinity of the development area. These have therefore been attributed a high potential for travel by bus. Modifications to service routes and frequencies may encourage further bus use and would need to be examined on an individual basis with operators.

Table 15: Comparative Evaluation of Locations: Potential for Public Transport

Location	Ward Bus Modal Share[11]	Ward Train Modal Share	Buses per hour, AM peak hour Frequency<30min	Comments
Land adjoining Weston	7%	3%	20	Close to established frequent services within a short walking distance of this location.
Land adjoining Odd Down	13%	3%	39	Close to established frequent services and ward has established bus use culture. Opportunities to bring buses into development.
Extension to MOD Ensleigh	5%	6%	8	Close to established frequent services including express P&R service. Ward has established sustainable travel culture.
Land to the West of Twerton	9%	2%	4	New/diverted services required if adequate frequency is to be provided within a short walk of the main developmental area. Uncompetitive journey times.
Land adjoining East Keynsham	7%	4%	16	Close to established frequent services along A4.
Land adjoining South West Keynsham	8%	3%	0	New/diverted services required and orientation makes diversion of services more difficult that other at other locations.
Land at Uplands	7%	4%	2	Close to established services and relatively short diversion to bring services into any development. Additional services potentially commercially viable based on quantum of development.
West of Keynsham	8%	4%	6	Close to established services and relatively short diversion to bring services into any development.
Hicks Gate, Keynsham	8%	4%	18	Close to established frequent services along A4.
Land at Whitchurch	6%	0%	22	Close to established frequent services along A37, but ward does not have bus use culture and relatively long journey times.

[11] Ward model share based on journey to work data for year 2011. Excludes those not in employment but includes those working from home.

4.3 Highways

4.3.1 Impact and Potential for Mitigation

Table 16 summarises the forecast impacts associated with maximum development at each location and potential for mitigation. The highways impact has been determined by the results of initial modelling based on an indicative land use mix. Potential for mitigation also considers the capacity for highway mitigation works, modal shift and internal capture. Each location has been broadly categorised based on the analysis undertaken and an engineering judgement as to the impact and potential for mitigation.

Table 16: Comparative Evaluation of Locations – Effect on Transport Network and Potential for Mitigation

Location	Modal Share: Car Driver[12]	Comments
Land adjoining Weston	52%	The area generally facilitates sustainable transport and has a relatively low car modal share. Single route into local area (Lansdown Lane). The vehicular impacts of development primarily occur along Lansdown Lane and disperse along Lower Bristol Road, Upper Bristol Road and Weston Lane/Weston Road. Journey speeds along the A4 into Bath are low according to *Strat-e-gis* data indicating capacity issues in the AM peak (12mph) and PM peak (15mph). There is some scope to mitigate impacts on routes into central Bath through highway capacity improvements along Combe Park and Upper Bristol Road. A P&R site is established on a key corridor potentially providing an opportunity to offset the impact of development. No significant increases in traffic volumes forecast on highways outside of Bath.
Land adjoining Odd Down	58%	The area generally facilitates sustainable transport with excellent bus links. Multiple routes to/from area. The vehicular impact of development would impact along the A367 Wellsway/Wells Road, Pennyquick, A367 Roman Road and Bradford Road. Journey speeds along the A367 Wellsway/Wells Road into Bath are low according to *Strat-e-gis* data indicating capacity issues in the AM peak (10mph) and PM peak (15mph). There is some scope for improving highway capacity through junction and link improvements although the A36 Churchill Bridge gyratory is a capacity constraint. Potential for Odd Down P&R to provide an element of traffic relief along Wells Road and Bradford Road. No significant increases in traffic volumes forecast on highways outside of Bath.
Extension to MOD Ensleigh	42%[13]	The area generally facilitates sustainable transport and has a relatively low car modal share. Single route into local area (Lansdown Road). The highway impact of development is confined to a few key links, in particular Lansdown Road into central Bath. The Lansdown Road/George Street/The Paragon junction is a key constraint. There is some scope to introduce mitigation measures through link/junction improvements along Lansdown Road and routes towards north-west Bath. The location offers opportunities to link into established public transport networks and the Lansdown P&R service could provide additional traffic relief on city centre corridor. No significant increases in traffic volumes forecast on highways outside of Bath.
Land to the West of Twerton	68%	The developmental area is relatively isolated with single route providing access (Pennyquick). The small size of the development area results in relatively little impact in terms of percentage increases in traffic, with the largest impacts forecast on Pennyquick and on routes into Bath (A4 &A36) which are somewhat congested with slow journey times according to *Strat-e-gis* data. As traffic diffuses across multiple routes into Bath the effect is not considered significant. There is little scope for promotion of modal shift and development of the location is likely to lead to car dependent travel patterns. No significant increases in traffic volumes forecast on highways outside of Bath.
Land adjoining East Keynsham	70%	The ward has a relatively poor sustainable transport mode share, but the development area is well located for bus travel. Access is from a high capacity highway with potential for a local access from existing residential streets. The employment/residential mix identified at this location should encourage internal capture. Increases in traffic will occur along the A4 into Bristol and A4 through Saltford locations with little scope for mitigation through additional highway capacity. Journey times along the A4 into Bristol average 10mph in the AM peak and 9mph in the PM peak according to *Strat-e-gis* data while the A4 through Saltford is forecast to operate above link capacity. The Brislington P&R facility could potentially offset some vehicular impact along the A4 and this location provides good access to the A4174 Ring Road allowing traffic to

[12] Ward model share based on journey to work data for year 2011 for car drivers only. Excludes those not in employment but includes those working from home.
[13] The Lansdown value show is considered an overestimate given the location of the developmental area and the values for the Odd Down ward are therefore considered more appropriate to this location. The Odd Down modal share has therefore been used in calculation of vehicular trips.

		disperse onto alternative routes into Bristol. Keynsham High Street area is overcapacity although approaches from the east provide reasonable average journey speeds to Bath Hill according to the *Strat-e-gis* data. The location offers scope for modal shift to cycle or buses on journeys into Keynsham, Bristol and Bath.
Land adjoining South West Keynsham	66%	Location is isolated encouraging car dependant behaviour. Single route to the area (Charlton Road). The majority of trips will utilise Charlton Road to access Keynsham town centre or the A4/A4174 via St Ladoc Road/Durley Hill. The highway into Keynsham town centre is constrained and there is little scope for capacity improvement. The Charlton Road-St Ladoc Road-Durley Hill route has sufficient link capacity but is residential in character. *Strat-e-gis* data shows that once on Bristol Road peak hour journey times to Hicks Gate roundabout are reasonable. A significant proportion of trips will use the congested A4 corridor into Bristol, with potential for some mitigation through expansion of Brislington P&R facility. Other traffic is likely to access Bristol via country lanes and then via the already congested A37 which has low average speeds in peak hours.
Land at Uplands	70%	Location is relatively isolated single point of access via the B3116 Wellsway and is likely to lead to car dependent travel patterns. Vehicular impacts are largely confined to the B3116 which should have sufficient link capacity to accommodate development but the route is bordered by a number of residences which would be affected by additional traffic. Some scope for junction capacity improvements along B3116. Bristol/Bath traffic can bypass main residential areas via Keynsham Bypass. *Strat-e-gis* data shows that Bath Road operates at 20mph in the AM peak hour allowing traffic a relatively short journey time to access the A4. Development would result in additional vehicular trips along the A4 into Bristol, with potential for some mitigation through expansion of Brislington P&R facility. Although the area is adjacent to an existing bus route development is likely to lead to predominantly car dependant travel patterns.
West of Keynsham	63%	Similar highways issues and impact to those of Land adjoining South West Keynsham with the majority of vehicular trips using Charlton Road to access Keynsham town centre or the A4/A4174 via St Ladoc Road/Durley Hill. The location has some potential for access by public transport with established services close to the development area. Routes into Bristol are likely to use the A4 corridor and routes to Bath will utilise the A4 through Saltford with both corridors are likely to be overcapacity in peak hours. A proportion of trips will use Charlton Road to access the already congested A37 which averages just 8mph into Bristol city centre in the AM peak hour according to *Strat-e-gis* data.
Hicks Gate, Keynsham	63%	Relatively isolated but well located to encourage bus travel via established services along the A4. Access can be provided is from a high capacity highway with potential for a link to Stockwood Lane for trips to south Bristol. Location and design of access will be critical to ensure manageable impacts on A4/A4174/A4175 junction which is over capacity at peak times. Development is likely to result in a significant increase in vehicular demand on the A4 into Bristol. Expansion of the Brislington P&R could provide an element of relief to the A4 and modal shift could occur onto buses. The location could encourage access onto Stockwood Lane (towards the A37) but this corridor also experiences significant congestion and is inappropriate for significant levels of traffic. Trips into Keynsham are likely to increase demand along Durley Hill and modifications to junctions into Keynsham may be required. A lower quantum of development would result in reduced traffic on key links.
Land at Whitchurch	80%	Ward performs poorly in terms of sustainable travel and driver mode share. Development area facilitates access to Whitchurch Village and there are opportunities for modal shift to bus services along the A37. Development is forecast to result in significant additional traffic along the A37 and A4 into Bristol, the A4174 Callington Road and through Keynsham (via Charlton Rd). Routes into Bristol are already heavily congested with low journey speeds (8mph & 10mph on A37 and 10mph & 9mph on A4 in AM and PM peak hour respectively). Little scope for mitigation measures on these routes through highway capacity improvement works. Some scope for modal shift due to good level of bus provision but journey times/distances may be uncompetitive with private car. Some potential for improved public transport and increased cycling via National Cycle Route 3

4.3.2 Additional Vehicular Km Generated by Development

The total number of additional vehicular kilometres generated by has been estimated for each of the locations. These calculations are based on peak hour trips only and distribution of trips according to journey to work data. It excludes trips made outside of peak hours and trips undertaken for education, retail and leisure purposes.

Based on this analysis the four locations around Bath and Hicks Gate result in the lowest vehicular commuter mileage per household, with Land at Whitchurch and Land at Uplands resulting in the highest average commuter travel distance per household.

Table 17: Comparative Evaluation: Km commuter car travel per dwelling per day

Location	Km
Land adjoining Weston	11.0
Land adjoining Odd Down	11.3
Extension to MOD Ensleigh	11.0
Land to the West of Twerton	13.9
Land adjoining East Keynsham	15.2
Land adjoining South West Keynsham	13.5
Land at Uplands	16.3
West of Keynsham	12.5
Hicks Gate, Keynsham	10.8
Land at Whitchurch	16.9

4.3.3 Forecast Emissions

Table 18 shows the estimated total CO_2 generated by commuters per day based on a standard factor of 0.128kg of CO_2 emitted every km travelled. This is directly related to the additional vehicular kilometres calculated in Table 17.

Table 18: Comparative Evaluation: Emissions generated by commuting per dwelling per day

Location	CO_2 (Kg)
Land adjoining Weston	1.40
Land adjoining Odd Down	1.45
Extension to MOD Ensleigh	1.40
Land to the West of Twerton	1.77
Land adjoining East Keynsham	1.95
Land adjoining South West Keynsham	1.73
Land at Uplands	2.09
West of Keynsham	1.60
Hicks Gate, Keynsham	1.38
Land at Whitchurch	2.16

4.3.4 Contribution to Road Traffic Accidents

The number of accidents generated by commuter trips resulting from development has been examined for trips to four key destinations in the area; Bath, Keynsham, Bristol and South Gloucestershire.

Accident rates have been calculated based on mileage and classification of highways used during this journey. This high-level analysis identifies the Land adjoining East Keynsham and Land at Whitchurch areas as resulting in the highest accident rates with the four Bath extensions resulting in by far the lowest accident rates.

Table 19: Comparative Evaluation of Locations: Accidents per dwelling

Location	Accidents/Dwelling	Comments
Land adjoining Weston	0.0022	Additional vehicular commuter trips are forecast to result in 0.66 accidents per annum, based on 300 dwellings.
Land adjoining Odd Down	0.0020	Additional vehicular commuter trips are forecast to result in 0.59 accidents per annum, based on 300 dwellings.
Extension to MOD Ensleigh	0.0021	Additional vehicular commuter trips are forecast to result in 0.25 accidents per annum, based on 120 dwellings.
Land to the West of Twerton	0.0019	Additional vehicular commuter trips are forecast to result in 0.58 accidents per annum, based on 500 dwellings.
Land adjoining East Keynsham	0.0031	Additional vehicular commuter trips are forecast to result in 1.54 accidents per annum, based on 500 dwellings.
Land adjoining South West Keynsham	0.0028	Additional vehicular commuter trips are forecast to result in 1.11 accidents per annum, based on 400 dwellings.
Land at Uplands	0.0031	Additional vehicular commuter trips are forecast to result in 0.94 accidents per annum, based on 300 dwellings.
West of Keynsham	0.0022	Additional vehicular commuter trips are forecast to result in 0.44 accidents per annum, based on 200 dwellings.
Hicks Gate, Keynsham	0.0021	Additional vehicular commuter trips are forecast to result in 1.67 accidents per annum, based on 800 dwellings.
Land at Whitchurch	0.0035	Additional vehicular commuter trips are forecast to result in 2.84 accidents per annum, based on 800 dwellings.

4.4 Conclusions

Table 20 summarises the different transport parameters examined for each location allowing a comparison to be drawn (based on the group each location was assigned to for each evaluation parameter). Not all parameters should be given equal weighting and highways impacts and opportunities for sustainable travel are considered more important that absolute mileage/CO_2 or accident rates.

Table 20: Comparative Evaluation of Locations: All Transport Factors

Location	Walking	Cycling	Bus	Highways	Mileage/ CO_2	Accidents
Land adjoining Weston						
Land adjoining Odd Down						
Extension to MOD Ensleigh						
Land to the West of Twerton						
Land adjoining East Keynsham						
Land adjoining South West Keynsham						
Land at Uplands						
West of Keynsham						
Hicks Gate, Keynsham						
Land at Whitchurch						

4.4.1 Best Performing Locations

The Land adjoining Weston and Land adjoining Odd Down perform well across all categories and are considered the two best performing areas for future development. They are well located to take account of sustainable transport opportunities and there are opportunities to mitigate highway impacts through modal shift, park and ride and local highway capacity improvements. Both are located in areas with existing neighbourhood facilities and in wards which have an established sustainable travel culture.

Extension to MOD Ensleigh is slightly isolated and therefore scores less well in terms of access on foot, but the ward has an established sustainable travel culture and there are local and express buses operating in the area. Highway impacts are confined to Lansdown Road and there are opportunities to mitigate development impacts through modal shift, expansion of P&R services and local highway capacity improvements.

4.4.2 Average Performing Locations

Land to the West of Twerton scores well in terms of highways impact as traffic can disperse across routes into Bath and it performs well in terms of additional

accidents per dwelling, but averagely in terms of CO_2 and additional mileage. This location is isolated discouraging sustainable travel with the quantum of development unlikely to present a good business case for bus diversion and journey times into Bath uncompetitive with the private car. Development at this location is therefore more likely to result in more car dependent behaviour than the other Bath locations.

Hicks Gate, Keynsham, scores well in terms of access to cycle routes and buses and contribution to road traffic accident rates. Development will result in additional demands on key congested links including the A4 into Bristol and through Saltford, and routes into Keynsham town centre as shown by the data in Section 3. Highway impacts can partially be mitigated but some residential impacts will result from development. Average journey distances from this location are lower than those associated with development at Keynsham, reducing contributions to CO_2. A reduced quantum of development could reduce the effect on the highway to acceptable levels, particularly if the development supports a high level of internal trips through a residential/employment mix with supporting facilities.

The Land adjoining East Keynsham area scores averagely in all categories except access to bus and cycle services. The development mix could encourage living and working in the same locality and the nearby employment area could further reduce vehicular trips. There are a number of buses along the A4 and development would facilitate bus travel to Bath, Bristol and Keynsham. Highway impacts can partially be mitigated but some residential impacts will result on congested corridors including the A4 and routes into Keynsham.

Land at Uplands scores averagely in most categories and poorly in the walking and additional travel distance categories. There is some scope to provide access by bicycle and public transport services operate in the area with scope for improvement through diversion and additional frequency. Vehicular trips into Keynsham will add to congestion along Bath Hill and trips into Bristol are likely to be via the A4.

4.4.3 Worst Performing Locations

The West of Keynsham provides a limited basis for sustainable travel behaviour via diversion of existing bus services and linkages with existing pedestrian/cycle routes. Any development at this location is likely to generate vehicular trips into Bristol on the A4 and into central Keynsham via Charlton Road and St Ladoc Road with impacts on residential neighbourhoods. There is an opportunity to access south Bristol wards via Charlton Road/A37. A smaller quantum of development plus measures to encourage sustainable travel into Keynsham would be of benefit in terms of reducing the impact of any development.

Land adjoining South West Keynsham has similar transport characteristics to the west of Keynsham. This location is isolated and relatively far from Keynsham town centre and it is therefore less accessible on foot. The East-West alignment of the area could make it difficult to integrate buses into the development due to the length of diversion necessary. Highway impacts are largely along residential streets or congested links. The development location is likely to result in car dependant behaviour.

The Land at Whitchurch location offers sustainable transport opportunities with reasonably good bus services operating in the area and opportunities for residents to access NCN3. It scores poorly in highways access, mileage and accident rates. The development area spans the A37 and any development will result in increased demand for peak hour travel into Bristol. The A37 corridor experiences congestion and has relatively poor journey times while alternative routes (A4) also experience these issues – as shown by the *Strat-e-gis* data provided in Section 3. Charlton Road provides a route to Keynsham avoiding the A4, but this route is also likely to be used by traffic accessing the A4174 and A4 towards Bath resulting in "rat-running" through residential neighbourhoods in Keynsham. Park and Ride and a Whitchurch bypass have been considered previously and found to have a marginal business case.

5 Scenario Testing

5.1 Introduction

B&NES has developed three scenarios to test the implications associated with promotion of different combinations of development locations within the core strategy:

- Scenario 1: Concentrates development around Bath with some supporting development east and south of Keynsham.
- Scenario 2: provides greater intensity of development around Keynsham with a corresponding lessening of development in south Bath.
- Scenario 3: Provides the greatest dispersal of development across B&NES with Whitchurch promoted and additional development in the Somer Valley and rural areas of the authority.

The transport implications of these strategies have been assessed based on the sustainable transport analysis undertaken for each location supported by a cumulative evaluation of highway implications.

Scenarios included allocations within the Somer Valley and Rural Areas of B&NES, the evaluation of which are outside the scope of the study. The impact of differences in these allocations is not considered to be significant when evaluating each scenario.

5.2 Land Use Assumptions

The following land use assumptions are made based on information issued by B&NES.

Scenario 1 locates development at Odd Down, Land adjoining Weston and Ensleigh in Bath along with development at Land adjoining South West Keynsham, Land adjoining East Keynsham and Whitchurch.

Table 21: Land Use Assumptions, Scenario One

Location	Land Use Schedule
Land adjoining Odd Down	300 dwellings
Land adjoining Weston	300 dwellings, primary school
Extension to MOD Ensleigh	120 dwellings
Keynsham Land adjoining South West Keynsham	200 dwellings
Land adjoining Keynsham East	250 dwellings, 25,000m² employment
Land at Whitchurch	200 dwellings
Somer Valley	300 dwellings
Rural Areas of B&NES	200 dwellings

Scenario 2 looks at the impacts of additional development around Keynsham with the Land adjoining South West Keynsham modelled at 450 dwellings and Land

adjoining East Keynsham modelled at 500 dwellings. Odd Down and Whitchurch are not developed in this scenario.

Table 22: Land Use Assumptions, Scenario Two

Location	Land Use Schedule
Land adjoining Odd Down	0 dwellings
Land adjoining Weston	300 dwellings, primary school
Extension to MOD Ensleigh	120 dwellings
Keynsham Land adjoining South West Keynsham	450 dwellings
Land adjoining Keynsham East	500 dwellings, 25,000m² employment, primary school
Land at Whitchurch	0 dwellings
Somer Valley	300 dwellings
Rural Areas of B&NES	200 dwellings

Scenario 3 models the impacts of major development at Whitchurch with 800 dwellings identified for this location. No residential development is identified around Keynsham, although Land adjoining East Keynsham retains 25,000m² of employment development.

Table 23: Land Use Assumptions, Scenario Three

Location	Land Use Schedule
Land adjoining Odd Down	0 dwellings
Land adjoining Weston	300 dwellings, primary school
Extension to MOD Ensleigh	120 dwellings
Keynsham Land adjoining South West Keynsham	0 dwellings
Land adjoining Keynsham East	25,000m² employment
Land at Whitchurch	800 dwellings, primary school
Somer Valley	400 dwellings
Rural Areas of B&NES	250 dwellings

5.3 Comparison of Sustainable Transport Opportunities

Sustainable transport opportunities are maximised when developments can offer good walk, cycle and public transport linkages to employment and local centres within a reasonable journey time.

Scenario 1 which has a Bath focus promotes a more sustainable approach when compared to other scenarios as the majority of development areas offer short walk times to local centres as well as being within a short journey time by cycle or public transport to Bath city centre. Scenario 1 includes development on Land adjoining Odd Down which is considered a highly sustainable location in comparison to additional allocations around Keynsham or on Land at Whitchurch as identified in Scenarios 2 and 3.

Scenarios 2 and 3 which propose more dwellings in the south east Bristol and Keynsham areas do not offer similar linkages to local centres and travel to city centre locations often takes longer. The proximity of the development locations to key distributor roads may encourage trips by car.

Scenario 3 is considered a more sustainable approach than Scenario 2 as the Land at Whitchurch location offers relatively good access to cycle and bus infrastructure/services compared to Land adjoining South West Keynsham. The focus on a single location, with 800 dwellings at Land at Whitchurch, could also provide a better commercial basis for improved bus access compared to Scenario 2.

Overall Scenario 1 is considered the most sustainable, with Scenario 3 marginally better than Scenario 2.

5.4 Comparison of Highways Impacts

5.4.1 Scenario 1

Scenario 1 includes development at six locations, of which 720 dwellings are identified at locations with "good" highways performance, 250 dwellings are at a location with "average" highways performance and 400 dwellings are at locations with "poor" highways performance.

Scenario 1 concentrates impacts in and around Bath, with small scale development in Keynsham and south-east of Bristol. Scenario 1 includes development at Land adjoining Odd Down and therefore results in the greatest increases in traffic in South Bath. A total of 450 dwellings are identified around Keynsham, split between Land adjoining East Keynsham and Land adjoining South West Keynsham resulting in some additional demand in in south-west Keynsham. A small quantum of development is allocated to Land at Whitchurch and this will result in additional demand along the A37.

Figure 2 shows the forecast cumulative increase in traffic volumes on selected links in Bath, Bristol and Keynsham in the AM peak hour, Figure 4 shows the PM peak hour. Figure 3 shows the forecast Volume/Capacity ratio for these highways in the AM peak hour for year 2029 in the worst performing direction, Figure 5 shows the PM peak hour V/C in the worst performing direction.

Trip generation for Scenario 1 is provided in Appendix X. Cumulative impact of development as per the Scenario 1 mix and land use schedule is shown in Appendix AA.

5.4.2 Scenario 2

Scenario 2 includes development at four locations, of which 420 dwellings are identified at locations with "good" highways performance, 500 dwellings are at a location with "average" highways performance and 450 dwellings are at a location with "poor" highways performance.

Scenario 2 apportions housing primarily around Keynsham, with some development in Bath and no development south-east of Bristol. Compared to

Scenario 1, Scenario 2 results in the higher traffic volumes around Keynsham and along the A4 into Bristol with lower traffic volumes in South Bath.

Figure 6 shows the forecast cumulative increase in traffic volumes on selected links in Bath, Bristol and Keynsham in the AM peak hour, Figure 8 shows the PM peak hour. Figure 7 shows the forecast Volume/Capacity ratio for these highways in the AM peak hour for year 2029 in the worst performing direction, Figure 9 shows the PM peak hour V/C in the worst performing direction.

Trip generation for Scenario 2 is provided in Appendix Y. Cumulative impact of development as per the Scenario 2 mix and land use schedule is shown in Appendix BB.

5.4.3 Scenario 3

Scenario 3 includes development at three locations, of which 420 dwellings are identified at locations with "good" highways performance with 800 dwellings at a location with "poor" highways performance.

Scenario 3 retains development in north Bath at Land adjoining Weston and Extension to MOD Ensleigh but the remaining requirement is largely allocated at Land at Whitchurch (800 dwellings). Scenario 3 results in the highest additional traffic demands in Bristol, in particular the A37, but lower traffic volumes in Bath than Scenario 1 and lower traffic volumes in Keynsham than Scenario 2.

Figure 10 shows the forecast cumulative increase in traffic volumes on selected links in Bath, Bristol and Keynsham in the AM peak hour, Figure 12 shows the PM peak hour. Figure 11 shows the forecast Volume/Capacity ratio for these highways in the AM peak hour for year 2029 in the worst performing direction, Figure 13 shows the PM peak hour V/C in the worst performing direction.

Trip generation for Scenario 3 is provided in Appendix Z. Cumulative impact of development as per the Scenario 3 mix and land use schedule is shown in Appendix CC.

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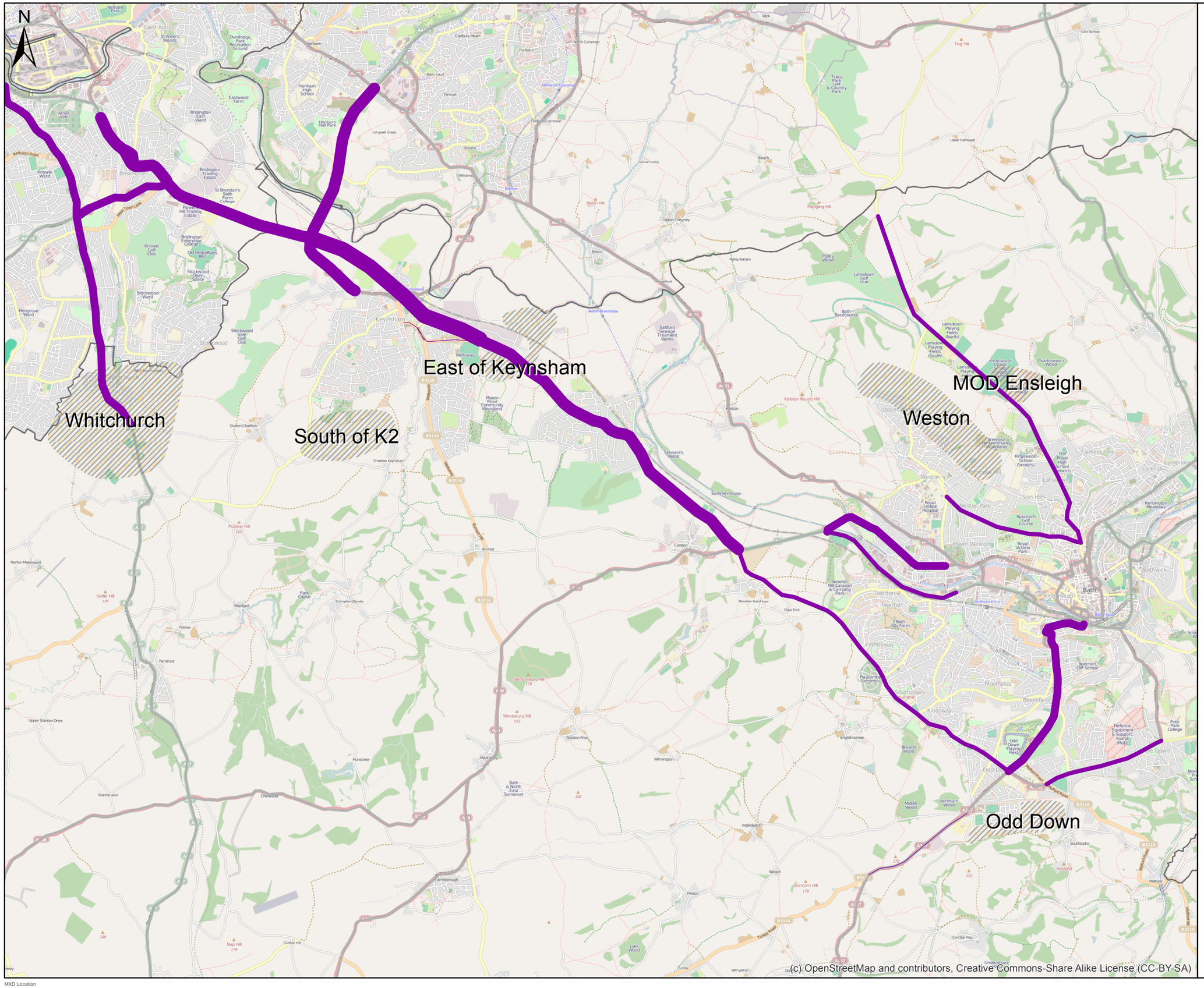

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Issue	Date	By	Chkd	Appd
P0	Feb 2013	HH	DW	AJ

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B&NES - Scenario 1 - AM Peak - Traffic Flow
[Total, both directions]

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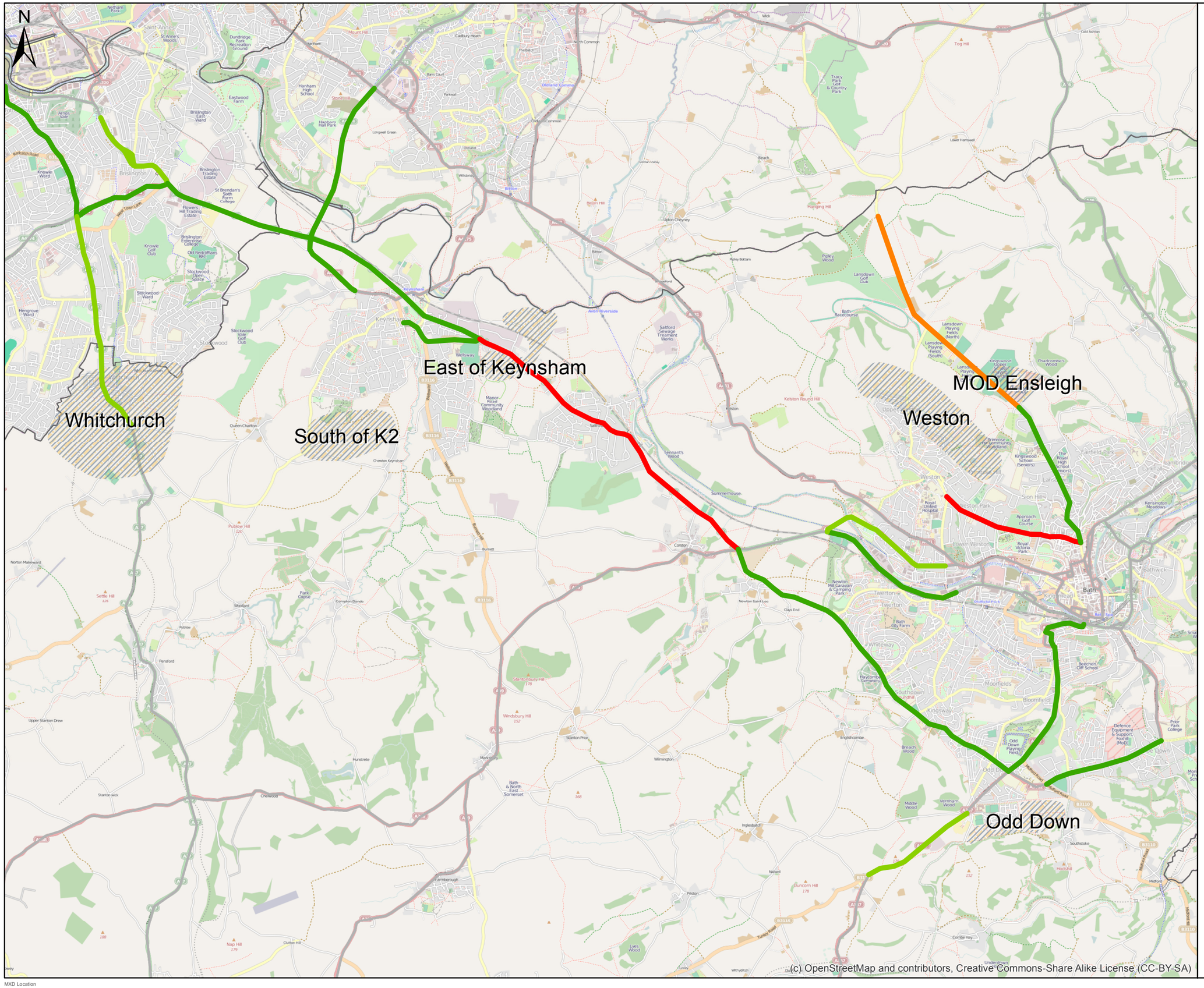

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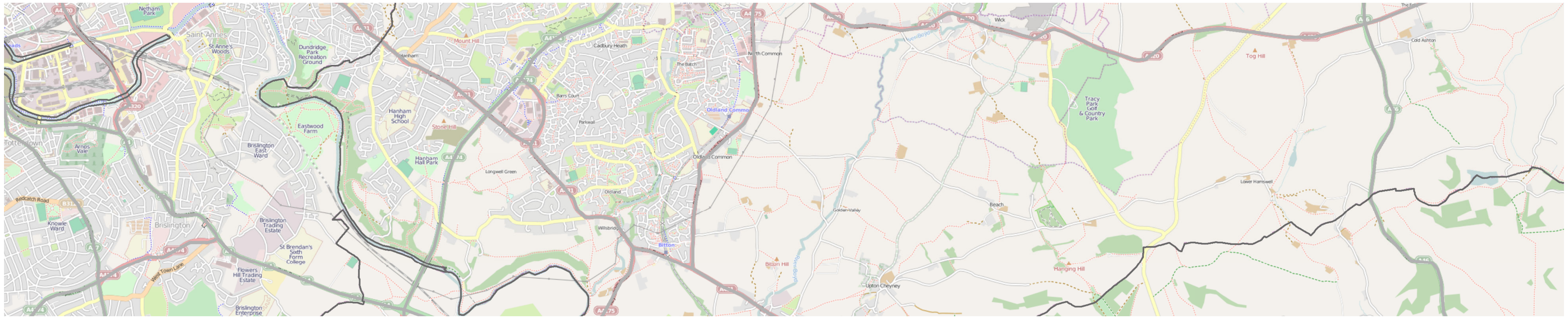

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Saint Anne's
St Anne's Woods
Dundridge Park Recreation Ground
Mount Hill
Hanham
Cadbury Heath
The Batch
North Common
Wick
Tog Hill
Cold Ashton
Hanham High School
Eastwood Farm
Brislington East Ward
Arnos Vale
Hanham Hall Park
Longwell Green
Barrs Court
Parkwall
Oldland Common
Oldland
Tracy Park Golf & Country Park
Lower Hamswell
Beach
Golden Valley
Willsbridge
Bitton
Bitton Hill
Upton Cheyney
Hanging Hill
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Knowle Ward
Brislington Trading Estate
St Brendan's Sixth Form College
Flowers Hill Trading Estate
Brislington Enterprise

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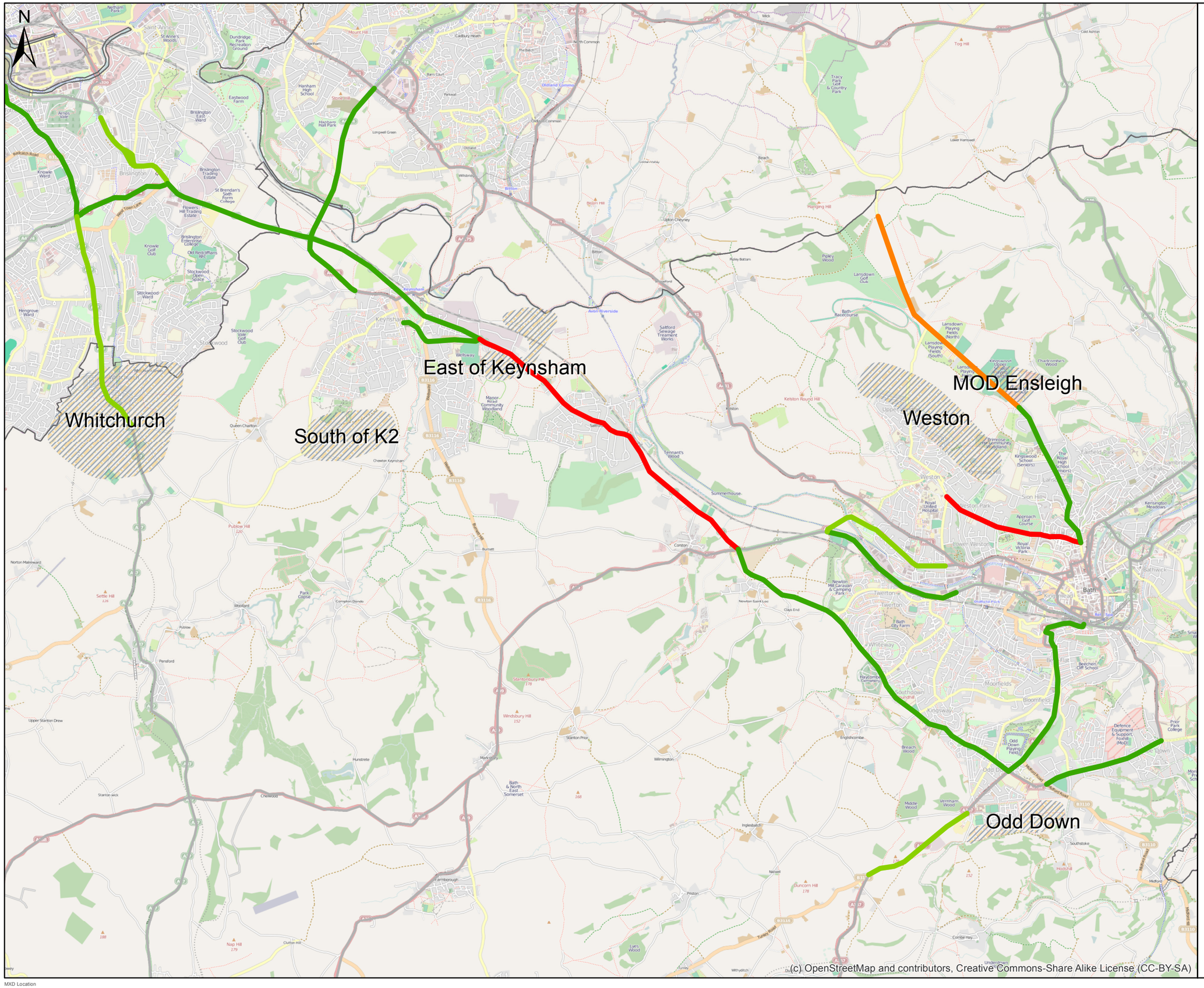

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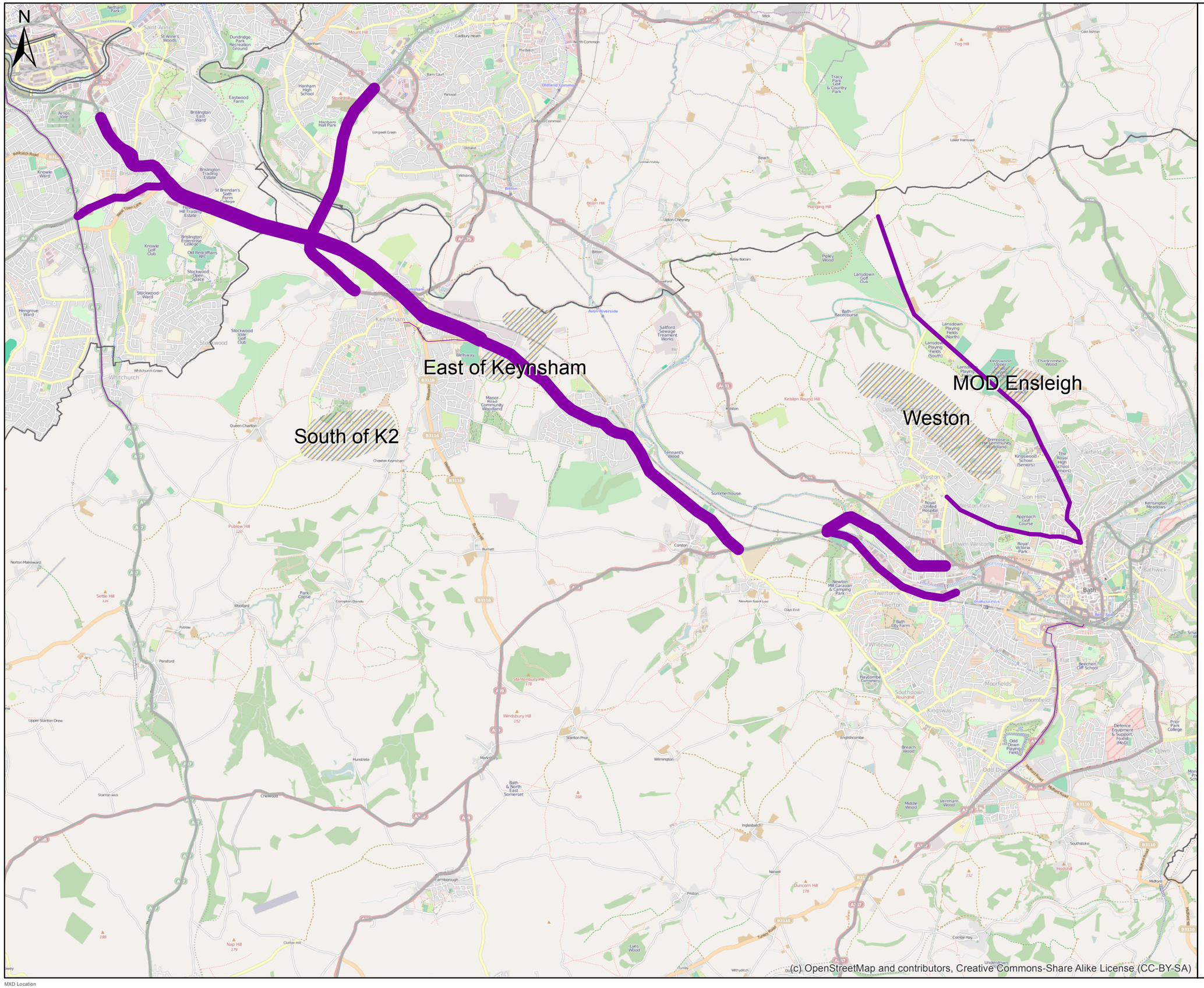

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B&NES - Scenario 2 - AM Peak - Traffic Flow
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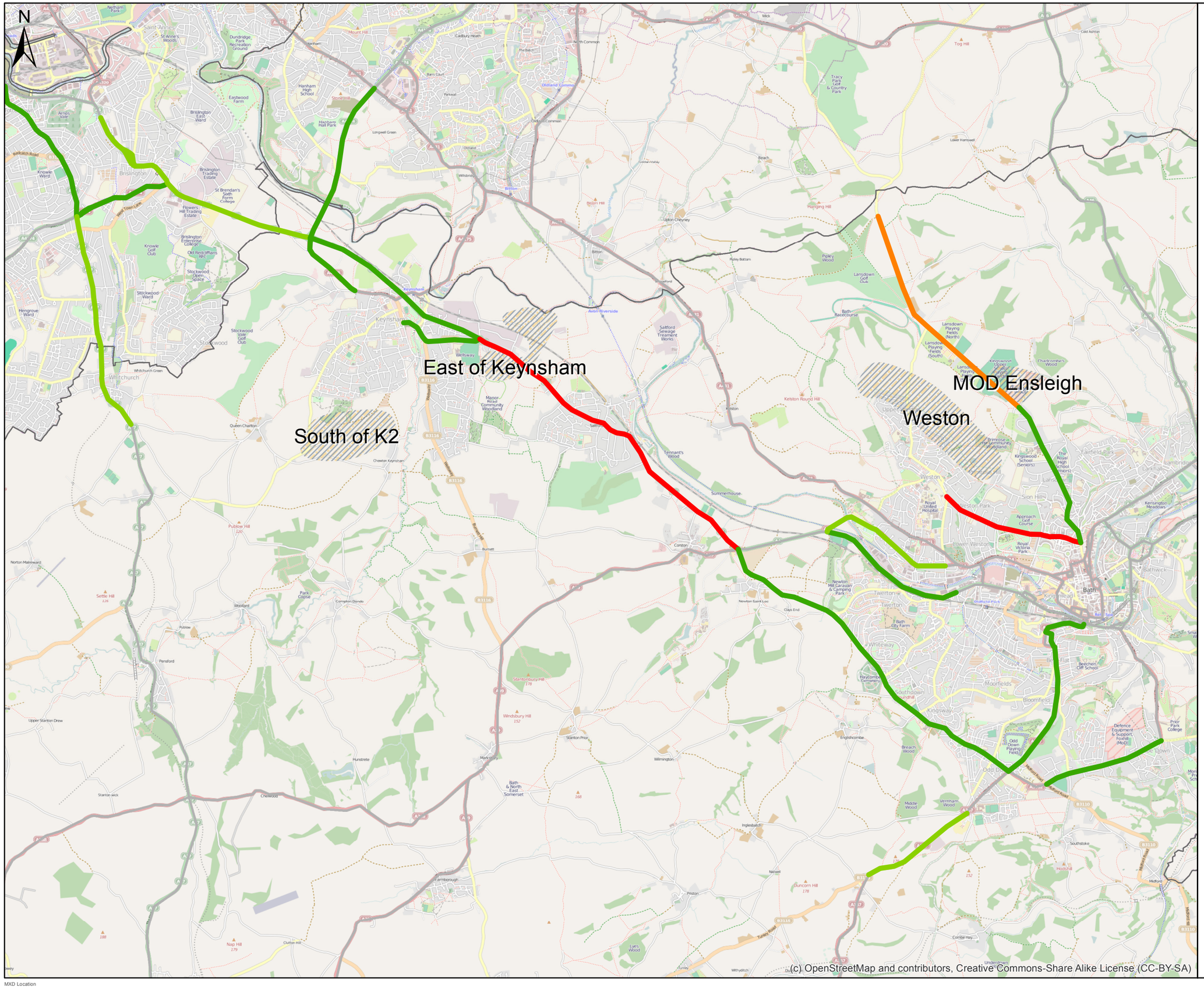

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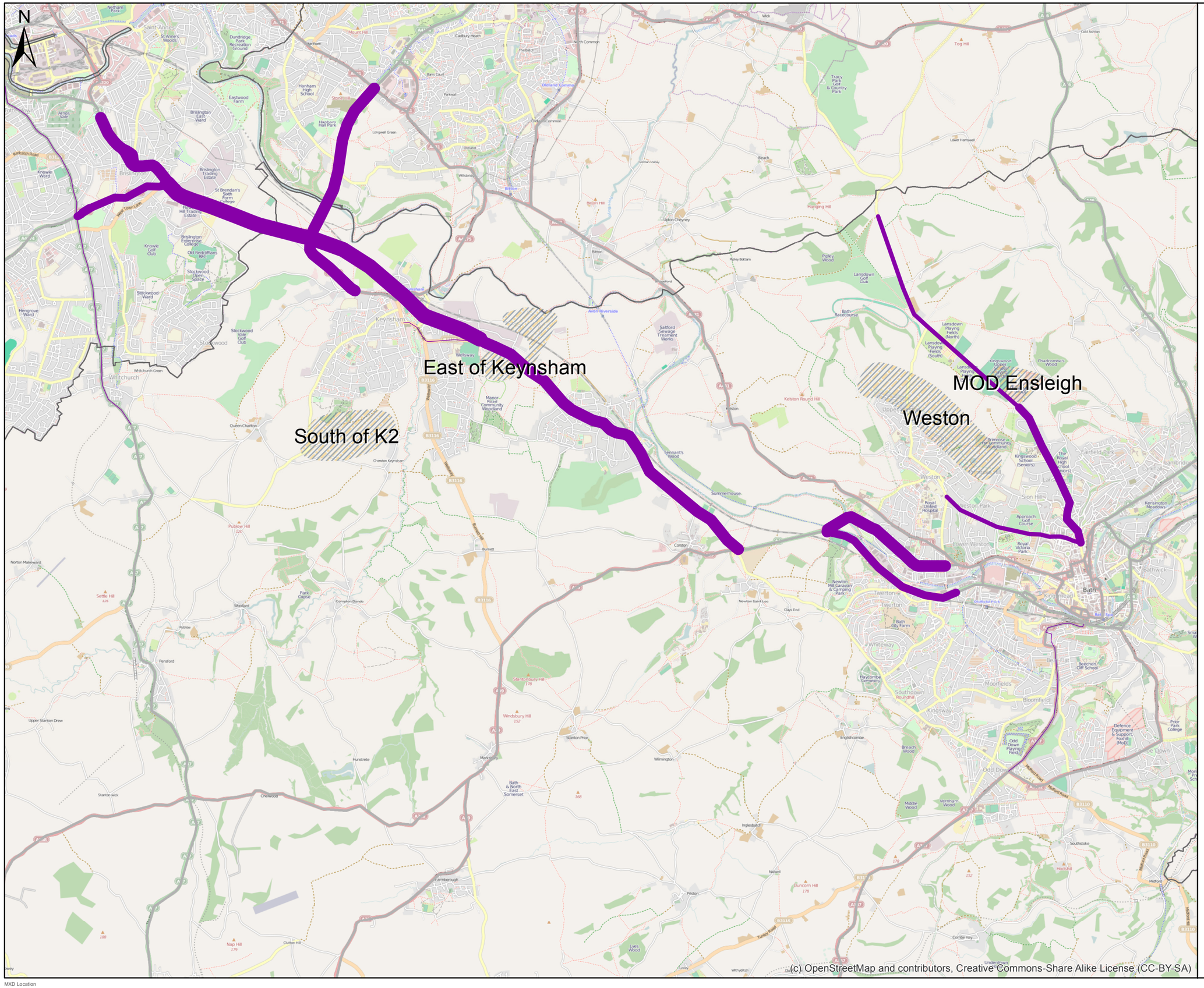

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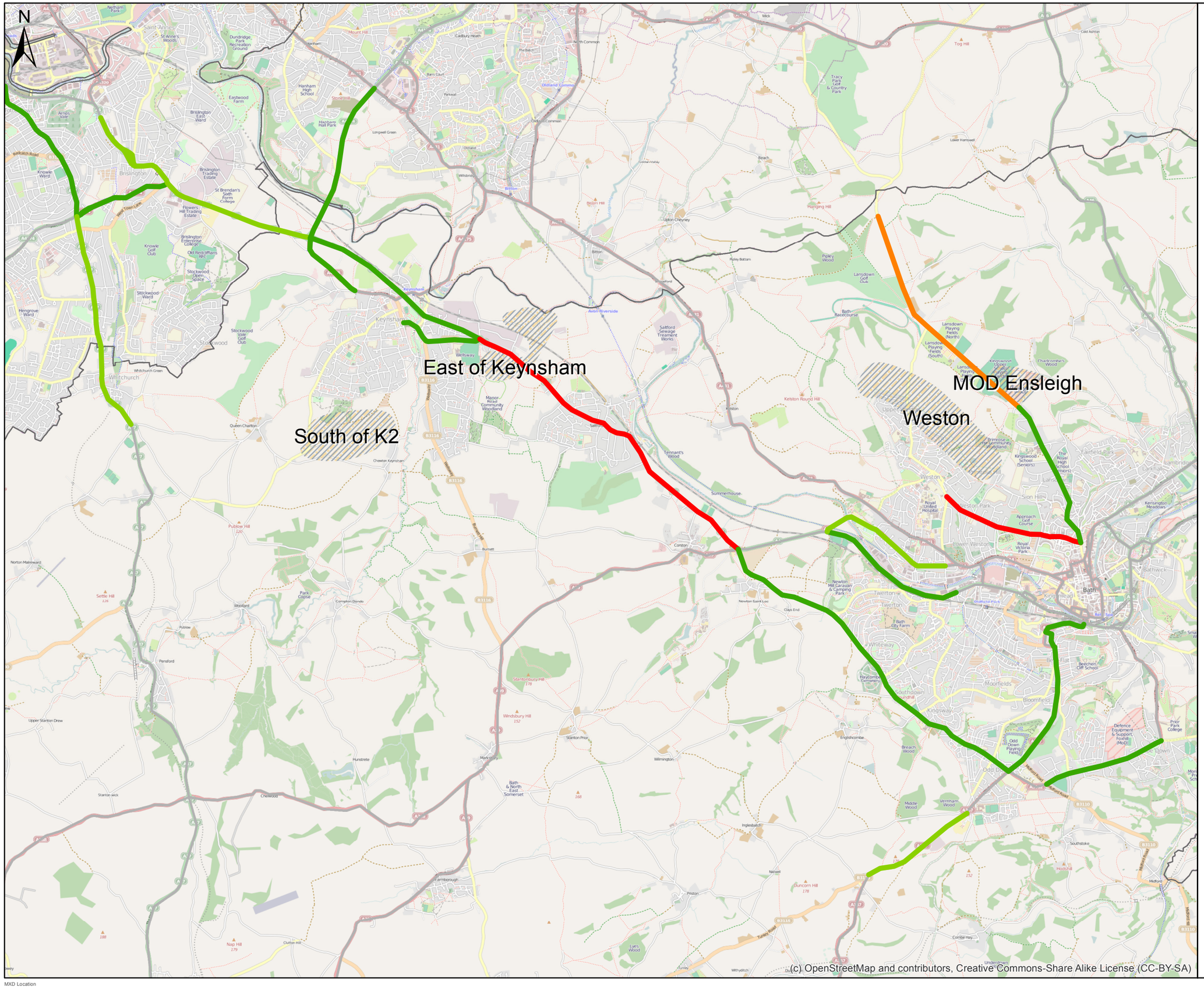

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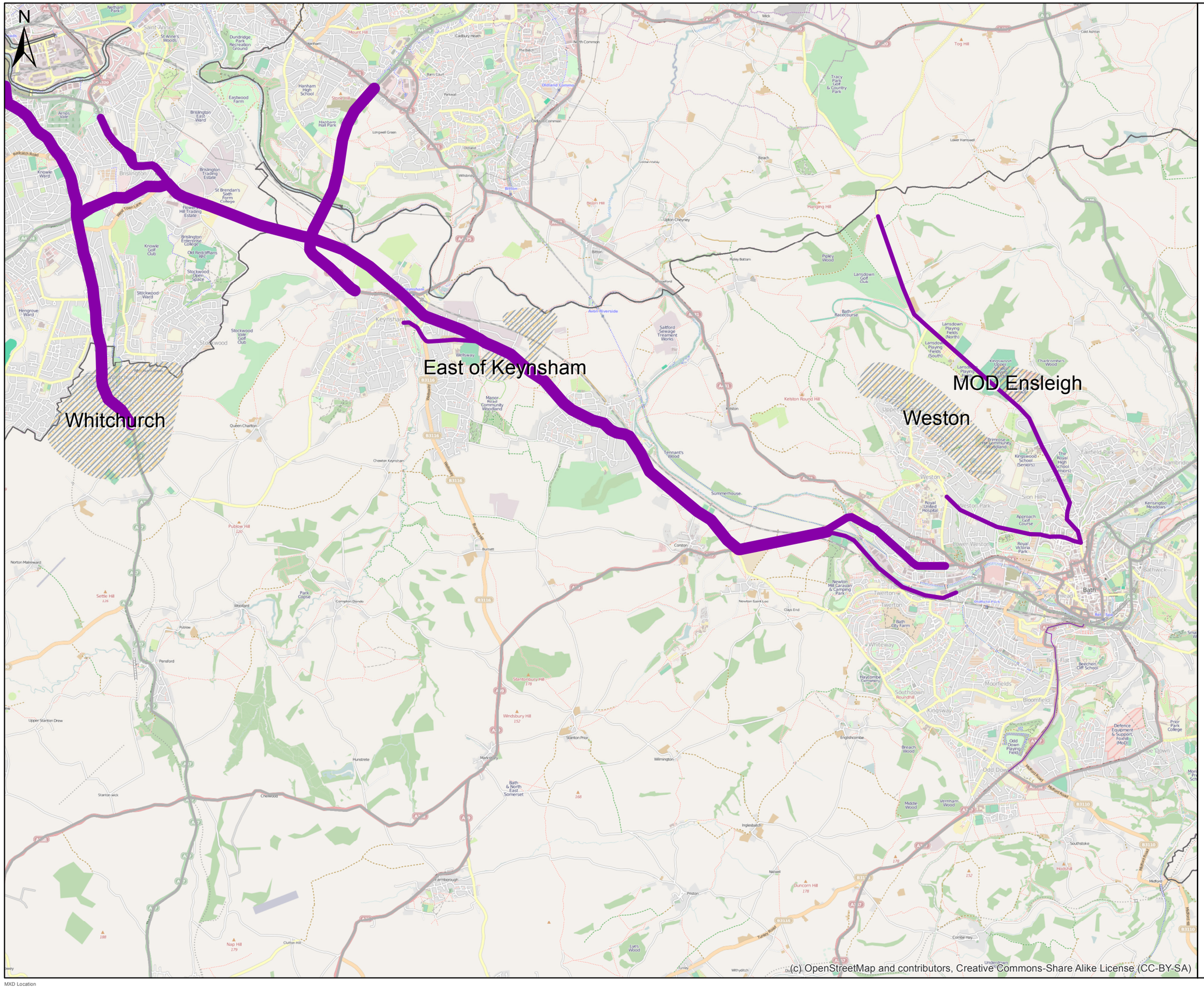

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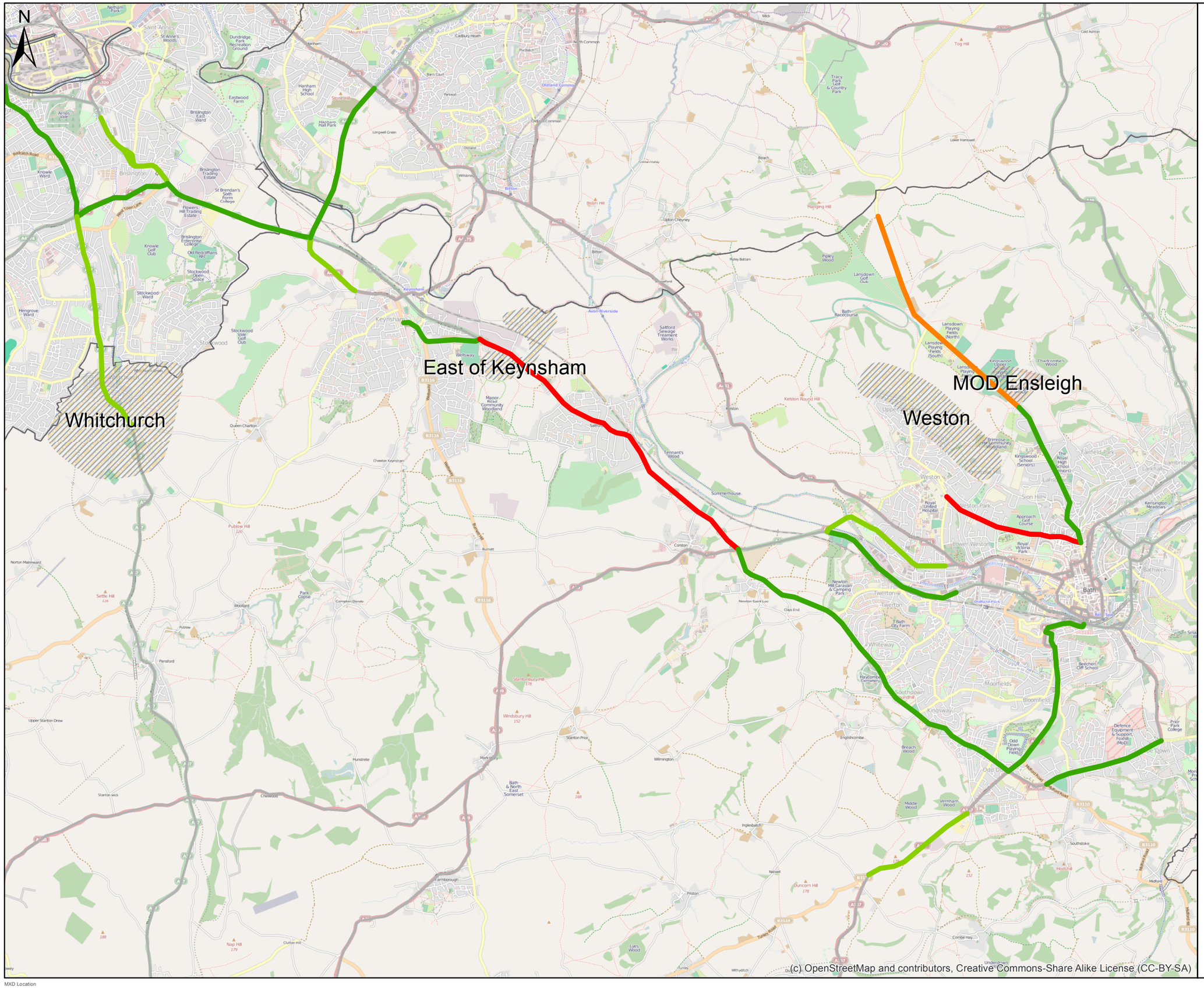

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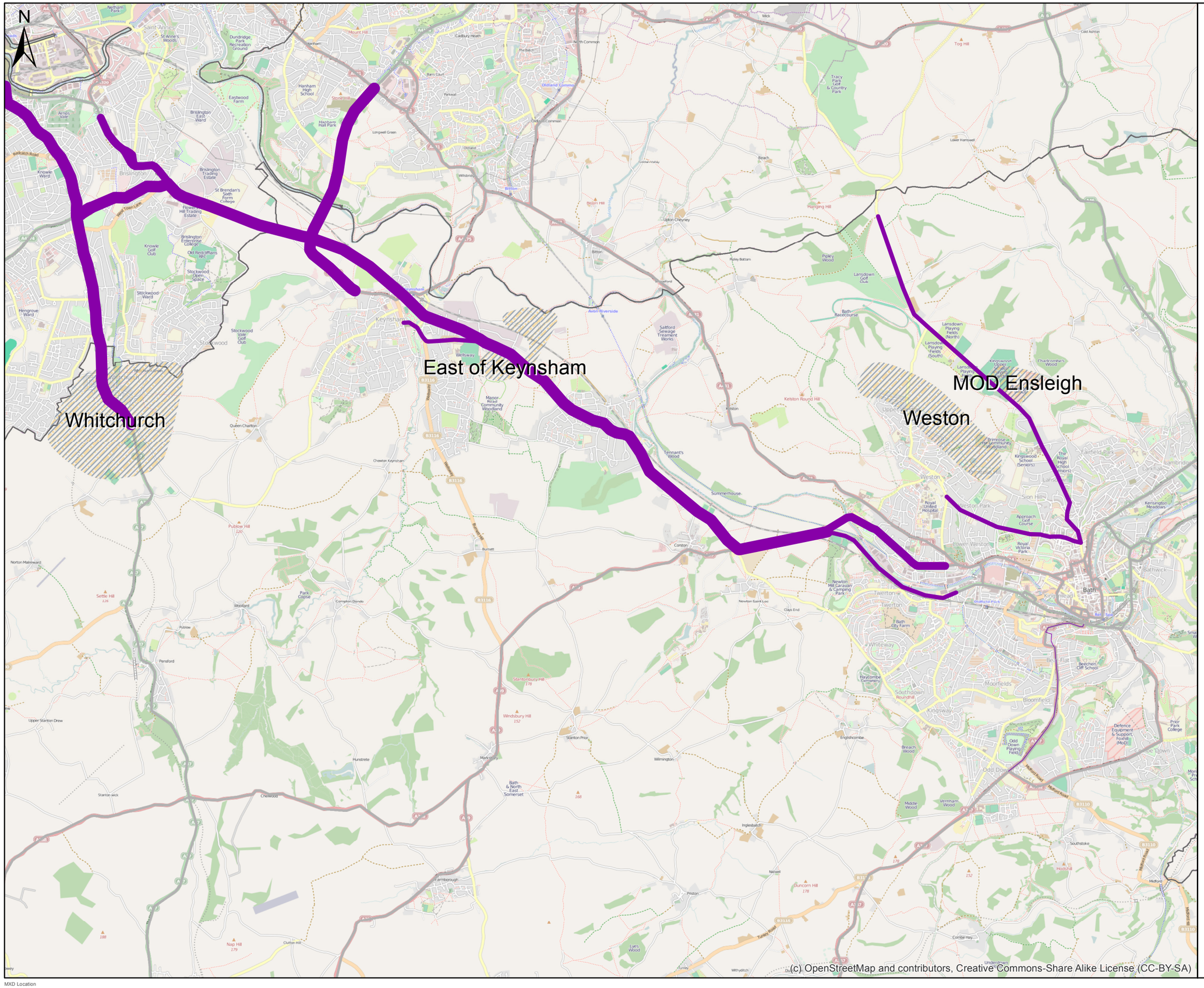

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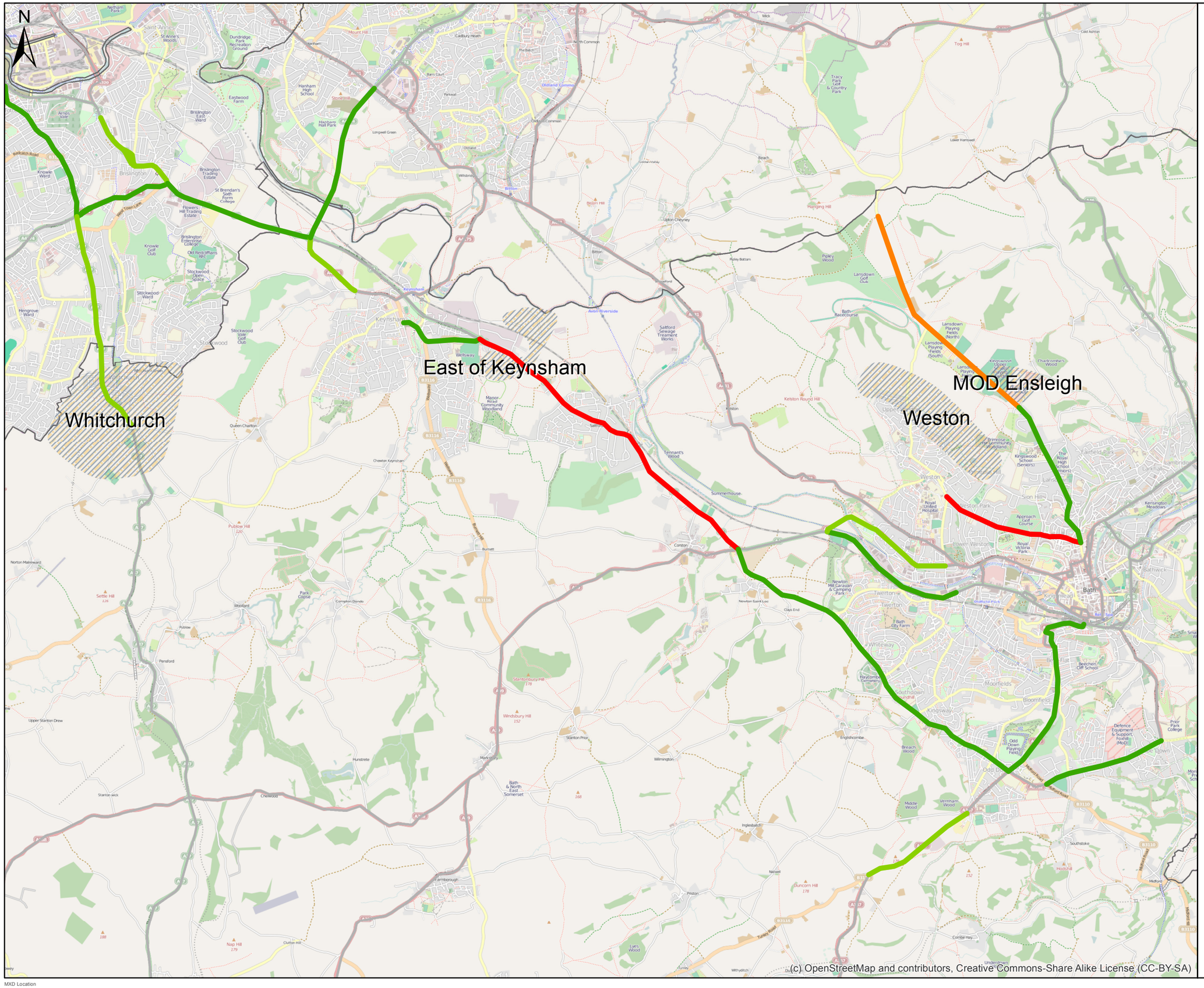

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[Worst Case, any direction]

Scale at A3

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Job No	Drawing Status
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Drawing No	Issue
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MXD Location

5.4.4 Comparison of Forecast Traffic Volumes on Key Links

To provide comparison between scenarios the forecast peak hour traffic increases have been tabulated for key links in the study area. Broadly speaking, Scenario 1 has greater effects around Bath, Scenario 3 results greater effects around Bristol and Scenario 2 provides a balance between the two. Comment is provided on link capacity and the possibility of mitigation is provided to give context (i.e. a large increase is not significant where there is spare capacity, conversely minor increases are significant where the highway operates above capacity).

Table 24: Comparison of Forecast Scenario Impacts on Key Links

Link	**Estimated Traffic (vph) Peak Hour, Two-way.**			**Comments**
	Scenario 1	**Scenario 2**	**Scenario 3**	
A4 into Bristol	95	130-140	60-65	Junctions along the A4 are operating at capacity in 2012 and are likely to be operating above capacity in 2029. There is little scope for highway capacity improvements due to restricted highway width through Brislington into the city centre. Scenario 2 results in the largest increase in traffic as the A4 is the most likely route into Bristol for traffic from Keynsham East. Scenario 1 performs marginally worse than Scenario 3 as traffic from Land at Whitchurch, will primarily use the A37. The Brislington P&R facility could offset some of the effects of development.
Callington Rd	60-70	40	130-170	Callington Road links two congested highways (A4/A37) into Bristol and is itself operating at capacity at key junctions in 2012. Scenario 3 results in significantly more trips along this link than scenarios 1 and 2 due to trips departing from Land at Whitchurch to access the A4174 and A4. The alternative route for traffic leaving Land at Whitchurch would be via Charlton Road – affecting residential streets in Keynsham.
A4174 Ring Rd	160	190-200	180-200	Scenario 1 has the lowest forecast impact on the A4174 as it has the greatest allocation of development in Bath. The Ring Road has sufficient link capacity to cope with additional traffic, but some junctions may require improvement in the future. Measures such as car sharing lanes have been adopted further north along the Ring Road.
A37 into Bristol	40-50	15	120-160	The A37 is the primary route into Bristol for traffic to/from Land at Whitchurch resulting in Scenario 3 having a significantly larger impact than Scenario 1. Scenario 2 has almost no effect on the A37 corridor. The A37 is operating at capacity in 2012 with little scope for capacity improvement due to restricted highway width through residential areas.

Durley Hill	80-100	110-135	110-155	Traffic in scenarios 1 and 2 is accessing Keynsham town centre. Traffic in scenario 3 is largely accessing the Ring Road/A4 through Keynsham. Scenario 1 has the smallest effect, Scenario 3 the largest.
Bath Rd, Keynsham	100	150	45-60	Scenario 2 results in the highest traffic effect as it has the largest quantum of development around Keynsham. Scenario 3 has the smallest effect.. Bath Rd has sufficient link capacity to accommodate additional flows but traffic accessing Keynsham town centre via Bath Hill/High Street is likely to result in additional queues and delays.
A4 Keynsham bypass	200-220	280	140-170	Scenario 2 results in the largest number of additional trips as Land adjoining Keynsham East generates demand to/from Bristol. The bypass has sufficient link capacity to accommodate demand but junctions may require improvement. Scenario 3 has the smallest effect as trips from Land at Whitchurch are largely attracted into Bristol.
A4 Saltford	105	110	70	The A4 through Saltford experiences congestion and relatively poor journey times in 2012 and is forecast to operate above link capacity in 2029 due to background traffic growth, including that arising from implementation of the Core Strategy. There is little scope for improvements along the existing highway corridor. Scenario 3 results in the smallest effect. Scenario 1 performs marginally better than Scenarios 2 but the difference is not significant.
Kelston Road	10	10	10	No major increases in traffic forecast and marginal differences between scenarios. Kelston Road is forecast to have spare link capacity in year 2029.
A4 Newbridge Rd	70	70	50-60	Scenario 3 results in the smallest increase along this link. Scenarios 1 and 2 are forecast to have identical effects. Newbridge road is forecast to operate close to capacity in year 2029 and junctions heading towards the city centre may need improvement. The Newbridge Road P&R facility provides an opportunity to capture inbound traffic reducing demand volumes.
A36 Lower Bristol Rd	30	40	30	Minor differences between scenarios. The A36 is forecast to operate below link capacity in 2029 however junctions towards the city centre may require improvement and highway width is constrained. Newbridge P&R provides a means of capturing trips into the city centre.
Pennyquick	35-45	10	5	Effects on Pennyquick are largely related to development at Odd Down as this route provides access to the A4 – Scenario 1 therefore has the largest effects.
A367 Roman Rd	15	5	5	No major increases in traffic forecast and marginal differences between scenarios. Scenario 1 is forecast to result in the largest effects due to development at Odd Down.
Wells Road	60-70	15	15	Wells Road provides the primary route into central Bath from Land adjoining Odd Down – Scenario 1 therefore has the biggest impact. Wells Road itself has sufficient highway capacity but the A4 gyratory is likely to be a constraint. There are good opportunities for modal shift to public transport and the Odd Down P&R facility provides a means of reducing peak hour traffic to offset the effects of demand.

Bradford Road	20-30	0	0	Effects are associated with development at Land adjoining Odd Down – Scenario 1 therefore has the largest increase. The Odd Down Park & Ride facility provides an opportunity to offset any increases in traffic on Bradford Road.
Weston Road	30	30	30	Effects on Weston Road are linked to development at Land adjoining Weston and all three scenarios propose the same quantum of development at this location.
Lansdown Rd (S)	40	40	40	Effects on Weston Road are linked to development at Land adjoining Weston and Extension to MOD Ensleigh and all three scenarios propose the same quantum of development at this location. The Lansdown P&R facility provides a means of reducing peak hour demands into Bath and further use of this facility could help offset the effects of development.
Lansdown Rd (N)	40	40	40	Effects on Weston Road are linked to development at Land adjoining Weston and Extension to MOD Ensleigh and all three scenarios propose the same quantum of development at this location.

Reviewing the highway effects of development and potential for mitigation in the form of highway improvement works or modal shift, it is concluded that:

- Scenario 1 results in the second largest traffic increases on key links including the A37, A4 and routes into Keynsham. Scenario 1 results in the largest effects in South Bath due to the quantum of development at Odd Down, however there is some scope to mitigate these impacts through modal shift, P&R and highway improvement works.
- Scenario 2 results in the highest increase in trips on the A4 into Bristol as a result of development. It also generally results in the largest traffic effects in Keynsham. While there is negligible impact in south Bath Scenario 2 has a similar impact to other scenarios on key east-west links (A36, A4). Impacts in north Bath are identical to Scenario 1.
- Scenarios 3 results in significant effects on the A37 and Callington Road key highways into Bristol which are overcapacity with limited scope for mitigation. Scenario 3 is also likely to result in additional traffic routing through Keynsham to avoid congestion on the A37/A4174/A4 with this traffic, in part, using residential streets (St Ladoc Road, Charlton Road). Scenario 3 does result in fewer trips along the A4 into Bristol than other scenarios and it has the least impact in east Keynsham. There is a negligible impact forecast south Bath and impacts in north Bath are identical to Scenario 1.

Scenario 1 is considered the best performing scenario in terms of traffic effects. The locational mix disperses traffic impacts across key routes and effects typically occur where there are options for modal shift, capacity improvements or existing park and ride facilities.

Scenario 2 results in the biggest effects in Keynsham and the largest effect on the A4 into Bristol. Scenario 3 is results in major traffic increases on the A37 corridor where there is little scope for mitigation. Scenario 2 disperses effects and is therefore considered to offer marginally more scope for mitigation than Scenario 3.

5.5 Supporting Analysis

5.5.1 Additional Vehicular Km Generated

The total number of additional vehicular kilometres generated by commuters from each development has been estimated for each of the scenarios on a location-by-location basis. This shows that Scenario 1 results in the fewest additional commuter miles with Scenario 3 resulting in the greatest additional amount.

It should be noted that the additional vehicular travel distance has been calculated for peak hour trips only and based on the distribution of trips according to journey to work. It therefore excludes trips made outside of peak hours and trips undertaken for education, retail and leisure purposes. Given the location and quantum of development it is likely that Scenario 1 would also result in the most "local" travel for these purposes thereby assisting the management of CO_2.

Table 25: Estimated Additional Vehicular Kilometres

Location	Car Mileage Generated (Km/day)		
	Scenario 1	**Scenario 2**	**Scenario 3[14]**
Land adjoining Weston	3,152	3,152	3,152
Land adjoining Odd Down	3,391	0	0
Extension to MOD Ensleigh	1,314	1,314	1,314
Land adjoining East Keynsham[15]	7,182	10,965	4,637
Land adjoining South West Keynsham	2,752	6,158	0
Land at Whitchurch	3,339	0	12,817
Total	**21,130**	**21,589**	**21,920**
Percentage change from best performing scenario.		2.2%	3.7%

5.5.2 CO_2

Table 26 shows the estimated total CO_2 generated by commuters per day based on a standard factor of 0.128kg of CO_2 emitted every km travelled. This is directly related to the additional vehicular kilometres calculated in Table 25.

Table 26: Estimated CO_2 Emissions Resulting from Development

Location	Car Mileage Generated (CO_2/day)		
	Scenario 1	**Scenario 2**	**Scenario 3[16]**
Land adjoining Weston	403	403	403
Land adjoining Odd Down	434	0	0
Extension to MOD Ensleigh	168	168	168
Land adjoining East Keynsham[17]	919	1,404	594
Land adjoining South West Keynsham	352	788	0
Land at Whitchurch	427	0	1,641
Total	**2,703**	**2,763**	**2,806**
Percentage change from best performing scenario.		2.2%	3.8%[18]

[14] Scenario 3 proposes additional housing in Somer Valley and Rural Areas which are outside the scope of this study. The total number of residences in Scenario 3 is therefore 11% lower (150/1370) than in Scenarios 1 and 2.
[15] East of Keynsham includes employment trips to/from 25,00sqm of industrial land use in all three scenarios.
[16] Refer to above footnotes.
[17] Refer to above footnotes.
[18] Change in percentage from distance table is due to rounding of individual location values in excel.

5.5.3 Accidents

The number of accidents generated by commuter trips resulting from development has been examined for trips to four key destinations in the area; Bath, Keynsham, Bristol and South Gloucestershire. Table 27 shows the estimated number of accidents generated by commuters per year.

Accident analysis suggests that Scenario 1 will result in the fewest number of accidents with Scenario 3 performing marginally worse than Scenario 2.

Table 27: Estimated Number of Accidents Generated by Commuter Trips

	Accidents Generated per Annum		
Location	**Scenario 1**	**Scenario 2**	**Scenario 3[19]**
Land adjoining Weston	0.63	0.63	0.63
Land adjoining Odd Down	0.59	0.00	0.00
Extension to MOD Ensleigh	0.25	0.25	0.25
Land adjoining East Keynsham[20]	1.44	2.21	0.94
Land adjoining South West Keynsham	0.56	1.26	0.00
Land at Whitchurch	0.70	0.00	2.69
Total	**4.17**	**4.35**	**4.51**
Percentage change from best performing scenario.		4.3%	8.2%

5.6 Conclusions

Scenario 1 is considered to be the best performing scenario in terms of providing opportunities for sustainable travel and reducing the impact of additional traffic on highways including contributions to CO_2 and road traffic accidents.

Scenario 2 performs worse than Scenario 1 in terms of sustainable travel opportunities, highways impact and potential for mitigation.

Scenario 3 is considered to offer more scope for sustainable travel than Scenario 2, but the locations lend themselves to additional travel distance, CO_2 and road traffic accidents. In highways terms a single large development offers less scope for dispersal of demand and mitigation of impacts and therefore Scenario 3 is considered less favourable than Scenario 2.

[19] Scenario 3 includes 11% fewer houses than Scenarios 1 and 2. Journeys to Bristol / Keynsham / Bath / South Gloucestershire considered only.
[20] East of Keynsham includes employment trips to/from Industrial Units in all scenarios.

6 Transport Measures to Support Development

6.1 Introduction

This scenario outlines the measures to be considered to facilitate implementation of the housing allocations identified in Scenario 1.

6.2 Public Transport Services

The location reviews have provided comment on the access to existing public transport services including stop locations. Based on the development mix identified in Scenario 1 the following measures have been identified at this initial stage:

- **Land adjoining Weston:** Consideration should be given to improvement of bus stops along Lansdown Lane, in particular those easily accessible from the development. Either services 14, off Eastfield Avenue or 17, off Napier Road could be diverted into any development.
- **Land adjoining Odd Down:** Improvement of bus stops along Midford Road and Wellsway should be considered and pedestrian infrastructure to/from stops should be examined. There are a large number of bus services operating in the area and consideration should be given to services through any development. The quality of this provision could be enhanced through bus gates/bus lanes developed in conjunction with operators.
- **Extension to MOD Ensleigh:** Stops on Lansdown Road should be upgraded. Development of the area, alongside the brownfield development, may provide justification for increasing the frequency of services 1 and/or 31 and this should be discussed with operators.
- **Land adjoining South West Keynsham:** Any development would benefit from additional new stops on Charlton Road providing connections to services 338 and 349.
- **Land adjoining East Keynsham:** Connections should be provided within the masterplan to stops along the A4 and these stops should be upgraded as appropriate. There may be scope to extend the 178, 338 or 339 services to feature stops within the development.
- **Land at Whitchurch:** Existing bus stops along the A37 should be upgraded. Any development would also benefit from additional stops along the A37 serving bus routes 376, 379 and 67. There are a number of services operating along the A37 and any masterplan should integrate bus services into the heart of the development. Thought should be given to service links and interchange facilities with the Bristol Bus Rapid Transit Route from Hengrove.

Further review of these measures should be undertaken in conjunction with bus operators with supporting analysis reviewing the business case for route

diversions and extensions. The feasibility of bringing services onto any development and connectivity to external bus stops will need to be considered.

6.3 Highway Improvement Works

The individual reviews have provided comment on the highway capacity works which may be required to mitigate the impact of development and the feasibility of implementing these measures. Based on the development mix identified in Scenario 1 the following works have been identified:

- **Land adjoining Weston:** Local highway capacity improvement and management works should be examined along Lansdown Lane and Crown Road including improvements to junctions on routes into Bath. The Newbridge P&R facility offers some scope to offset increases in traffic resulting from development and future expansion should be considered. Cycle links from the development to Bath city centre should be developed.
- **Land adjoining Odd Down:** Local junctions including the A367/A3062 roundabout may require modification or conversion to signals to provide additional capacity and peak hour traffic management. The feasibility of reallocating road space along Wellsway/Wells Road should be reviewed, particularly with reference to introduction of bus lanes. The Odd Down P&R facility offers some scope to offset increases in traffic resulting from development and future expansion should be considered.
- **Extension to MOD Ensleigh:** Local junctions along Lansdown Road may require improvement, in particular Julian Road /Morford Street to better facilitate access along Lansdown Road. The Richmond Road/Lansdown Road junction may require improvement or a change in priority. Changes to the Lansdown Road/George Street/The Paragon junction are likely to be required. An uphill bicycle lane could also be considered to improve cycle safety. The Lansdown P&R facility offers some scope to offset increases in traffic resulting from development and expansion should be considered along with increases in bus frequency.
- **Land adjoining South West Keynsham:** Routes from the development location to the A4 will require improvement, in particular junction control and capacity works at the St Ladoc Road/Charlton Road junction and the St Ladoc Road/A4175 Bristol Road junction. Development will produce addition demand on infrastructure in Keynsham Town Centre which may require highway modifications such as junction capacity and control modifications Highway improvements may be required along Charlton Road (to south Bristol), including junction modifications at the A37 junction.
- **Land adjoining East Keynsham:** A new junction onto the A4 would be the most likely means of access with the form of junction to be assessed. Improvement of junctions in Keynsham town centre as outlined above may be required. Access from the north is restricted by the presence of the railway line and existing routes have limited capacity. Improvements to these would be needed in order to facilitate development north of the railway line.

- **Land at Whitchurch:** The quantum of development is insufficient to support the major highway infrastructure needed to relieve congested highways into Bristol. Local capacity improvement measures will be required at junctions leading into the city but these are unlikely to mitigate all impacts. Expansion of the Brislington park and ride could reduce pressure on the A4 into Bristol with drivers transferring from the A37 to take advantage. Thought should be given to re-examination of the feasibility of an A37 Park and Ride facility, in particular if development can facilitate this service through linkages with residential development and provision of bus infrastructure/priority routes.

6.4 Park and Ride

The three Bath Park and Ride facilities operating on weekdays[21] (Odd Down, Newbridge Road, and Lansdown) are located on key corridors into the city which will be affected by vehicular trips generated by development. The cumulative impact of the development mix identified in Scenario 1 is equivalent to the following additional AM peak hour vehicular trips into Bath along these corridors:

- A367 Wells Road – 60 trips;
- A4 Newbridge Road – 30 trips;
- A36 – 20 trips;
- Lansdown Road – 20trips.

Scenario 1 results in relatively few journeys into the centre of Bath along east-west corridors and a relatively minor expansion in the Newbridge Road P&R facility would, if utilised by drivers, offset the effects of development on the A36 and A4.

Increased use of the Odd Down P&R facility would potentially be capable of offsetting the increase in trips along Wells Road and Bradford Road resulting from development at Land adjoining Odd Down. Furthermore, increased use of the Lansdown Road facility would similarly offset the additional trips generated by development of Ensleigh.

The feasibility of expanding the Brislington P&R facility (within Bristol City Council's area) to reduce traffic demands along the A4 should be considered. The cumulative impact of the developments within Scenario 1 is approximately 55 vehicles westbound along the A4 into Bristol in the AM peak.

It should also be noted that increased congestion along key routes into Bath, resulting from future traffic growth related to increased economic activity and development as prescribed in the Core Strategy, could provide an added incentive for drivers to transfer to P&R facilities, particularly if bus priority can be provided along key sections of highway. Parking charges and space availability also play a key role in determining drivers' choices and should be considered in a holistic manner alongside P&R and public transport costs.

[21] A fourth part and ride service operates on Saturdays from the University of Bath under agreement between the university and First Group.

6.5 A4 Bath-Keynsham-Bristol

The A4 is the major east-west route linking Bath, Keynsham and Bristol. Through Saltford the A4 is constrained by existing development within the village, pedestrian crossing infrastructure and local access junctions.

The traffic forecasts produced during this study indicate that if growth occurs in line with Tempro forecasts the A4 will operate above link capacity in future assessment years of 2021 and 2029.

The effect of the Scenario 1 development mix is an increase in traffic of approximately 60 vehicles forecast in the major direction of travel in peak hours, equivalent to a 5% increase in forecast 2029 volumes. This effect could therefore be offset by modest increases in public transport use resulting from modal shift onto bus or rail services along this corridor. The quantum and locations of development as reviewed in this report are therefore not considered justification for a bypass at the current time.

While the Scenario 1 development mix would not by itself act as a trigger for a bypass, should the need for a bypass be confirmed at a later date, it may be appropriate for developer contributions to be made from the locations identified within this study. In the meantime, it is suggested that a preferred route be identified and safeguarded for future implementation and this information be used to inform masterplanning of potential development around Keynsham.

6.5.1 Rail Services

The development locations identified in Scenario 1 are generally located too far from rail stations for rail travel to provide an alternative to the private car or bus use. There is however potential for modal shift from residents in more central wards of Bath and Bristol (and central areas of Keynsham) to result in a reduction in car trips along key corridors (notably the A4) offsetting the impact of development.

It is acknowledged that increases in rail patronage may generate capacity issues along main line services however the electrification of the Great Western Railway to Cardiff, which is due to be completed in 2016, will increase the number of trains per hour to London and provide quicker journey times via Parkway Station. As a result, a significant proportion of Bristol to London travellers will transfer to this route, creating capacity on the Bristol Temple Meads-Bath Spa route. Additional capacity on existing services may therefore be generated as a result of the electrification.

In addition, the Greater Bristol Metro project will provide half-hourly train services on all routes within the Greater Bristol commuting area, including services every 15 minutes between Bristol Temple Meads and Bath Spa (including InterCity trains to/from London Paddington). The Government has promised £94m to the West of England Partnership (the four unitary authorities of Greater Bristol) to implement the scheme as part of the Bristol City Deal, on condition that a board, such as an Integrated Transport Authority (ITA) or a concession similar to Transport for London, is set up to deliver the improvements.

The Greater Bristol Metro scheme is a 10-year project to be implemented in two stages with phase 1 introducing a Bristol Temple Meads - Bath shuttle service.

The implementation of this project is therefore within the timescales for development considered in this study.

6.6 Travel Planning/Smarter Choices

Future development at these locations should be secured against the implementation of a robust travel plan which provides the appropriate infrastructure, services and information for people to encourage modal shift to sustainable modes.

Measures could include:

- The creation of a permeable development maximising connectivity for pedestrians and cyclists within the development as well as links to external routes, in particular those on desire lines to neighbourhood centres and major employment sites.
- Adequate provision for cyclists including secure storage for residents bicycles, connections to external routes, provision of new routes across the development and incentives such as discounted or free equipment.
- Improvements to bus stops including pedestrian routes to/from these stops, real-time information boards, discounted tickets and information on routes and services. Consideration should be given to routing services into developments facilitating this through bus gates and bus priority routes if required by operators.
- Car clubs offers residents and employees cost-effective access to vehicles without the costs of car ownership. In residential developments they are particularly suitable for replacing "second cars" in any household and statistics show that car usage as a whole can reduce where they are provided to residents. Car clubs vehicles are typically smaller and "greener" than average and reductions in car ownership can provide benefits in terms of parking and access. All development locations should consider the introduction of a car club, with City Car Club an established operator in the south west.

7 Conclusions and Recommendations

7.1 Conclusions

A high-level transport evaluation has been undertaken to inform the choice of locations which will be promoted for primarily residential, but also employment land uses within the emerging B&NES Core Strategy.

The analysis has considered the 'pros and cons' of ten locations and three development mix scenarios. The evaluation has considered the individual locations and scenarios in terms of opportunities to promote sustainable transport and potential highway impacts associated with development. Locations have been considered favourably if they are located adjacent to established sustainable transport networks to enable good access to employment destinations and local amenities and if the highway impacts are considered to be manageable through mitigation measures. The converse has been considered if development locations are isolated or are adjacent to congested highway links with little scope for mitigation.

7.1.1 Individual Evaluations

A review of the ten locations has been undertaken with the locations broadly grouped into three categories based upon their performance in a number of transport areas:

Best Performing: Land adjoining Weston, Extension to MOD Ensleigh, Land adjoining Odd Down.

Average Performing: Land to the West of Twerton Land adjoining East Keynsham, Hicks Gate, Uplands.

Worst Performing: Land at Whitchurch, West of Keynsham, Land adjoining South West Keynsham.

The Land adjoining Weston, Extension to MOD Ensleigh and Land adjoining Odd Downs perform well across all categories and are considered the best performing areas for future development. They are well located to take account of sustainable transport opportunities and there are opportunities to mitigate highway impacts through modal shift, park and ride and local highway capacity improvements. Land adjoining Weston and Land adjoining Odd Down are located in areas with existing neighbourhood facilities and all three wards which have an established sustainable travel culture.

Land to the West of Twerton scores well in terms of highways impact as traffic can disperse across routes into Bath however the development area is isolated discouraging sustainable travel with the quantum of development presenting a marginal business case for bus diversion and journey times into Bath uncompetitive with the private car. Development at this location is therefore more likely to result in more car dependent behaviour than the other Bath locations.

The Land adjoining East Keynsham area scores averagely in all categories except access to bus services where it scores well due to a number of established services along the A4. Highway impacts can partially be mitigated but some residential

impacts will result on congested corridors including the A4 and routes into Keynsham.

Hicks Gate, Keynsham scores well in terms of access to cycle and bus links. The development will result in additional demands on the A4 and on routes into Keynsham and can be partially mitigated but some residential impact will result from development.

Land at Uplands scores averagely in most categories and poorly in the walking and additional travel distance categories. There is some scope to provide access by bicycle and public transport services operate in the area with scope for improvement through diversion and additional frequency. Vehicular trips into Keynsham will add to congestion along Bath Hill and trips into Bristol are likely to be via the A4.

The three worst performing locations are amongst the most isolated considered in this review and all three perform poorly in terms of highways impact and scope for mitigation.

West of Keynsham provides a limited basis for sustainable travel behaviour via diversion of existing bus services and linkages with existing pedestrian/cycle routes however any development is likely to generate vehicular trips into Bristol on the A4 along residential streets in Keynsham.

Land adjoining South West Keynsham has similar transport characteristics to the west of Keynsham. The development area is further from Keynsham town centre making it less accessible on foot and the east-west alignment of the area could make it difficult to integrate buses into the development so travel patterns are likely to be car dependent.

The Land at Whitchurch location offers sustainable transport opportunities with reasonably good bus services operating in the area and opportunities for residents to access NCN3. It scores poorly in highways access, mileage and accident rates. Any development will result in increased demand for peak hour travel into Bristol along the A37 corridor which experiences congestion and has relatively poor journey times. Development is also likely have an effect on residential streets in Keynsham.

7.1.2 Scenario Testing

Three scenarios, comprising of the development mixes outlined in Table 28 have been produced by B&NES.

Table 28: Scenarios Developed by B&NES for Evaluation

Locations	Scenario 1	Scenario 2	Scenario 3
Land adjoining Odd Down	300 dwellings	0 dwellings	0 dwellings
Land adjoining Weston	300 dwellings Primary school	300 dwellings Primary school	300 dwellings Primary school
Extension to MOD Ensleigh	120 dwellings	120 dwellings	120 dwellings
Keynsham Land adjoining South West Keynsham	200 dwellings	450 dwellings	0 dwellings
Land adjoining Keynsham East	250 dwellings, 25,000m² employment	500 dwellings, 25,000m² employment, Primary School	0 dwellings, 25,000m² employment
Land at Whitchurch	200 dwellings	0 dwellings	800 dwellings, primary school
Somer Valley	300 dwellings	300 dwellings	400 dwellings
Rural Areas of B&NES	200 dwellings	200 dwellings	250 dwellings

The location and development mixes have been reviewed based on the information gathered in the individual appraisals. The cumulative effects of traffic have also been examined with reference to highway capacity and potential for mitigation through highway capacity improvements and/or modal shift.

Scenario 1 is considered the most sustainable combination of development locations. The locations identified in Scenario 1 offers the best access to walking, cycling and public transport facilities/services. Scenario 1 locations also forecast to result in the lowest net increase in commuter car travel, CO_2 emissions and road traffic accidents. Highway effects associated with Scenario 1 have the most scope for mitigation through modal shift, park and ride and highway capacity improvements.

Scenario 2 and Scenario 3 include development at locations which are less sustainable than the Land adjoining Odd Down included in Scenario 1. Scenario 3 provides better potential access to sustainable transport facilities as the Land at Whitchurch is connected to the NCN and well served by buses operating on the A37. However the development area is isolated from major employment sites (for the purposes of walking) and the ward exhibits car dependent behaviour. Scenario 2 is forecast to result in less additional commuter mileage, CO_2 emissions and road traffic accidents. Overall, scenario 2 is considered marginally preferable to Scenario 3 as the dispersal of development across different locations reduces the impact at any one junction offering better scope for local highway capacity improvements and demand management measures. In particular, Scenario 3 is forecast to generate significant demand on the A37 into Bristol which experiences poor journey times and has little scope for mitigation.

7.2 Recommendation

Based on a high-level examination of potential allocation to identify the potential for sustainable travel and analysis of the likely cumulative traffic impacts and scope for mitigation we would recommend Scenario 1.This is considered the best performing in terms of providing opportunities for sustainable travel, reducing the impact of additional traffic on the highway network and providing scope for mitigation without costly infrastructure provision.

Scenario 2 is considered marginally preferential to Scenario 3 as the allocation of development reduces the impact at any one location offering better scope for local highway capacity improvements and demand management measures.