Broxbourne Local Plan Development

FORECASTING REPORT

Report

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Report Record

Job No.	Report No.	Issue No.	Prepared	Verified	Approved	Status	Date
ST13395	1	1	AH	CS	CS	Draft	05/05/2015
ST13395	1	2	AH	CS	CS	Rev1	20/05/2015
ST13395	1	2	AH	CS	CS	Rev2	07/10/2015

Contents Amendments Record

Issue No.	Revision description	Approved	Status	Date
2	Comments addressed from BBC 14/05/2015 = JT Info etc...	CS	Rev1	20/05/2015
3	Comments addressed from HCC and Highways England	CS	Rev2	07/10/2015

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Executive Summary

1.1 JMP Consultants Ltd has been commissioned to assess the highway impacts of different spatial planning scenarios associated with the development of the emerging Broxbourne Local Plan. Testing has been undertaken using the SATURN based East London Highway Assignment Model (ELHAM) which has been extended and enhanced to incorporate the highway network within Broxbourne.

1.2 This forecasting report has been prepared to compare the performance of the 'Do Minimum' highway conditions against three Local Plan scenarios known as the (as described in **Section 3**);

- ✓ 'Preferred';
- ✓ 'Alternative' and;
- ✓ 'Combined'.

1.3 The 'Do Minimum' or Reference Case excludes any proposed site allocations within the Local Plan.

1.4 JMP have calibrated and validated the ELHAM model to a 2013 Base Year using traffic count data and journey time information, in accordance with DfT TAG Guidelines. The performance of the network was reported within the Local Model Validation Report (LMVR)

1.5 A forecast year assessment was undertaken for a 2029 future year which included:-

- Committed network interventions to 2029;
- Consented development to 2029;
- Background traffic growth.

1.6 An assessment has been undertaken using the trip rates used in the 2029 'Do Minimum' (DM) model to allow consistency between the models. The ELHAM model has been used to assess the effect of the proposed scenarios on the network and the net effect of each proposed scenario has been determined.

1.7 Table 0.1 below provides a comparison of the network performance statistics between the Base Year 2013 and Reference Case 2029 DM scenario. The 2029 DM represents the benchmark from which each of the specified Local Plan development quanta can be compared.

1.8 Table 0.1 therefore identifies the future base performance of the highway network and is useful in illustrating how the network would operate irrespective of local plan growth.

1.9 The Reference Case demand forecasts include a consideration of the consented developments and background economic growth, in accordance with DfT TAG Unit M4 – Forecasting and Uncertainty.

1.10 The Freight demand (LGV & HGV) proportion has been increased in line with the National Transport Model Road Type Forecast 2011.

1.11 In addition, the DM scenario includes the M25 J23-J27 "Smart Motorways" scheme and the A10 Turn ford Link Road as delivered and committed highway interventions.

Table 0.1 Broxbourne Network Performance by 2013 compared with. DM 2029

ID	Indicator	Unit	AM Peak Hour (08-09)			PM Peak Hour (17-18)		
			BY 2013	DM 2029	% Diff	BY 2013	DM 2029	% Diff
1	Demand	PCU	46,711	55,825	**20%**	44,110	53,158	**21%**
2	Total Travel Time	PCU/Hrs	7,007	9,617	**37%**	7,129	11,344	**59%**
3	Total Distance Travelled	PCU/km	396,327	477,701	**21%**	381,006	472,772	**24%**
4	Average Travel Time	PCU/min	9	10	**15%**	10	13	**32%**
5	Average Distance Travelled	PCU/km	8	9	**1%**	9	9	**3%**
6	Average Speed	kph	56.6	49.7	**-12%**	53.4	41.7	**-22%**
7	Total Travel Time Delay	PCU/Hrs	1,054	1,727	**64%**	1,389	3,611	**160%**
8	Delay as % of Total Travel Time	%	15%	18%	**3%**	19%	32%	**12%**

1.12 Table 0.1 above demonstrates that the Reference Case growth is circa 20% and most notably impacts the performance of the PM peak hour, as characterised by the significant reduction in average speed of 20%.

1.13 It should be noted that in the AM peak hour traffic patterns are characterised by primarily movements based on commuter routes, however, the PM peak hour is characterised by a mixture of travel patterns which generates a more susceptible network to changes in demand conditions.

1.14 In addition, the total volume of queued traffic in the PM peak has nearly tripled from the Base Year 2013 volume, which indicates a significant deterioration in network performance and overall operating capacity.

1.15 The 2029 DM model indicates significant capacity constraints along the A10 corridor, particularly along the southern corridor, from the A10 Great Cambridge Road / Church Lane junction to the A10 Great Cambridge Road / A1055 Bullsmoor Lane junction.

1.16 The following key junctions along the southern A10 corridor, are identified as having clear capacity constraints;

- ✓ A10 Great Cambridge Road / Church Lane (Signalised 4 Arm Junction);
- ✓ A10 Great Cambridge Road / College Road (Signalised 4 Arm Junction);
- ✓ A10 Great Cambridge Road / A121 Winston Churchill Way / B198 Lieutenant Ellis Way (RB 4 Arms);
- ✓ M25 Junction 25 / A10 Great Cambridge Road (Grade Separated Motorway Intersection, 4 Arms);
- ✓ A10 Great Cambridge Road / A1055 Bullsmoor Lane (Signalised 4 Arm Junction);

1.17 Table 0.2 below presents the network performance statistics for the specified Local Plan scenarios in the AM Peak Hour, in comparison to the Reference Case DM scenario (as described in **Section 2)**. It should be noted that the Local Plan scenario demand has been assigned onto the DM network, excluding any mitigation beyond the definition of suitable access and egress points.

1.18 Each scenario represents a sequential reduction in the network performance which relates to the increase in the development quantum.

1.19 It should be noted that the overall distribution of developments within the Local Plan scenarios, principally varies in only 3 of the 13 specified sites;

i. Brookfield (Retail & Residential);
ii. Goff's Oak (Residential) ; and
iii. Albury Farm (Residential).

1.20 The 'Preferred' scenario generates the minimum detrimental impact, whereas the 'Combined' represents the maximum impact, principally due to the concentration of demand along the A10 corridor.

Table 0.2 Network Performance Local Plan Scenario Comparison AM Peak Hour 2029

ID	Indicator	Unit	AM Peak Hour (08-09)						
			DM 2029	Preferred 2029	% Diff DM	Alternative 2029	% Diff DM	Combined 2029	% Diff DM
1	Demand	PCU	55,825	59,682	**7%**	60,318	**8%**	60,766	**9%**
2	Total Travel Time	PCU/Hrs	9,617	10,880	**13%**	11,511	**20%**	11,705	**22%**
3	Total Distance Travelled	PCU/km	477,701	503,006	**5%**	508,864	**7%**	512,730	**7%**
4	Average Travel Time	PCU/min	10	11	**6%**	11	**11%**	12	**12%**
5	Average Distance Travelled	PCU/km	9	8	**-2%**	8	**-1%**	8	**-1%**
6	Average Speed	kph	49.7	46.2	**-7%**	44.2	**-11%**	43.8	**-12%**
7	Total Travel Time Delay	PCU/Hrs	1,727	2,492	**44%**	3,009	**74%**	3,125	**81%**
8	Delay as % of Total Travel Time	%	18%	23%	**5%**	26%	**8%**	27%	**9%**

1.21 Table 0.3 below presents the network performance statistics for the specified Local Plan scenarios in the PM Peak Hour, in comparison to the Reference Case DM scenario (as described in **Section 2)**.

1.22 Following the pattern demonstrated in the AM, each scenario represents a sequential reduction in the network performance as the development quantum increases.

1.23 The Preferred scenario generates the minimum detrimental impact, whereas the 'Combined' represents the maximum impact, once again, due to the concentration of demand along the A10 corridor. However the level of growth at between 8% and 10% is less than half that generated by background traffic growth and consented developments between 2013 and 2029.

Table 0.3 Network Performance Local Plan Scenario Comparison PM Peak Hour 2029

ID	Indicator	Unit	PM Peak Hour (17-18)						
			DM 2029	Preferred 2029	% Diff DM	Alternative 2029	% Diff DM	Combined 2029	% Diff DM
1	Demand	PCU	53,158	57,438	**8%**	58,007	**9%**	58,420	**10%**
2	Total Travel Time	PCU/Hrs	11,344	14,147	**25%**	14,531	**28%**	14,648	**29%**
3	Total Distance Travelled	PCU/km	472,772	509,766	**8%**	513,659	**9%**	516,521	**9%**
4	Average Travel Time	PCU/min	13	15	**15%**	15	**17%**	15	**18%**
5	Average Distance Travelled	PCU/km	9	9	**0%**	9	**0%**	9	**-1%**
6	Average Speed	kph	41.7	36.0	**-14%**	35.3	**-15%**	35.3	**-15%**
7	Total Travel Time Delay	PCU/Hrs	3,611	5,744	**59%**	6,054	**68%**	6,123	**70%**
8	Delay as % of Total Travel Time	%	32%	41%	**9%**	42%	**10%**	42%	**10%**

1.24 The analysis of the Local Plan scenarios in the Broxbourne SATURN model has identified that the network is susceptible to changes in the overall network performance statistics, based on the inclusion of the proposed Local Plan development proposals. However, in context of the Reference Case Do-Minimum (DM) 2029 scenario performance, the level of deterioration is primarily characterised as an exacerbation of the existing constraints within the DM 2029. There are also localised impacts at some junctions which are identified in **Appendix A** of this report.

1.25 Mitigation is therefore primarily (but not exclusively) required to address existing constraints, which should be future proofed to accommodate the additional demand arising from local plan growth.

1.26 The analysis of the Local Plan scenarios indicates only minor variations in the locations of the capacity constraints, which is representative of the near consistency in the development quantum within the specified Local Plan scenarios.

1.27 The A10 Great Cambridge Road remains the principal capacity constraint within the Broxbourne highway network. In general, the Local Plan development scenarios lead to the exacerbation of the identified capacity constraints in the 2029 DM rather than the generation of new congestion locations.

1.28 It is clear that in order to accommodate the 2029 DM demand and subsequent Local Plan developments, further mitigation is required along the A10 corridor, particularly at the five specified sites;

i. A10 Great Cambridge Road / Church Lane (Signalised 4 Arm Junction);

ii. A10 Great Cambridge Road / College Road (Signalised 4 Arm Junction);

iii. A10 Great Cambridge Road / A121 Winston Churchill Way / B198 Lieutenant Ellis Way (RB 4 Arms);

iv. M25 J25 / A10 Great Cambridge Road (Grade Separated Motorway Intersection, 4 Arms);

v. A10 Great Cambridge Road / A1055 Bullsmoor Lane (Signalised 4 Arm Junction);

1.29 The alternative to mitigating the locations above would be to divert traffic away from the A10 corridor. However, this is undesirable given the capacity constraints of the parallel north – south routes through Broxbourne and the limited ability for these routes to accommodate additional demand. Enhanced public transport capacity into North and Central London could assist in alleviating the capacity constraints on the road network but this has not been tested as part of this study.

1 Introduction

STUDY BACKGROUND

1.1 JMP Consultants Ltd (JMP) has been commissioned by a Broxbourne Council ('the Council'), to develop a SATURN model of Broxbourne.

1.2 The aim of the model is to provide a tool which simulates the existing traffic situation in the borough and can be used to test the impact of development scenarios related to the Council's Local Plan as well as any other traffic and transportation related tests which may later be required.

1.3 It was deemed from the outset of the transport study that the best methodology for developing a model for the area would be achieved by utilising the Transport for London (TfL) East London Highway Assignment Model (ELHAM). This is an existing SATURN model with a base year of 2009 which has been revalidated to a 2013 base year. It is part of the TfL group of regional Highway Assignment Models (HAMs) and covers the study area. This model was considered to provide a suitably robust basis for the development of the Broxbourne forecasting scenarios which this report documents. Further details on the model development are provided in the Local Model Validation Report (LMVR).

PURPOSE OF REPORT

1.4 This report gives a detailed description of the development of the Broxbourne forecasting scenarios which assess the impact of three different local plan scenarios namely the:-

- Preferred Local Plan Scenario
- Alternative Local Plan Scenario; and the
- Combined Local Plan Scenario

STRUCTURE OF REPORT

1.5 Following this introduction, this report contains the following chapters:

- Chapter 2 gives an overview of the development of the do minimum 2029 Reference Case forecast
- Chapter 3 outlines how the local plan scenarios were developed
- Chapter 4 describes the results of the local plan assessments comparing these with the do minimum 2029 Reference Case forecast;
- Chapter 5 provides a summary of the main conclusions.

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1.7 Unless specifically stated, all map extracts are taken from Ordnance Survey data © Crown copyright and database 2006.

2 DM 2029 Reference Case Forecast

INTRODUCTION

2.1 The following section provides an overview of the approach to generating the Do-Minimum (DM) 2029 Reference Case scenario, which is used as a 'benchmark' for the evaluation of the Local Plan development proposals described in the **Section 3**.

2.2 The DM scenario represents the network structure and demand for the Broxbourne highway network for 2029, including;

- ✓ Committed Infrastructure;
- ✓ Committed Developments; and
- ✓ Background Traffic Growth.

2.3 The DM scenario effectively represents the potential network conditions for the Broxbourne highway network, excluding the proposed Local Plan developments.

COMMITTED INFASTRUCTURE

2.4 In order to establish a robust basis for the Do-Minimum scenario, the modelled network is required to represent the potential available network in the forecast year. This includes existing schemes which have been constructed after the modelled Base Year 2013 and programmed committed schemes.

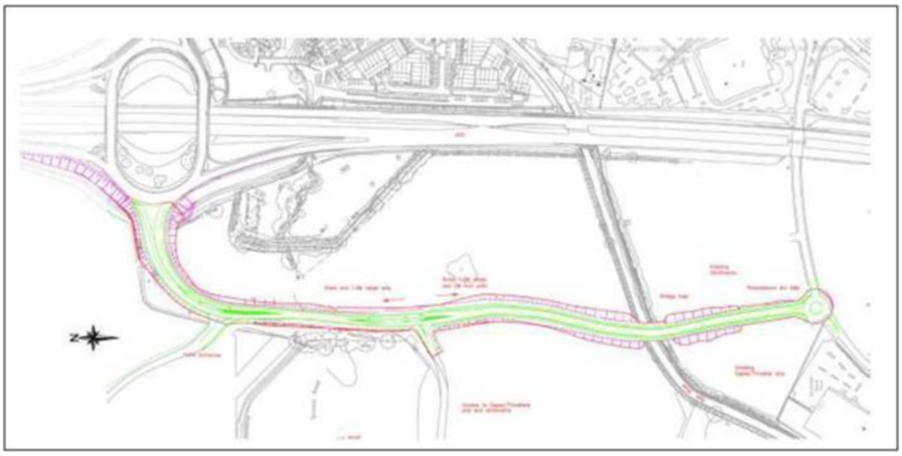
2.5 In context of the Broxbourne modelled network, the following schemes have been incorporated to create a representative Do-Minimum network for 2029;

- ✓ The M25 J23-J27 "Smart Motorways" - Opened 2014; and
- ✓ A10 Turnford Interchange to Halfhide Link Road, as presented in Figure 2.1

2.6 The M25 J23-J27 "Smart Motorways" scheme is a constructed scheme, which opened in 2014. The scheme involves the management of the motorway network through the application of variable speed limits and the adoption of the hard shoulder as a running traffic lane during peak periods. The scheme has been represented in the model as an increase in the available motorway capacity and a reduction in the maximum achievable speed (50mph). The scheme is designed to improve the resilience for the M25, whilst reducing the variability in journey times.

2.7 The A10 Turnford Interchange to Halfhide Link Road is a direct strategic link form Halfhide Lane to the A10. This link allows traffic travelling from the Goff's Oak areas to access and egress from the A10 north, bypassing the A1170 Great Cambridge Road. In addition, it provides a secondary access point directly from the A10 into the Brookfield Retail Centre.

Figure 2.1 A10 Turn ford Interchange and Halfhide Link Road



COMITTED DEVELOPMENTS

2.8 The committed developments represent the consented development growth which is approved to be built within the Broxbourne highway network during the interim period between 2013 & 2029. This growth is considered as independent of the Local Plan allocations.

2.9 A comprehensive list of the committed developments has been provided by the council and is contained in **Appendix F**. Based on the specified land use allocations, the development quantum of the committed developments can be summarised as follows;

- Employment – 20 sites (49,000 sqm);
- Retail – 25 sites (6,500 sqm);
- Leisure – 11 sites (17,500 sqm);
- Education – 13 sites (5,800 sqm); and
- Residential – 2,150 dwellings (mixture of flats and houses).

2.10 In is assumed that the all consented development is constructed by 2029 and is therefore considered within the demand assumptions within the 2029 traffic growth forecast.

2.11 The trip generations and attractions for each land use classification have been determined and applied to generate a trip volume based on the supplied development quantum. This value represents the maximum volume of committed development trips which could be generated based on the concept that the committed development represents new developments.

2.12 However, the information supplied indicates that the consented developments may not result in new trips, due to numerous reasons including;

- Change of use to a lower traffic generating use compared to the extant permission;;
- Brownfield site currently occupied; or
- Expansion of existing sites where the new land use will not generate additional trips.

2.13 Therefore, considering the total volume of committed development as new trips may misrepresent the actual trip impact of the consented sites. Based on this understanding, the committed developments have been reviewed and a consideration has been given to the likely outcome of the development to generate new trips.

2.14 Based on this review, the following additional trips have been either added to representative existing zones or allocated - New zones generated have been primarily for Greenfield allocations.

- AM peak hour - ~1,200 Origins, ~1,000 Destinations = ~2,200 trip total
- PM peak hour - ~1,000 Origins, ~1,200 Destinations = ~2,200 trip total

2.15 The distribution of these development trips has been based on the information presented within Transport Assessments such as census data. Where this data has been absent trips have been distributed based on existing zones or adjacent zones with similar characteristics.

BACKGROUND TRAFFIC GROWTH

2.16 Background traffic growth represents the traffic growth which will incur independent of any committed developments within Broxbourne or the Local Plan. This generally represents economic growth and the growth from other regions within Hertfordshire and beyond.

2.17 The methodology for considering the background traffic growth follows the approach outlined within the DfT modelling guidance documentation - TAG Unit M4 – Forecasting and Uncertainty

2.18 The background growth is calculated for two primary classifications;

- ✓ Cars;
- ✓ Freight, including Light Goods Vehicles (LGV's) & Heavy Good Vehicles (HGV).

Further information regarding the calculation of background growth for each classification is provided below;

Car Background Growth

2.19 The standard approach to forecasting car based growth is to apply factors using the planning based tool TEMPRO as specified by the DfT. TEMPRO provides a level of growth for an area, based on the predicted level of employment and housing specified in the regional development forecast for Origin and Destinations.

2.20 This forecast is then uplifted by an additional economic factor as specified in WebTAG Table M4.2.1, which accounts for economic based growth, using indicators of income and fuel. This is representative of the additional growth in demand which is independent or as a product of development growth.

2.21 This forecast represents the maximum potential growth in demand within the assessed area. The committed developments are added to the Base Year demand and the overall demand increase is constrained to the TEMPRO based forecast to prevent optimistic or pessimistic forecasting. In essence, the committed developments provide the primary locations for the forecasted traffic growth.

2.22 In the case of this assessment, the Local Plan is considered to represent the planned growth within the TEMPRO forecast; therefore an alternative scenario has been generated in TEMPRO. This scenario assumes that the employment and household volume for Broxbourne in 2029 remain as the 2013 Base Year levels. This produces a forecast for Broxbourne which represents demand changes based on the forecasts for regions which influence demand within Broxbourne such as Hertfordshire and neighbouring counties.

2.23 The application of the forecast is based on the division of the demand matrix into four classifications, each of which is increased in line with a representative factor;

- (External – External) - National Transport Model forecast growth;
- (External – Internal) - TEMPRO adjusted Destination growth;
- (Internal – External) - TEMPRO adjusted Origin growth; and
- (Internal – Internal) - TEMPRO average Origin & Destination growth

2.24 The External – External movements represent strategic trips through the modelled area which is increased independent of the impact of development growth, based on the National Transport Model forecast (AF09), for all road types, as extracted from the TEMPRO NTM extraction facility.

2.25 Table 2.1 presents the range of factors that have been defined for the DM background growth in the AM & PM peak hours, based on the approach outlined above and specified in DfT guidance WebTAG Table M4.2.1.

Table 2.1 Car Background Growth Factors 2013-2029

Classification	AM Peak Hour (08-09)	PM Peak Hour (17-18)
External – External (EXT-EXT)	24%	25%
External – Internal (EXT-INT)	20%	14%
Internal – External (INT-EXT)	11%	19%
Internal – Internal (INT-INT)	16%	16%
Average Factor	18%	18%

2.26 Table 2.2 & Table 2.3 present the matrix totals for the car based trips using the applied factors as determined above and including the committed development allocations.

2.27 In summary, based on the TEMPRO forecasting approach the overall background growth in car based demand increases by circa 20% in both the AM & PM peak hours across the modelled network, with the primary increase in the External – External demand, which represents 45% of the total demand, which is representative of a network containing the M25.

Table 2.2 AM Peak Hour (08-09) Total Car Growth 2013 - 2029

Classification	Base Year 2013	DM 2029	% Growth
External – External (EXT-EXT)	16,250	20,147	24%
External – Internal (EXT-INT)	5,798	6,956	20%
Internal – External (INT-EXT)	6,651	7,403	11%
Internal – Internal (INT-INT)	8,132	9,403	16%
Total	36,832	43,909	19%

Table 2.3 PM Peak Hour (08-09) Total Car Growth 2013 - 2029

Classification	Base Year 2013	DM 2029	% Growth
External – External (EXT-EXT)	16,433	20,530	25%
External – Internal (EXT-INT)	6,412	7,285	14%
Internal – External (INT-EXT)	5,657	6,726	19%
Internal – Internal (INT-INT)	8,717	10,134	16%
Total	37,218	44,675	20%

Freight Background Growth

2.28 The Freight forecast is based on information derived for the National Transport Model (NTM) which generates the Regional Traffic Forecast 2013 (RTF13). Based on the interpolation of the information provided for All Road Types in the East of England, the following forecast factors presented in Table 2.4 have been applied to the relevant Freight vehicle classification, to derive a forecast demand for 2029 from the 2013 Base Year.

2.29 It should be noted, that the SATURN model demand is in Passenger Car Units (PCUs) rather than vehicle trips. Therefore, the forecast factor has been applied to the vehicle volume rather than the PCU volume, based on the PCU factors specified in Table 2.4.

Table 2.4 Regional Traffic Forecast 2013 Interpolated Freight Forecast

Classification	Factor	PCU Factor
LGV	35%	1.25
HGV	12%	2.5

SUMMARY

2.30 In summary, Table 2.5 & Table 2.3 present the matrix totals for the Base Year 2013 and Reference Case DM 2029 for each assigned vehicle classification.

2.31 The overall background traffic growth, including committed developments and economic growth equates to circa 20% in both the AM and PM peak hours at approximately 1.25% per annum, based on the approach outlined above.

2.32 It should be noted, that the forecasting approach has excluded the Local Plan allocations, therefore the influence of double counting of the forecast demand has been removed.

2.33 The overall level of growth aligns with National Transport Model forecast for growth for all road types in the East of England circa 25%, based on the inclusion of a representation of the overarching Local Plan proposal.

Table 2.5 AM Peak Hour (08-09) Matrix Totals 2013 – 2029 (in vehicles) - Total Network

Classification	Base Year 2013	DM 2029	% Growth
Cars	36,832	43,909	19%
LGV	2,834	3,833	35%
HGV	2,509	2,820	12%
Total	42,175	50,562	20%

Table 2.6 PM Peak Hour (08-09) Matrix Totals 2013 – 2029 (in vehicles) – Total Network

Classification	Base Year 2013	DM 2029	% Growth
Cars	37,218	44,675	20%
LGV	2,507	3,391	35%
HGV	1,469	1,651	12%
Total	41,194	49,717	21%

3 Local Plan Development Scenarios

INTRODCUTION

3.1 The following section provides an overview of the Broxbourne Local Plan developments scenarios;

- ✓ 'Preferred';
- ✓ 'Alternative' and;
- ✓ 'Combined'.

3.2 In order to assess the impact of the various Local Plan proposals, the following assumptions are required and are described in further details within this section;

- ✓ Development Quantum;
- ✓ Trip Generations; and
- ✓ Distributions & Assignment;

LOCAL PLAN DEVELOPMENT QUANTUM

3.3 Table 3.2 provides a summary of the development quantum for each of the 13 proposed locations specified within the appraised Local Plan scenarios. The 'Combined' scenario represents the maximum build out of all 13 sites.

3.4 It should be noted, that based on the information provided only 3 of the 13 sites presents a variation in the Local Plan quantum, as follows;

i. Brookfield (Retail Park & Residential);
ii. Goff's Oak (Residential) ; and
iii. Albury Farm (Residential).

TRIP GENERATIONS

3.5 The specified development scenarios have been converted into trip origin (departure) and destination (arrival) volumes based on the example trip rates specified in Table 3.1 below, as calculated through the TRICS database;

3.6 Tables 3.3 & Table 3.4 present the trip generations for each Local Plan scenario based on the agreed trip rates. It is assumed that as part of this assessment the Local Plan trips represent new trips, however, it acknowledged that a proportion will be transferred or diverted existing trips.

Table 3.1 Trip Rates

Land Use (Generic)	Unit	AM Arrival	AM Departure	PM Arrival	PM Departure
Office (B1a/B1b)	area per 100sqm	1.128	0.014	0.043	1.056
Housing – Homes (C)	per unit	0.161	0.448	0.396	0.204
Housing – Apartments (C)	per unit	0.023	0.255	0.255	0.104
Retail – A1,A3 & Hotel	area per 100sqm	2.724	1.714	4.329	5.313
Leisure – D2	area per 100sqm	14.157	10.229	41.244	30.851
Primary School	per pupil	0.381	0.281	0.027	0.036
Secondary School	per pupil	0.086	0.040	0.005	0.019

Table 3.2 Local Plan Development Quantum

ID	Local Plan Site	Proposed Land Use	'Preferred'	'Alternative'	'Combined'
1	Park Plaza North	Office/Business Park uses B1a, B1b and Hotel	50k sqm Gross and 1,5k jobs	50k sqm Gross and 1,5k jobs	50k sqm Gross and 1,5k jobs
2	Park Plaza West	Office/Business Park uses B1a, B1b	30k sqm Gross and 1,4k jobs	30k sqm Gross and 1,4k jobs	30k sqm Gross and 1,4k jobs
3	Albury Farm	Primary School	2 ha site - approx 450 pupils	-	2 ha site - approx 450 pupils
		Housing	-	150 Homes	-
4	Bury Green	Housing	100 Homes	100 Homes	100 Homes
5	Dark Lane	Housing	57 Homes	57 Homes	57 Homes
6	Churchgate	Primary School	2 ha site - approx 450 pupils	2 ha site - approx 450 pupils	2 ha site - approx 450 pupils
7	West Of Hoddesdon	Housing	507 Homes	507 Homes	507 Homes
		Care Home	80 Care Home units	80 Care Home units	80 Care Home units
		Primary School	2 ha site - approx 450 pupils	2 ha site - approx 450 pupils	2 ha site - approx 450 pupils
		Community Centre & Retail	*See below	*See below	*See below
8	Brookfield*	Retail A1, A3 Restaurants and Hotel	36k sqm Gross Retail ~ 1k jobs	36k sqm Gross Retail ~ 1k jobs	36k sqm Gross Retail ~ 1k jobs
		D2 Leisure	12k sqm Gross Leisure	12k sqm Gross Leisure	12k sqm Gross Leisure
		Commercial - B1 offices and Civic Space	47k sqm Gross and 2.15k jobs	47k sqm Gross and 2.15k jobs	47k sqm Gross and 2.15k jobs
		Housing	1,500 Homes	-	1,500 Homes
		Apartments	275 Units	-	275 Units
		Elderly Persons Housing	75 Units	75 Units	75 Units
		Two Primary Schools and Two Nurseries	2x 2ha sites for schools/nurseries ~900 pupils	-	2x 2ha sites for schools/nurseries ~900 pupils
9	Broxbourne Secondary School	Housing & School Expansion	120 Homes & 210 pupils	120 Homes & 210 pupils	120 Homes & 210 pupils
10	Ryelands Site / Land at Dinant Link Road Hoddesdon	Primary School & B1a/b Office	1 ha site - approx 210 pupils & 1.4 ha of office and B1a/b	1 ha site - approx 210 pupils & 1.4 ha of office and B1a/b	1 ha site - approx 210 pupils & 1.4 ha of office and B1a/b
11	Waltham Cross	Primary School	2 ha site - approx 450 pupils	2 ha site - approx 450 pupils	2 ha site - approx 450 pupils
12	Goff's Oak	Primary School	1 ha site - approx 210 pupils	2x 2ha sites - ~900 pupils	2x 2ha sites - ~900 pupils
		Housing	200 Homes	1,825 homes	1,825 homes
13	Church Lane Secondary School	Secondary School	1,200 pupils	1,200 pupils	1,200 pupils
	*West Hoddesdon Retail	170 jobs which includes 60 bed hotel, 100 sqm gym, 370 sqm shop and 465 sqm B1a			

Table 3.3 AM Peak Hour (08-09) Local Plan Scenario Net Trip Generations (Car Trips)

Site	Site Name	Location	'Preferred'			'Alternative'			'Combined'		
			Dep	Arr	Total	Dep	Arr	Total	Dep	Arr	Total
1	Park Plaza North	A121/A10	7	564	**571**	7	564	**571**	7	564	**571**
2	Park Plaza West	A10/Lieutenant Ellis Way	4	338	**342**	4	338	**342**	4	338	**342**
3	Albury Farm	Great Cambridge Road	32	43	**75**	99	67	**166**	32	43	**75**
4	Bury Green	Lieutenant Way	74	56	**130**	74	56	**130**	74	56	**130**
5	Dark Lane	Dark Lane	26	9	**35**	26	9	**35**	26	9	**35**
6	Churchgate	Churchgate	31	43	**74**	31	43	**74**	31	43	**74**
7	West Of Hoddesdon	Hertford Road/ A10	268	194	**462**	268	194	**462**	268	194	**462**
8	Brookfield*	A10/ Park Lane Paradise	725	933	**1,658**	322	767	**1,088**	712	916	**1,628**
9	Broxbourne Secondary School	High Road Broxbourne	56	24	**80**	56	24	**80**	56	24	**80**
10	Ryelands Site / Land at Dinant Link Road Hoddesdon	Essex Road	16	161	**177**	16	161	**177**	16	161	**177**
11	Waltham Cross	High Street	30	40	**70**	30	40	**70**	30	40	**70**
12	Goff's Oak	St James's Road	105	52	**157**	881	380	**1,261**	881	380	**1,261**
13	Church Lane Secondary School	Church Lane	12	15	**27**	12	25	**37**	12	25	**37**
TOTAL TRIP GENERATION			**1,386**	**2,472**	**3,858**	**1,826**	**2,688**	**4,493**	**2,149**	**2,793**	**4,942**

Key

Dep – Departure trips

Arr – Arrival trips

(*) Brookfield Retail includes a 50% trip reduction from the Master-plan, to account for the existing retail quantum.

Table 3.4 PM Peak Hour (17-18) Local Plan Scenario Net Trip Generations (Car Trips)

Site	Site Name	Location	'Preferred'			'Alternative'			'Combined'		
			Dep	Arr	Total	Dep	Arr	Total	Dep	Arr	Total
1	Park Plaza North	A121/A10	528	22	**550**	528	22	**550**	528	22	**550**
2	Park Plaza West	A10/Lieutenant Ellis Way	317	13	**330**	317	13	**330**	317	13	**330**
3	Albury Farm	Great Cambridge Road	4	3	**7**	35	62	**97**	4	3	**7**
4	Bury Green	Lieutenant Way	24	42	**66**	24	42	**66**	24	42	**66**
5	Dark Lane	Dark Lane	12	23	**35**	12	23	**35**	12	23	**35**
6	Churchgate	Churchgate	4	3	**7**	4	3	**7**	3	3	**6**
7	West Of Hoddesdon	Hertford Road/ A10	170	214	**384**	170	214	**384**	170	214	**384**
8	Brookfield*	A10/ Park Lane Paradise	1,396	1,153	**2,549**	1,224	818	**2,042**	1,394	1,152	**2,546**
9	Broxbourne Secondary School	High Road Broxbourne	25	48	**73**	25	48	**73**	25	48	**73**
10	Ryelands Site / Land at Dinant Link Road Hoddesdon	Essex Road	135	7	**142**	135	7	**142**	135	7	**142**
11	Waltham Cross	High Street	4	3	**7**	4	3	**7**	4	3	**7**
12	Goff's Oak	St James's Road	43	80	**123**	380	729	**1,109**	380	729	**1,109**
13	Church Lane Secondary School	Church Lane	5	2	**7**	5	2	**7**	5	2	**7**
TOTAL TRIP GENERATION			**2,667**	**1,613**	**4,280**	**2,863**	**1,986**	**4,849**	**3,001**	**2,261**	**5,262**

Key

Dep – Departure trips

Arr – Arrival trips

(*) Brookfield Retail includes a 50% trip reduction from the Master-plan, to account for the existing retail quantum.

DISTRIBUTION & LOADING POINTS

3.7 The distribution of the Local Plan locations is based on the 2013 Base Year distribution of representative zones or areas which have similar characteristics. In the absence of a detailed Transport Assessment (TA) for each individual Local Plan site, the application of the Base Year distribution is considered acceptable.

3.8 In addition to a review of the distribution, the proposed access and egress (loading points) for each development site has been reviewed. This ensures that the development demand is capable of accessing and leaving the network via a suitable junction arrangement. **Appendix G** provides an overview of the assumption applied for loading points for the Local Plan sites.

LOCAL PLAN MATRIX TOTALS

3.9 Table 3.5 & Table 3.6 present the matrix totals for the appraised Local Plan scen**arios for** the AM & PM peak hours, including reference to the percentage increase from the 2029 DM forecast.

3.10 The 'Combined' scenario represents the maximum quantum of development and associated trips, resulting in a circa 10% increase in the total vehicles.

3.11 It should be noted, that despite the noticeable reduction in the 'Preferred' development quantum, the overall impact on the total demand remains a substantial increase, in excess of 7% in the AM peak hour.

3.12 It should be noted, the Local Plan development trips have been assigned to the model as new car based trips, however the actual volume of new trips is likely to be significantly lower, due to duplication of existing trips which may be 'diverted', 'pass-by' or 'transferred' trips to the Local Plan sites and omission of linked trips between Local Plan developments i.e. Commuter trips between proposed residential and employment sites. Therefore, assessing the Local Plan demand as new trips represents the 'worst case' scenario.

Table 3.5 AM Peak Hour (08-09) Local Plan Matrix Totals 2029 (in vehicles)

Classification	DM 2029	'Preferred'	'Alternative'	'Combined'
Background Traffic	50,562	50,562	50,562	50,562
Local Plan	0	3,858	4,493	4,942
Total	50,562	54,420	55,055	55,504
% Increase DM 2029	0%	7.6%	8.9%	9.8%

Table 3.6 PM Peak Hour (17-18) Local Plan Matrix Totals 2029 (in vehicles)

Classification	DM 2029	'Preferred'	'Alternative'	'Combined'
Background Traffic	49,717	49,717	49,717	49,717
Local Plan	0	4,280	4,849	5,262
Total	50,562	53,997	54,566	54,979
% Increase DM 2029	0%	8.6%	9.8%	10.6%

3.13 The following section assesses the impact of the Local Plan scenarios on the operation of the network.

4 Forecast Traffic Conditions

INTRODUCTION

4.1 The following section provides an overview of the modelled results for the various Local Plan scenarios in comparison to the Reference Case Do-Minimum (DM) 2029 scenario (as described in **Section 2**). The objective of this section is to demonstrate how the various Local Plan development quantum and distributions influences the operational performance of the modelled highway network.

4.2 The analysis is presented for the following indicators;

- ✓ Network Performance;
- ✓ Travel Times;
- ✓ Junction Constraints;
- ✓ Link Constraints; and
- ✓ Turning Movement Constraints.

NETWORK PERFORMANCE

4.3 The Broxbourne SATURN model generates a series of indicators which can be used to demonstrate the performance of the modelled highway network and provides consistent basis for comparing scenarios.

4.4 The following indicators have been extracted from the various SATURN model assignments;

i. Demand – Matrix input in Passenger Car Units (PCU);
   - Total matrix demand input into the modelled scenario.

ii. Total travel time – PCU hours;
   - Total travel time for all origin and destination trips.

iii. Total distance travelled – PCU kilometres;
   - Total travel distance for all origin and destination trips.

iv. Average travel time – PCU minutes;
   - Average travel time for all origin and destination trips.

v. Average distance travelled – PCU kilometres;
   - Average distance travelled for all origin and destination trips.

vi. Average speed – kph;
   - Average speed in kph for all origin and destination trips.

vii. Total travel time delay – PCU hours; and
   - Total travel time delay incurred by all origin and destination trips i.e. > free flow conditions.

viii. Delay as percentage of Total travel time - percentage.
   - Travel delay as a proportion of the total travel time.

4.5 The primary indicators used to demonstrate variations in the network performance are the average travel time and average speed and delay as a proportion of total travel time. An increase in the proportion of delay indicates an increase in the level of congestion within the highway network, which is characterised as slower travel time speeds and vehicle queues.

Base Year 2013 compared to 2029 Background Traffic Impacts

4.6 Table 4.1 below presents an overall network performance comparison between the 2013 Base Year model and the DM 2029 scenario for the AM and PM peak hours.

4.7 The objective of Table 4.1 is to present the results for a 'benchmark' 2029 scenario, from which each of the Local Plan scenarios can be compared against on a consistent basis.

4.8 In the AM peak hour, the 20% increase in demand, based on the background traffic growth and committed developments can be accommodated in the 2029 DM network. That is the additional committed network improvements can accommodate the additional traffic generated to 2029. A particular contributory factor is the inclusion of the M25 "Smart Motorways" interventions, which increases the resilience of the M25 in the AM peak hour. This impact is reflected in the reduction in the proportion of delay within the modelled scenario, despite the increase in overall demand.

4.9 In the PM peak, the impact of the DM demand growth has resulted results in a deterioration in the network performance, with the average speed decreasing by over 20% and the proportion of delay increasing by nearly 10%, indicating the additional capacity on the M25 is not capable of sustaining the additional background traffic growth in the PM peak and that the overall network conditions are sensitive to changes in the demand quantum. The key pressure is generated by External to External movements and not those generated within Broxbourne.

4.10 The overall analysis indicates that the inclusion of the M25 'Smart Motorways' programme has increased the resilience of the highway network, as demonstrated in the AM peak hour. Whereas in the PM peak hour the highway network is more susceptible to these increases in demand, resulting in a significant deterioration in the network performance.

4.11 In essence the PM peak hour represents the most sensitive and therefore congested period.

Table 4.1 Network Performance BY 2013 compared to DM 2029

ID	Indicator	Unit	AM Peak Hour (08-09)				PM Peak Hour (17-18)		
			BY 2013	DM 2029	% Diff		BY 2013	DM 2029	% Diff
1	Demand	PCU	46,711	55,825	**20%**		44,110	53,158	**21%**
2	Total Travel Time	PCU/Hrs	7,007	9,617	**37%**		7,129	11,344	**59%**
3	Total Distance Travelled	PCU/km	396,327	477,701	**21%**		381,006	472,772	**24%**
4	Average Travel Time	PCU/min	9	10	**15%**		10	13	**32%**
5	Average Distance Travelled	PCU/km	8	9	**1%**		9	9	**3%**
6	Average Speed	kph	56.6	49.7	**-12%**		53.4	41.7	**-22%**
7	Total Travel Time Delay	PCU/Hrs	1,054	1,727	**64%**		1,389	3,611	**160%**
8	Delay as % of Total Travel Time	%	15%	18%	**3%**		19%	32%	**12%**

DM 2029 compared to Local Plan Scenarios

4.12 Table 4.2 & Table 4.3 indicates that the PM peak hour network performance follows the same trend as the AM peak, with the performance reducing relative to the increase in development quantum.

4.13 Reductions in performance can be identified by the increases in the average travel time and the significant increase in the proportion of total travel time delay, reaching 45% in the 'Combined' scenario.

4.14 The 'Combined' scenario represent the worst network performance results, however the overall variation in the result is marginal compared to the lowest quantum 'Preferred' in both the AM & PM peak hours. The average travel time remains at less than approximately 15 minutes throughout.

4.15 Table 4.3 presents the network performance results for the AM and PM peak hours for the various Local Plan scenarios in comparison to the 'benchmark' DM 2029 scenario.

4.16 Table 4.2 demonstrates that in the AM peak hour the overall network performance deteriorates relative to the increases the development quantum within each Local Plan scenario, whereby the 'Combined' represents the maximum quantum.

4.17 A noticeable reduction in the network performance can be identified by the increases in the average travel time and the significant increase in the proportion of total travel time delay, reaching a maximum of 25% in the 'Combined' scenario.

4.18 It should be noted that despite the increase in the overall demand, the AM peak hour network performance is comparable with the performance of the DM 2029 PM peak hour in that the average travel time is less than 15 minutes, indicating a level of journey time reliability, despite the overall increase in demand and congestion.

Table 4.2 Network Performance Local Plan Scenario Comparison AM Peak Hour

ID	Indicator	Unit	AM Peak Hour (08-09)					
			DM 2029	Preferred 2029	% Diff DM	Alternative 2029	% Diff DM	Combined 2029	% Diff DM
1	Demand	PCU	55,825	59,682	**7%**	60,318	**8%**	60,766	**9%**
2	Total Travel Time	PCU/Hrs	9,617	10,880	**13%**	11,511	**20%**	11,705	**22%**
3	Total Distance Travelled	PCU/km	477,701	503,006	**5%**	508,864	**7%**	512,730	**7%**
4	Average Travel Time	PCU/min	10	11	**6%**	11	**11%**	12	**12%**
5	Average Distance Travelled	PCU/km	9	8	**-2%**	8	**-1%**	8	**-1%**
6	Average Speed	kph	49.7	46.2	**-7%**	44.2	**-11%**	43.8	**-12%**
7	Total Travel Time Delay	PCU/Hrs	1,727	2,492	**44%**	3,009	**74%**	3,125	**81%**
8	Delay as % of Total Travel Time	%	18%	23%	**5%**	26%	**8%**	27%	**9%**

4.19 Table 4.3 indicates that the PM peak hour network performance follows the same trend as the AM peak, with the performance reducing relative to the increase in development quantum.

4.20 Reductions in performance can be identified by the increases in the average travel time and the significant increase in the proportion of total travel time delay, reaching 45% in the 'Combined' scenario.

4.21 The 'Combined' scenario represent the worst network performance results, however the overall variation in the result is marginal compared to the lowest quantum 'Preferred' in both the AM & PM peak hours. The average travel time remains at less than approximately 15 minutes throughout.

Table 4.3 Network Performance Local Plan Scenario Comparison PM Peak Hour

ID	Indicator	Unit	PM Peak Hour (17-18)					
			DM 2029	Preferred 2029	% Diff DM	Alternative 2029	% Diff DM	Combined 2029	% Diff DM
1	Demand	PCU	53,158	57,438	**8%**	58,007	**9%**	58,420	**10%**
2	Total Travel Time	PCU/Hrs	11,344	14,147	**25%**	14,531	**28%**	14,648	**29%**
3	Total Distance Travelled	PCU/km	472,772	509,766	**8%**	513,659	**9%**	516,521	**9%**
4	Average Travel Time	PCU/min	13	15	**15%**	15	**17%**	15	**18%**
5	Average Distance Travelled	PCU/km	9	9	**0%**	9	**0%**	9	**-1%**
6	Average Speed	kph	41.7	36.0	**-14%**	35.3	**-15%**	35.3	**-15%**
7	Total Travel Time Delay	PCU/Hrs	3,611	5,744	**59%**	6,054	**68%**	6,123	**70%**
8	Delay as % of Total Travel Time	%	32%	41%	**9%**	42%	**10%**	42%	**10%**

TRAVEL TIMES

4.22 The following section provides an analysis of the changes in modelled travel times, across the appraised scenarios, previously described. This analysis is intended to demonstrate how the changes in the global network performance indicators are reflected at a local level.

4.23 In order to relate the information to daily travel patterns, the information is presented in two formats;

- ✓ Travel Time Movements; and
- ✓ Journey Times.

4.24 The presentation journey times based on fixed travel routes is the traditional approach to presenting the changes in travel times. However, in the context of an interurban network, the travel patterns are determined by the range of route choice and network conditions. Therefore, presenting a series of fixed travel time routes may be misrepresentative of the actual routes chosen within the model assignment.

4.25 The alternative approach to presenting travel times which account for the route choice element, is to present the travel times based on generalised movements between fixed points within the network. This information is easily presented in a matrix or grid format, enabling the identification of the changes in generalised travel times between specific reference points to multiple destinations.

4.26 In order to provide detailed information regarding the changes in modelled travel times, the information is present in both formats.

Travel Time Movements

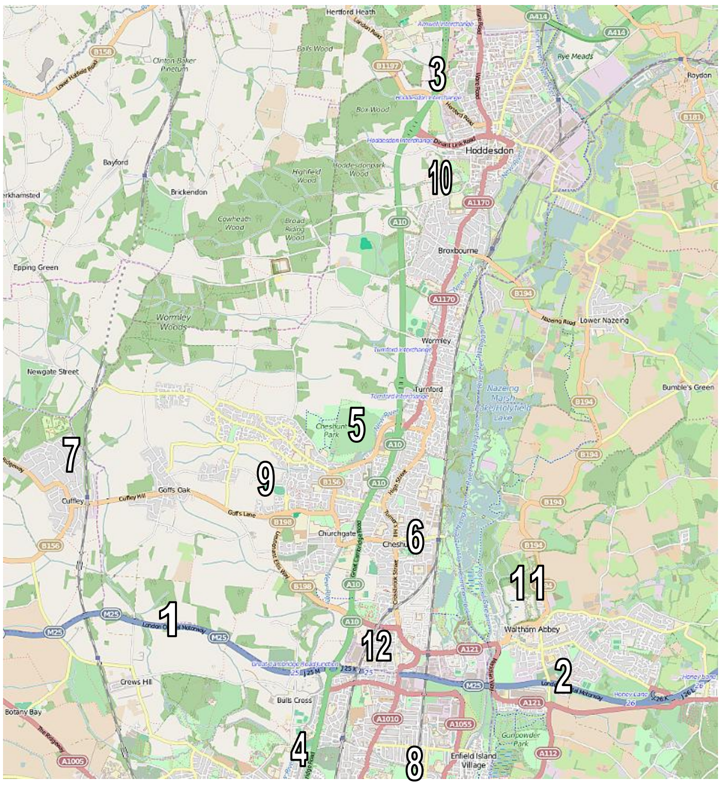
4.27 In order to demonstrate the changes in travel times throughout the modelled Broxbourne network, the travel time data has been extracted for the following 11 locations shown in Figure 4.1 and listed below;

4.28 These locations represent a mixture of strategic and localised movements, in order to demonstrate how the change in travel time influences different highway users. This analysis approach enables the assessment and presentation of 110 potential movements, within a clear and concise format.

Travel Time Locations

1. M25-W
2. M25-E
3. A10-N
4. A10-S
5. BFD – Brookfield Retail
6. CHT – Cheshunt
7. CFY – Cuffley
8. EW – Enfield Wash
9. GFOK – Goff's Oak
10. HDN – Hoddesdon
11. WA – Waltham Abbey; and
12. WC – Waltham Cross.

Figure 4.1 Travel Time Movement Locations



4.29 **Appendix B** contains the complete analysis of the travel time movements in the 2013 Base Year and the 2029 Do-Minimum, including the average travel time and average distance travelled. The deterioration in network conditions is reflected in both statistics, as the increases in the distance travelled are representative of the adoption of new routes or detours, which involve additional distance to the quickest route or shortest path.

4.30 Table 4.4 & The PM peak hour results represent a substantial increase in general travel times as characterised by the 30% increase for all movements, including Internal-Internal movements in isolation. This result is representative of PM peak hour conditions, which are characterised by a mixture of commuter trips and other activities, which generates more varied patterns of travel and demand on the highway network.

4.31 The PM peak hour results demonstrate the clear constraint of the southern A10 corridor through Enfield, with significant increases in travel time to access the M25 and the Waltham Cross area.

4.32 Table 4.5 present the percentage travel time change between the 11 selected locations in the 2013 Base Year and the 2029 Do-Minimum (DM) scenarios, for the AM peak hour and the PM peak hour respectively.

4.33 The AM peak hour results are typically representative of a primarily commuter network, with clearly identifiable increases in travel time to and from the M25 West and A10 South. The overall increase in travel time for the complete movements is 9%, with the Internal-Internal movements experiencing on average a 5% increase.

Table 4.4 AM Peak Hour 2029 DM to 2013 Base Year Travel Time Percentage Change

DM/Base Year		Percentage Change (DM/Base Year) (%)												
ID	**Location**	**M25-W**	**M25-E**	**A10-N**	**A10-S**	**BFD**	**CHT**	**CFY**	**EW**	**GFOK**	**HDN**	**WA**	**WC**	**TOTAL**
M25-W	**M25-W**	-	26%	18%	40%	25%	22%	22%	40%	20%	19%	25%	29%	**25%**
M25-E	**M25-E**	35%	-	14%	15%	19%	16%	16%	17%	14%	10%	7%	17%	**16%**
A10-N	**A10-N**	27%	13%	-	20%	-5%	5%	5%	18%	5%	6%	12%	9%	**12%**
A10-S	**A10-S**	22%	17%	9%	-	13%	10%	16%	23%	7%	11%	16%	16%	**14%**
BFD	**Brookfield**	31%	13%	-3%	22%	-	4%	12%	20%	10%	-1%	12%	7%	**14%**
CHT	**Cheshunt**	37%	17%	3%	27%	5%	-	16%	24%	14%	2%	15%	8%	**17%**
CFY	**Cuffley**	15%	13%	3%	20%	5%	5%	-	19%	-2%	1%	11%	7%	**10%**
EW	**Enfield Wash**	24%	18%	12%	14%	16%	12%	18%	-	10%	13%	11%	24%	**15%**
GFOK	**Goff's Oak**	32%	12%	4%	22%	5%	4%	-1%	20%	-	2%	10%	5%	**12%**
HDN	**Hoddesdon**	27%	5%	2%	20%	-5%	6%	3%	19%	3%	-	4%	9%	**11%**
WA	**Waltham Abbey**	30%	12%	12%	11%	16%	13%	13%	13%	11%	4%	-	9%	**13%**
WC	**Waltham Cross**	37%	8%	6%	25%	9%	0%	5%	35%	0%	7%	2%	-	**12%**
TOTAL		**28%**	**14%**	**9%**	**22%**	**12%**	**10%**	**12%**	**22%**	**9%**	**8%**	**11%**	**12%**	**14%**

4.34 The PM peak hour results represent a substantial increase in general travel times as characterised by the 30% increase for all movements, including Internal-Internal movements in isolation. This result is representative of PM peak hour conditions, which are characterised by a mixture of commuter trips and other activities, which generates more varied patterns of travel and demand on the highway network.

4.35 The PM peak hour results demonstrate the clear constraint of the southern A10 corridor through Enfield, with significant increases in travel time to access the M25 and the Waltham Cross area.

Table 4.5 PM Peak Hour 2029 DM to 2013 Base Year Travel Time Percentage Change

DM/Base Year		Percentage Change (DM/Base Year) (%)												
ID	Location	M25-W	M25-E	A10-N	A10-S	BFD	CHT	CFY	EW	GFOK	HDN	WA	WC	TOTAL
M25-W	M25-W	-	31%	17%	46%	14%	13%	12%	47%	13%	16%	29%	22%	22%
M25-E	M25-E	29%	-	32%	16%	36%	35%	26%	18%	36%	32%	7%	16%	29%
A10-N	A10-N	54%	27%	-	38%	-2%	1%	3%	38%	5%	3%	26%	10%	23%
A10-S	A10-S	70%	73%	45%	-	53%	54%	48%	108%	49%	40%	74%	132%	62%
BFD	Brookfield	68%	36%	-2%	50%	-	2%	11%	50%	13%	-2%	35%	13%	32%
CHT	Cheshunt	89%	62%	34%	77%	71%	-	28%	66%	38%	32%	62%	21%	56%
CFY	Cuffley	45%	33%	6%	4%	5%	4%	-	8%	1%	2%	32%	3%	15%
EW	Enfield Wash	112%	36%	50%	7%	60%	54%	29%	-	48%	45%	38%	42%	51%
GFOK	Goff's Oak	67%	35%	6%	29%	4%	6%	-8%	31%	-	2%	34%	8%	24%
HDN	Hoddesdon	55%	15%	2%	39%	-2%	2%	1%	39%	1%	-	16%	10%	21%
WA	Waltham Abbey	25%	15%	30%	12%	33%	32%	23%	12%	33%	30%	-	5%	26%
WC	Waltham Cross	119%	94%	61%	74%	83%	80%	73%	125%	86%	61%	89%	-	83%
TOTAL		67%	41%	29%	38%	34%	29%	22%	44%	30%	28%	40%	22%	36%

4.36 Following the approach for the Do-Minimum 2029 to 2013 Base Year comparison, the detailed analysis of the Local Plan scenarios is presented in **Appendix B.** The following information presents the comparison between the Combined Local Plan scenario and the 2029 DM, in order to demonstrate the impact of the maximum quantum of development.

4.37 Table 4.6 presents the AM peak hour travel time percentage change for the combined scenario compared to the reference case DM 2029. The results indicate a general increase in overall travel time for all movement of 14%, which is representative of the increase in demand.

4.38 Clear increases are generated for movements from Goff's Oak and Waltham Cross, which is representative of the proposed developments.

Table 4.6 AM Peak Hour Combined Local Plan to 2029 DM Travel Time Percentage Change

Combined/DM		Percentage Change (Combined/DM) (%)												
ID	Location	M25-W	M25-E	A10-N	A10-S	BFD	CHT	CFY	EW	GFOK	HDN	WA	WC	TOTAL
M25-W	M25-W	-	0%	5%	-3%	9%	3%	4%	-2%	5%	7%	0%	3%	3%
M25-E	M25-E	0%	-	3%	1%	7%	0%	1%	1%	2%	1%	0%	2%	2%
A10-N	A10-N	20%	29%	-	23%	10%	5%	5%	23%	5%	8%	30%	35%	20%
A10-S	A10-S	17%	17%	13%	-	22%	15%	3%	14%	18%	15%	18%	20%	15%
BFD	Brookfield	29%	45%	4%	35%	-	13%	8%	33%	11%	9%	48%	55%	30%
CHT	Cheshunt	15%	28%	3%	18%	9%	-	-2%	22%	0%	3%	30%	53%	16%
CFY	Cuffley	17%	36%	6%	19%	8%	9%	-	18%	3%	1%	38%	58%	20%
EW	Enfield Wash	7%	2%	3%	0%	6%	1%	2%	-	2%	4%	0%	0%	3%
GFOK	Goff's Oak	30%	54%	7%	42%	11%	12%	0%	41%	-	4%	58%	75%	33%
HDN	Hoddesdon	20%	10%	2%	23%	11%	6%	2%	23%	3%	-	12%	36%	16%
WA	Waltham Abbey	0%	0%	3%	1%	7%	0%	1%	1%	2%	1%	-	1%	2%
WC	Waltham Cross	-6%	2%	4%	-6%	10%	1%	1%	-6%	3%	6%	-2%	-	1%
TOTAL		15%	22%	5%	17%	10%	5%	3%	18%	5%	5%	24%	31%	13%

4.39 Table 4.15 indicates that in the PM peak hour the overall increase in travel time for all movements is 21%, a characterised by a general increase in both origin and destination travel times for virtually all locations.

4.40 The impact of the Brookfield development is clearly identifiable in the analysis, with a 30% increase in travel time to the development. It should be noted that the A10 Turnford Link Road provides a direct access to the site for strategic traffic. However, localised movements, such as vehicles to and from Cheshunt interact more closely with the local congested network which results in a significant increase in travel time.

Table 4.7 PM Peak Hour Combined Local Plan to 2029 DM Travel Time Percentage Change

Combined/DM		Percentage Change (Combined/DM) (%)												
ID	Location	M25-W	M25-E	A10-N	A10-S	BFD	CHT	CFY	EW	GFOK	HDN	WA	WC	TOTAL
M25-W	M25-W	-	0%	19%	7%	29%	18%	18%	7%	21%	20%	0%	20%	15%
M25-E	M25-E	0%	-	15%	0%	21%	12%	17%	1%	15%	15%	0%	2%	12%
A10-N	A10-N	17%	22%	-	24%	8%	1%	6%	23%	7%	1%	23%	11%	16%
A10-S	A10-S	17%	18%	26%	-	35%	28%	44%	28%	34%	23%	19%	29%	27%
BFD	Brookfield	20%	27%	1%	29%	-	3%	7%	27%	8%	1%	29%	14%	19%
CHT	Cheshunt	31%	44%	38%	33%	65%	-	36%	31%	43%	39%	46%	23%	38%
CFY	Cuffley	2%	24%	7%	23%	17%	4%	-	19%	5%	4%	26%	6%	13%

4.41 Table 4.8 & Table 4.9 presents a summary of the total travel time for all 11 appraised locations for each modelled scenarios, for the AM & PM peak hours, respectively.

4.42 The overall results indicate that in the AM the impact of the Local Plan development growth potentially equates to a 20-25% increase in travel times from the 2013 Base Year conditions, which is a 10-15% increase from the potential DM 2029 background scenario.

4.43 In the PM peak hour, the impact is dramatic with an increase in travel time in excess of 50%, from the 2013 Base Year conditions. However, it should be noted that 60% of the increase is generated by the DM 2029 background growth, independent of the Local Plan demand.

4.44 In essence, the PM peak hour results demonstrate that the Local Plan growth exacerbates existing issues within the network.

4.45 It should be noted, that the overall results for the Local Plan scenarios indicate that varying the scale of development generates only a minor variation in the travel times, in context to the scale of change between the 2013 Base Year and the DM 2029.

Table 4.8 AM Peak Hour Total Travel Time Analysis

Analysis	BY 2013	DM 2029	'Preferred'	'Alternative'	'Combined'
Total Travel Time (minutes)	1,543	1,762	1,914	1,960	1,993
% BY 2013 Change	-	14%	24%	27%	29%
% DM 2029 Change	-	-	9%	11%	13%

Table 4.9 PM Peak Hour Total Travel Time Analysis

Analysis	BY 2013	DM 2029	'Preferred'	'Alternative'	'Combined'
Total Travel Time (minutes)	1,622	2,210	2,534	2,590	2,598
% BY 2013 Change	-	36%	56%	60%	60%
% DM 2029 Change	-	-	15%	17%	18%

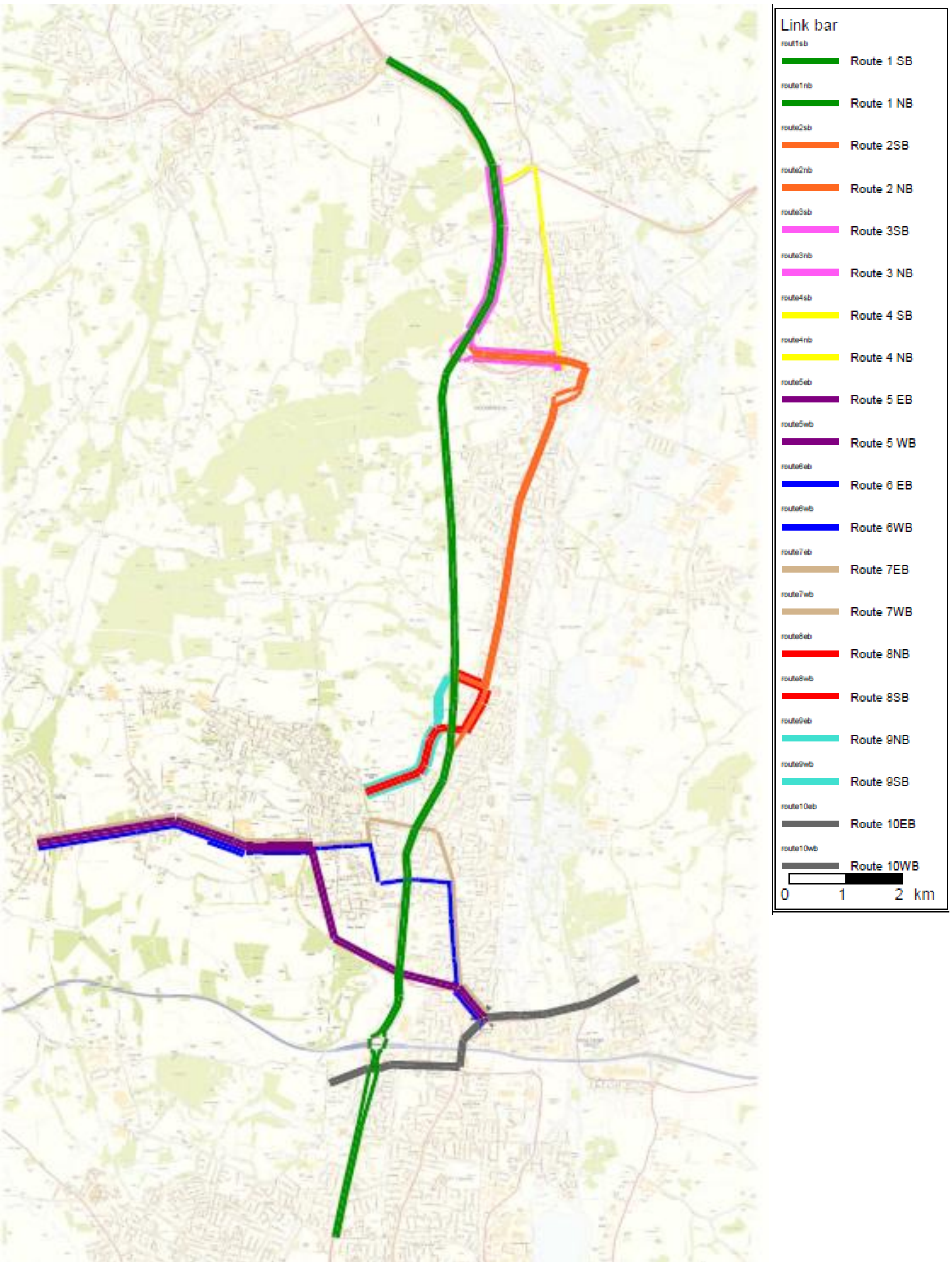
4.46 The complete analysis of the Travel Time Movements is presented in **Appendix B.**

Journey Times

4.47 The following sections provide an overview of the change in travel times at a route specific level. This analysis gives a clearer understanding of the locations of congestion along a route which is contributing to the increase in travel time.

4.48 Figure 4.2 presents the location of 10 journey time routes, covering multiple movements across the modelled network;

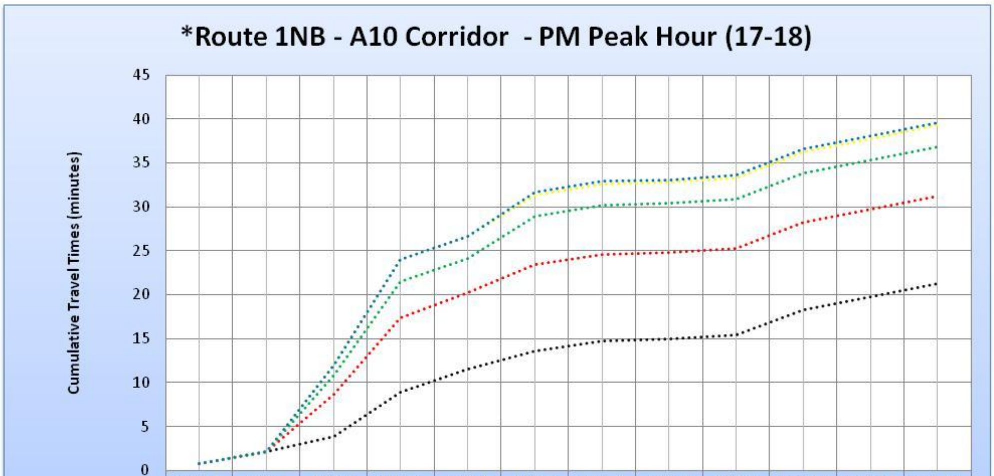
Figure 4.2 Journey Time Routes



Appendix C contains a detailed analysis of the cumulative journey time profile of each route across the assessed scenarios, based on a series of set timing points, as demonstrated for the A10 corridor in Figure 4.3 &

4.49 Figure 4.4 below. Timing points are key junctions along a particular route.

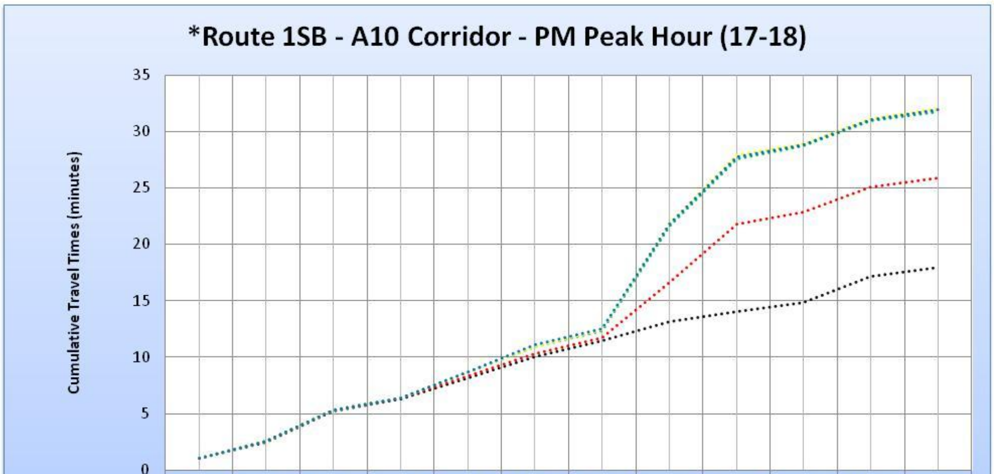
Figure 4.3 Route 1 NB – A10 Corridor – PM Peak Hour



	1NB-1	1NB-2	1NB-3	1NB-4	1NB-5	1NB-6	1NB-7	1NB-8	1NB-9	1NB-10	1NB-11	1NB-12
BY 2013	1	2	4	9	12	14	15	15	15	18	20	21
DM 2029	1	2	9	17	20	23	25	25	25	28	30	31
Preferred	1	2	11	21	24	29	30	30	31	34	35	37
Alternative	1	2	12	24	27	31	33	33	33	36	38	39
Combined	1	2	12	24	27	32	33	33	34	37	38	40

Timing Points & Cumulative Travel Times (minutes)

Figure 4.4 Route 2 SB – A10 Corridor – PM Peak Hour



	1SB-1	1SB-2	1SB-3	1SB-4	1SB-5	1SB-6	1SB-7	1SB-8	1SB-9	1SB-10	1SB-11	1SB-12
BY 2013	1	2	5	6	8	10	11	13	14	15	17	18
DM 2029	1	3	5	6	8	10	12	17	22	23	25	26
Preferred	1	3	5	6	9	11	12	22	28	29	31	32
Alternative	1	3	5	6	9	11	12	22	28	29	31	32
Combined	1	3	5	6	9	11	13	22	28	29	31	32

Timing Points & Cumulative Travel Times (minutes)

4.50 It should be noted that the journey timing points are reversed by direction and vary by location. **Appendix C** contains detailed plans for each journey time route, including the location of the timing points.

4.51 Table 4.10 presents the journey time results for the AM peak hour, including a comparison between the DM 2029 and the 2013 Base Year and a subsequent comparison between the various Local Plan scenarios and the DM 2029.

4.52 The result indicates that the total travel time across all increases by 15% in the DM 2029 scenario. However, it should be noted that the majority of this increase is directly attributable to Route 10 crossing the network east to west (vice versa) along the A1010 Abbey Road and A121 Eleanor Cross Road.

4.53 In the Local Plan scenarios the overall increase in travel time from the DM 2029 scenario varies from 14% in the preferred scenario to 19% in the combined. Key increases are identifiable for movements crossing the A10 corridor in the eastbound direction from Cuffley to Waltham Cross, most noticeably for route 5.

4.54 It should be noted that routes in Hoddesdon area (Routes 2-4) performance remains consistent across the Local Plan scenarios, due to the consistency of the appraised developments within this area.

Table 4.10 AM Peak Hour Journey Time Results

AM Peak Hour (08-09)			Dir	Distance (km)	BY & DM Comparison			Local Plan Comparison					
					Travel Times (minutes)			Travel Times (minutes)					
ID	Ref	Route Description			BY 2013	DM 2029	% BY Diff	Preferred	% DM Diff	Alternative	% DM Diff	Combined	% DM Diff
1	R1SB	*Route 1SB - A10 Corridor	SB	16.8	18	21	18%	25	16%	25	17%	26	21%
2	R1NB	*Route 1NB - A10 Corridor	NB	16.9	18	19	9%	21	9%	22	13%	22	14%
3	R2SB	*Route 2SB - A10/A1170 Interchange to A10 Turnford Interchange SB Merge	SB	7.4	11	11	3%	11	5%	12	6%	12	7%
4	R2NB	*Route 2NB - A10 Turnford Interchange NB Diverge to A10/A1170 Interchange	NB	7.2	10	10	2%	10	1%	10	2%	10	2%
5	R3SB	*Route 3SB - A10/A414 Interchange to Hoddesdon via A10	SB	4.0	3	3	5%	4	12%	4	12%	4	11%
6	R3NB	*Route 3NB - Hoddesdon to A10/A414 Interchange via A10	NB	4.3	4	4	2%	4	2%	4	3%	4	4%
7	R4SB	*Route 4SB - A10/A414 Interchange to Hoddesdon via Amwell RB	SB	3.5	5	5	2%	5	1%	5	1%	5	1%
8	R4NB	*Route 4NB - Hoddesdon to A10/A414 Interchange via Amwell RB	NB	3.7	5	6	3%	6	1%	6	2%	6	2%
9	R5EB	*Route 5EB - Cuffley to Waltham Cross via B198 Lieutenant Ellis Way	EB	7.0	8	9	10%	12	37%	16	74%	16	79%
10	R5WB	*Route 5WB - Waltham Cross to Cuffley via B198 Lieutenant Ellis Way	WB	7.5	9	10	8%	10	0%	10	0%	10	1%
11	R6EB	*Route 6EB - Cuffley to Waltham Cross via College Road	EB	8.1	14	15	11%	19	25%	20	30%	21	34%
12	R6WB	*Route 6WB - Waltham Cross to Cuffley via College Road	WB	8.1	15	16	10%	19	14%	19	16%	20	19%
13	R7EB	*Route 7EB - Cuffley to Waltham Cross via Church Lane	EB	8.4	17	19	12%	22	18%	23	22%	24	27%
14	R7WB	*Route 7WB - Waltham Cross to Cuffley via Church Lane	WB	8.5	17	19	14%	17	-9%	18	-5%	18	-4%
15	R8NB	*Route 8NB - Flamstead End to A10 Turnford Interchange via A1170	NB	2.9	5	5	2%	5	8%	5	13%	5	15%
16	R8SB	*Route 8SB - A10 Turnford Interchange to Flamstead End via A1170	SB	2.9	5	5	9%	6	14%	6	13%	7	32%
17	R9NB	*Route 9NB - Flamstead End to A10 Turnford Interchange via Turnford Link Road	NB	2.4	N/A	4	-	5	8%	5	14%	5	17%
18	R9SB	*Route 9SB - A10 Turnford Interchange to Flamstead End via Turnford Link Road	SB	2.3	N/A	5	-	6	15%	5	14%	7	35%
19	R10EB	*Route 10EB - Capel Manor to Abbey Gardens	EB	3.3	7	13	72%	14	8%	14	11%	14	12%
20	R10WB	*Route 10WB - Abbey Gardens to Capel Manor	WB	3.1	6	14	110%	16	18%	16	18%	16	18%
			TOTAL	**128.0**	**176**	**213**	**21%**	**236**	**11%**	**244**	**15%**	**251**	**18%**
			Average Speed (kph)		**44**	**36**	**-17%**	**33**	**-10%**	**31**	**-13%**	**31**	**-15%**

4.55 Table 4.11 presents the journey time results for the PM peak hour, following the format applied for the AM previously.

4.56 The result indicates that at a detailed journey time route level the overall travel time significantly increases in the DM 2029 scenario from the 2013 Base Year by approximately 40%. However, similar to the AM a significant proportion of this change is attributable to Route 10 crossing the network east to west (vice versa) along the A1010 Abbey Road and A121 Eleanor Cross Road.

4.57 In the Local Plan scenarios the overall increase in travel time from the DM 2029 scenario varies from 18% to 20% in the combined. Key increases are identifiable for movement crossing the A10 corridor in the both the eastbound and westbound directions.

4.58 Individually to the PM peak, the impact of the Brookfield development is clearly identifiable in journey time results for Routes 8 & 9, which is a direct impact of the circa 2,500 trips generated by the site during this period.

4.59 A comprehensive analysis of the individual journey time results and cumulative profile is presented in **Appendix C**.

Table 4.11 PM Peak Hour Journey Time Results

PM Peak Hour (17-18)			Dir	Distance (km)	BY & DM Comparison			Local Plan Comparison					
					Travel Times (minutes)			Travel Times (minutes)					
ID	Ref	Route Description			BY 2013	DM 2029	%BY Diff	Preferred	%DM Diff	Alternative	%DM Diff	Combined	%DM Diff
1	R1SB	*Route 1SB - A10 Corridor	SB	16.8	18	26	44%	32	23%	32	23%	32	23%
2	R1NB	*Route 1NB - A10 Corridor	NB	16.9	21	31	47%	37	18%	39	26%	40	27%
3	R2SB	*Route 2SB - A10/A1170 Interchange to A10 Turnford Interchange SB Merge	SB	7.4	10	11	0%	11	2%	11	2%	11	2%
4	R2NB	*Route 2NB - A10 Turnford Interchange NB Diverge to A10/A1170 Interchange	NB	7.2	10	10	1%	10	1%	10	2%	10	2%
5	R3SB	*Route 3SB - A10/A414 Interchange to Hoddesdon via A10	SB	4.0	3	3	3%	3	1%	3	1%	3	1%
6	R3NB	*Route 3NB - Hoddesdon to A10/A414 Interchange via A10	NB	4.3	4	4	4%	4	1%	4	1%	4	2%
7	R4SB	*Route 4SB - A10/A414 Interchange to Hoddesdon via Amwell RB	SB	3.5	5	5	2%	5	1%	5	1%	5	1%
8	R4NB	*Route 4NB - Hoddesdon to A10/A414 Interchange via Amwell RB	NB	3.7	5	6	4%	6	0%	6	0%	6	0%
9	R5EB	*Route 5EB - Cuffley to Waltham Cross via B198 Lieutenant Ellis Way	EB	7.0	10	10	2%	10	3%	10	3%	10	3%
10	R5WB	*Route 5WB - Waltham Cross to Cuffley via B198 Lieutenant Ellis Way	WB	7.5	10	16	61%	18	11%	19	16%	19	16%
11	R6EB	*Route 6EB - Cuffley to Waltham Cross via College Road	EB	8.1	15	22	46%	28	23%	28	23%	28	24%
12	R6WB	*Route 6WB - Waltham Cross to Cuffley via College Road	WB	8.1	16	24	45%	26	8%	26	11%	26	11%
13	R7EB	*Route 7EB - Cuffley to Waltham Cross via Church Lane	EB	8.4	17	24	43%	31	27%	31	27%	31	28%
14	R7WB	*Route 7WB - Waltham Cross to Cuffley via Church Lane	WB	8.5	18	25	42%	30	17%	30	19%	31	21%
15	R8NB	*Route 8NB - Flamstead End to A10 Turnford Interchange via A1170	NB	2.9	5	5	4%	6	22%	6	21%	6	31%
16	R8SB	*Route 8SB - A10 Turnford Interchange to Flamstead End via A1170	SB	2.9	5	7	22%	8	18%	8	18%	8	20%
17	R9NB	*Route 9NB - Flamstead End to A10 Turnford Interchange via Turnford Link Road	NB	2.4	N/A	4	-	5	25%	5	23%	6	34%
18	R9SB	*Route 9SB - A10 Turnford Interchange to Flamstead End via Turnford Link Road	SB	2.3	N/A	6	-	7	19%	7	19%	7	21%
19	R10EB	*Route 10EB - Capel Manor to Abbey Gardens	EB	3.3	6	16	148%	15	-5%	16	-3%	16	-3%
20	R10WB	*Route 10WB - Abbey Gardens to Capel Manor	WB	3.1	7	17	167%	18	3%	17	-2%	17	-2%
			TOTAL	**128.0**	**186**	**273**	**46%**	**309**	**13%**	**313**	**15%**	**315**	**16%**
			Average Speed (kph)		**41**	**28**	**-32%**	**25**	**-12%**	**25**	**-13%**	**24**	**-14%**

Journey Time Key Points

4.59.1 Based on the information presented in the journey time route analysis, the following impacts can be clearly identified:

- Route 1 – A10 corridor
  - Clear reduction in the performance of the A10 corridor in both directions, most noticeably in the PM peak hour.
  - The initial breakdown of the corridor performance is a result of the background traffic growth in the DM, equating to a 45% increase in travel time in the PM. This is further exacerbated by the additional demand generated be the Local Plan.
  - Key junction constraints include:
    - i. A10 / A1055 Bullsmoor Lane traffic signals
    - ii. M25 J25
    - iii. A10 / B198 Lieutenant Ellis Way / A121 Winston Churchill Way roundabout
    - iv. A10 / College Road traffic signals
    - v. A10 / Church Lane traffic signals
- Routes 5 to 7 – Cuffley to Waltham Cross
  - Clear reduction in the performance of the various available routes, based on the scale of demand attempting to access and cross the primary A10 corridor.
  - The demand travelling from Cuffley and Goff's Oak and vice versa, re-distributes across the available routes, in order to complete their journeys in the shortest possible time.
  - The model is indicating the level of congestion on the A10 corridor is resulting is significant congestion on the local accesses
  - The Local Plan demand results in a further exacerbation of these constraints principally relate to the southern A10 corridor, as per the junction locations above.
- Routes 8 and 9 – Flamstead End to A10 via Turnford Interchange
  - The introduction of the Halfhide Lane to the A10 Turnford Interchange results in a substantial increase in the available capacity to access the A10 from the existing Brookfield Retail and Goff's Oak area.
  - The introduction of the extended Brookfield development, primarily along the Halfhide link road leads to uptake of the newly available capacity, which is turn results in a correlated increase in the travel times to and from the A10 Turnford Interchange.
- Routes 10 – Capel Manor to Abbey Gardens
  - Route 10 covers the movements to the crossing the network to the south of the study area, via the alternative route of the A1010 Abbey Road.
  - This route experiences a significant deterioration in travel conditions, as the M25 J25 becomes saturated and traffic attempts to utilise the alternative routes.
  - The model indicates that the A10 / A1055 Bullmoor Lane traffic signals are operating over capacity, resulting in a significant increase in the junction delay for the minor approaches.
  - In the Local Plan scenario these journey times in the AM peak hour are exacerbated by the influence of the Local Plan demand. In the PM the journey time remain relatively consistent with the DM results.

JUNCTION CONSTRAINTS

4.60 The SATURN model monitors the operational capacity of the network based on the calculated Volume to Capacity Ratio (V/C). A network constraint is characterised by a capacity ratio in excess of 85%, in that traffic flow is likely to be more unstable resulting in a reduction in journey time reliability.

4.61 Network elements operating above 100% are operating over capacity, whereby the actual demand exceeds the capacity of the network. Under these conditions flow breakdown is more frequent and the occurrence of journey time delays is more prevalent. Journey times also become highly variable with a consequential knock on effect on journey time reliability. The incidence of rat running to less suitable routes also increases.

4.62

4.63 Table 4.12 & Table 4.13 demonstrates that the impact of the Local Plan is represented by a minor increase in the level of network constraints in the modelled scenarios. This indicates that the model constraints remain consistent and that the increase in demand is insufficient to generate an additional detrimental impact at an aggregate junction level. However, detrimental impacts are generated at an individual movement level for link approaches and specific junction turning movements. These are discussed in the following section.

4.64 The primary locations operating over capacity remain consistent throughout, with an emphasis towards locations on the A10 Great Cambridge Road, rather than the M25 as characterised in the AM peak hour.

4.65 Key constraints include;

- A10 Great Cambridge Road / Bullmoor Lane – Signalised junctions;
- A10 Great Cambridge Road / College Road – Signalised junctions; and
- M25 J25 – approaches & circulatory.

4.66 Table 4.13 present the junction (node) operation capacity constraints for the Local Plan scenarios in comparison to the 'benchmark' DM 2029, for the AM & PM peak hours.

4.67 Further detailed information regarding the Top 25 constrained junctions in the DM 2029 & 'Combined' Local Plan scenarios is contained within **Appendix A**, including comparison statistics from the all assessed scenarios.

4.68 **Appendix A** also contains information regarding the status of these constraints, based on three classifications;

- ✓ LOCAL – local road junctions within Broxbourne where mitigation measures may be required;
- ✓ SRN – Strategic Road locations where mitigation may be required but is outside the control of the local highway authority; and
- ✓ OTHER - adjacent locations to the Broxbourne Borough Council boundary.

4.69

4.70 Table 4.12 indicates that in the AM peak hour the proportion of network constraints increases in line with the growth in the Local Plan demand, with the ‘Combined’ option representing the worst case scenario.

4.71 It should be noted, that despite the increase in the demand, the key network constraints operating over capacity are consistent throughout the options, indicating that the network is capable of sustaining the Local Plan growth in AM peak hour, without a significant breakdown in the network performance.

Table 4.12 Junction Performance - Local Plan Scenarios compared to DM 2029 scenario - AM Peak Hour

ID	Indicator	Unit	AM Peak Hour (08-09)						
			DM 2029	Preferred 2029	% Diff DM	Alternative 2029	% Diff DM	Combined 2029	% Diff DM
1	Nodes/Junctions	N°	497	497	0%	497	0%	497	0%
2	% V/C >100%	N°	0	0	100%	0	100%	0	100%
		%	0%	0%	100%	0%	100%	0%	100%
3	% V/C > 85%	N°	5	12	140%	14	180%	12	140%
		%	1%	2%	140%	3%	180%	2%	140%

4.72 Table 4.13 demonstrates that the impact of the Local Plan is represented by a minor increase in the level of network constraints in the modelled scenarios. This indicates that the model constraints remain consistent and that the increase in demand is insufficient to generate an additional detrimental impact at an aggregate junction level. However, detrimental impacts are generated at an individual movement level for link approaches and specific junction turning movements. These are discussed in the following section.

4.73 The primary locations operating over capacity remain consistent throughout, with an emphasis towards locations on the A10 Great Cambridge Road, rather than the M25 as characterised in the AM peak hour.

4.74 Key constraints include;

- A10 Great Cambridge Road / Bullmoor Lane – Signalised junctions;
- A10 Great Cambridge Road / College Road – Signalised junctions; and
- M25 J25 – approaches & circulatory.

Table 4.13 Junction Performance - Local Plan Scenarios compared to DM 2029 scenario - PM Peak Hour

ID	Indicator	Unit	PM Peak Hour (17-18)						
			DM 2029	Preferred 2029	% Diff DM	Alternative 2029	% Diff DM	Combined 2029	% Diff DM
1	Nodes/Junctions	N°	497	497	0%	497	0%	497	0%
2	% V/C >100%	N°	4	4	0%	4	0%	4	0%
		%	1%	1%	0%	1%	0%	1%	0%
3	% V/C > 85%	N°	5	10	100%	10	100%	10	100%
		%	1%	2%	100%	2%	100%	2%	100%

4.75 Further information regarding the geographical locations of these junction constraints is provided in a series of Operational Capacity Stress Pots contained in **Appendix D** for each modelled scenario.

4.76 It should be noted that the information presented above represents the model operational statistics for the modelled nodes, which is not necessarily reflective of number of modelled junctions, as complex junctions consist of multiple nodes.

DETAILED CONSTRAINTS

4.77 In order to provide further information at a detailed level regarding the scale of capacity constraints within the modelled scenarios, the following section provides an overview of the magnitude of these capacity constraints based on two network definitions;

- ✓ Link Constraints; and
- ✓ Turn Constraints.

Link Constraints

4.78 Link constraints represent the locations where the road section by direction is operating above the 85% capacity indicator or beyond the 100% capacity classification.

4.79 Table **4**.14 & Table 4.15 presents an overview of the volume of link constraints within the AM peak hour and PM peak hour, respectively.

4.80 Details' regarding the geographical location of each link constraint is presented in Operational Capacity Stress Pots contained in **Appendix D.**

4.81 The results indicate that in the AM peak hour at a link level the network is more susceptible to changes in the level of demand, with an identifiable increase in the proportion of the network operating over capacity, with a >100% increase from the DM 2029 scenario for the 'Combined' development quantum.

Table 4.14 Link Operation - Capacity Constraints Local Plan Scenarios compared to DM 2029 – AM Peak

ID	Indicator	Unit	AM Peak Hour (08-09)						
			DM 2029	Preferred 2029	% Diff DM	Alternative 2029	% Diff DM	Combined 2029	% Diff DM
1	Links	N°	1,128	1,128	0%	1,128	0%	1,128	0%
2	% V/C >100%	N°	12	18	50%	23	92%	25	108%
		%	1%	2%	50%	2%	92%	2%	108%
3	% V/C > 85%	N°	49	63	29%	69	41%	70	43%
		%	4%	6%	29%	6%	41%	6%	43%

4.82 In the PM peak hour the volume of links operating over capacity increases by 50% based on the 'Combined' scenario. The overall PM Peak results indicate only a minor variation between the 'Preferred' and 'Combined' scenarios by two locations.

Table 4.15 Link Operation - Capacity Constraints Local Plan Scenarios compared to DM 2029 - PM

ID	Indicator	Unit	PM Peak Hour (17-18)						
			DM 2029	Preferred 2029	% Diff DM	Alternative 2029	% Diff DM	Combined 2029	% Diff DM
1	Links	N°	1,128	1,128	0%	1,128	0%	1,128	0%
2	% V/C >100%	N°	23	33	43%	31	35%	35	52%
		%	2%	3%	43%	3%	35%	3%	52%
3	% V/C > 85%	N°	42	64	52%	64	52%	67	60%
		%	4%	6%	52%	6%	52%	6%	60%

Turn Constraints

4.83 In addition to the link constraints previously described, a more detailed analysis of the network congestion can be evaluated based on the volume of turning movements experiencing congestion in the modelled network.

4.84 Table 4.16 & Table 4.17 present an overview of the volume of turn constraints within the AM peak hour and PM peak hour, respectively, based on the > 85% and >100% volume to capacity ratio classifications.

4.85 It should be noted that the junction based capacity constraints previously presented will cover the majority of movements identified in the statistics below. However, the SATURN calculation takes an average across all arms and therefore this can mask the performance of individual turning movements at a junction.

4.86 The Operational Capacity Stress Plots contained in **Appendix D** provide further details of the locations of the isolated turn capacity constraints for each modelled scenario.

4.87 Overall the statistic demonstrate a deterioration in the in the overall turn capacity based on the increase in demand throughout the Local Plan scenarios, increasing from 1-3% of all turns operating over capacity in the DM 2029 to 3-4% in the various Local Plan scenarios in both the AM & PM peak hours.

4.88 The AM peak hour experiences the most notable reduction in performance, with the 'Combined' scenario representing a 100% increase in the volume of turn operating over capacity compared with the DM 2029.

4.89 The PM peak hour demonstrates a level of consistency across the three Local Plan scenarios indicating the volume of locations that are susceptible to variations in the level of growth are reasonably consistent, regardless of the distribution of the developments within the Local Plan.

Table 4.16 Turn Operation Capacity Constraints Local Plan Scenarios compared to DM 2029 - AM

ID	Indicator	Unit	AM Peak Hour (08-09)						
			DM 2029	Preferred 2029	% Diff DM	Alternative 2029	% Diff DM	Combined 2029	% Diff DM
1	Turns	N°	1,938	1,938	0%	1,938	0%	1,938	0%
2	% V/C >100%	N°	30	46	53%	54	80%	59	97%
		%	2%	2%	53%	3%	80%	3%	97%
3	% V/C > 85%	N°	83	122	47%	128	54%	132	59%
		%	4%	6%	47%	7%	54%	7%	59%

Table 4.17 Turn Operation Capacity Constraints Local Plan Scenarios compared to DM 2029 - PM

ID	Indicator	Unit	PM Peak Hour (17-18)						
			DM 2029	Preferred 2029	% Diff DM	Alternative 2029	% Diff DM	Combined 2029	% Diff DM
1	Turns	N°	1,938	1,938	0%	1,938	0%	1,938	0%
2	% V/C >100%	N°	51	74	45%	70	37%	78	53%
		%	3%	4%	45%	4%	37%	4%	53%
3	% V/C > 85%	N°	87	119	37%	117	34%	121	39%
		%	4%	6%	37%	6%	34%	6%	39%

4.89.1 For clarification, a modelled turn is a movement at a junction between two roads, for example at a typical priority junction with three arms has six possible modelled turns:

- ✓ Major arm 1 - Straight and right
- ✓ Major arm 2 - Straight and left
- ✓ Minor arm 3 – Left and right.

4.89.2 The SATURN model calculates an operational capacity for the turning movement based on the volume of traffic making the various movements at the junction. In the case a typical priority junction, the magnitude of the mainline movements has a significant impact on the capacity of the minor arm movements.

4.89.3 A turn constraint is a location whereby the volume of traffic that wants to make the movement at the junction approaches or even exceeds the potential operational capacity at the junction.

4.89.4 It should be noted, the model is designed to re-distribute traffic to realistic alternative routes in order to minimise the level of congestion. However, once the alternative corridors become unviable, the only solution for the model is to run over capacity.

Detailed Constraints Summary

4.90 In summary, the analysis has demonstrated the incremental increase in network constraints at a junction, link and turn level from the benchmark DM 2029 scenario across the three Local Plan scenarios.

4.91 It should be noted that the Broxbourne transport model is a strategic model, therefore the information and results extracted at a detailed turning movements level should be viewed in this context.

4.92 **Appendix E** contains a series of tables demonstrating the variations in the results for the network Link and Turn constraints across the apprised scenarios, in order to demonstrate the scale of change at a detailed level, covering;

- ✓ Top 40 – Link Constraints; and
- ✓ Top 75 – Turn Constraints.

4.93 These detailed results clearly demonstrate that the increase in the development demand within each scenario is primarily characterised as an exacerbation in the existing constraints in the DM 2029 or the incremental increase in the scale of the constraint from the Preferred to the Combined.

4.94 It should be noted that in the majority of instances the scale of the constraints remains consistent throughout the appraised scenarios.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 This report has set out the approach to the development of a representative DM 2029 scenario and has provided a comprehensive overview of the change in network conditions arising from Local Plan growth. The assessment has considered multiple indicators, including;

- ✓ Network Performance;
- ✓ Junction Capacity Constraints;
- ✓ Link Capacity Constraints; and
- ✓ Turn Capacity Constraints.

5.2 The overall assessment of the Local Plan scenarios indicates that the various development quanta generate similar results and that the operational performance of the 'Combined' scenario is not significantly worse than the preferred and alternative scenarios. In comparison with the Reference Case Do-Minimum (DM) 2029 scenario performance, the level of deterioration is primarily characterised as an exacerbation of existing network constraints.

5.3 It is clear that in order to accommodate the 2029 DM Reference Case demand and subsequent Local Plan developments, further mitigation is required along the A10 corridor, particularly at the five specified sites;

- ✓ A10 Great Cambridge Road / Church Lane (Signalised 4 Arm Junction);
- ✓ A10 Great Cambridge Road / College Road (Signalised 4 Arm Junction);
- ✓ A10 Great Cambridge Road / A121 Winston Churchill Way / B198 Lieutenant Ellis Way (Roundabout 4 Arms);
- ✓ M25 J25 / A10 Great Cambridge Road (Grade Separated Motorway Intersection, 4 Arms);
- ✓ A10 Great Cambridge Road / A1055 Bullsmoor Lane (Signalised 4 Arm Junction);

5.4 However there are other geographical locations with capacity constraints which have been identified in the model assessment and these are presented in a series of Operational Capacity Stress Plots contained in **Appendix D**.

5.5 **Appendix A** also indicates those locations where other junctions are operating in excess of capacity.

5.6 The overall assessment has demonstrated that the AM peak hour is characterised by primarily commuter travel patterns, with the attendant issues of some localised congestion on the A10 in particular. The travel patterns in the PM peak hour result in more congestion than in the AM Peak. This is largely due to the mixture of activities undertaken during this period, as other purposes utilise the network, such as Leisure. This variation in activity generates a mixture of demand requirements, leading to an increase in the sensitivity of the network to changes in demand volumes.

5.7 The sensitivity of the PM peak hour network is demonstrated in the results for the A10 corridor. Several key junctions are signalised crossroads (A10 Great Cambridge Road / Church Lane & A10 Great Cambridge Road / College Road), which are capable providing sufficient capacity for the predominate movements i.e. A10 N-S in the AM peak hour. However, the junction performance reduces dramatically as the demand increases on the minor approaches or most notably conflicting movements i.e. right turn crossing movements.

5.8 Based on this understanding, several key movements along the corridor are unopposed in the AM peak hour become opposed or conflicting movements in the PM peak hour, leading to a clear deterioration in the junction performance. For example, the flow from the College Road east to A10 Great Cambridge Road south is unopposed in the AM peak hour but becomes the conflicting right turn movement in the

PM peak, which can only be accommodated to the determent of the southbound A10, based on the crossroad design.

5.9 This impact is also represented in the trip generations, based on the Brookfield development which contain a mixture of residential, retail and leisure land uses, generating a high volume of arrival and departure trips, equating to 2,550 (1,400 Departure, 1,150 Arrival). The Brookfield development travel patterns represent conflicting demand on the highway network, which is representative of the general PM peak conditions. The provision of a the secondary access to the site directly from the A10 via the Turnford Interchange and Halfhide to Turnford Link road is vital to the sustainability and viability of the site.

5.10 The analysis of the other proposed Local Plan allocations indicates that the impacts of developing these locations is represented as an exacerbation of existing constraints with the highway network in the DM 2029 scenario or is sustainable with the remaining network capacity. This is typically characterised by the Goff's Oak development, which represents a significant quantum of development trips in excess of 1,100 in each period.

5.11 The Goff's Oak development has multiple access and egress points both into the site and the principal A10 Great Cambridge Road corridor. Therefore, the network impact of the total development quantum is offset by the ability of the traffic to spread across multiple routes. However, based on this analysis the A10 corridor remains the principal point of the constraints, due to the limited availability of alternative routes.

5.12 It should be noted, that following the mitigation of the constraints along the A10, further mitigation could be required throughout the local network, as traffic reroutes to utilise the additional capacity along the A10. In essence, due to the scale of constraints within the assessment, the identification of a mitigation strategy will be an incremental process which will need to balance the need of all users.