Brentwood Borough Local Plan

Transport Assessment

On behalf of **Brentwood Borough Council**

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Executive Summary

Introduction

Peter Brett Associates now part of Stantec (PBA) have been commissioned by Brentwood Borough Council (BBC) to support the development of the transport evidence base to support the borough's Local Plan (LP). The specific work being undertaken by PBA is to provide transport modelling support, to assess the impact of the LP on the local and strategic highways in the borough, up to the end of the proposed plan period in 2034.

This Transport Assessment (TA) sets out the approach to the modelling work, the results of the modelling and junction assessments, highlights those worse performing junctions that may require mitigation, the sustainable measures that are proposed and the impact this has on the junction assessments, to enable the development sites to come forward.

The assessment requires that sustainable transport should be the main emphasis of the local plan infrastructure requirements and this aligns with both the Guidance detailed above and the National Planning Policy Framework.

In transport terms, there is a need to demonstrate that the plan is sustainable and that transport will play a key role, with emphasis on sustainable mobility, including virtual mobility, which is being made possible through advances in wider technology, enabling more flexible working patterns and lifestyles, including greater tele-working and internet based shopping for example.

To inform the Local Plan, computer modelling is used to analyse the traffic impact of developments. The modelling provides outputs to understand how traffic distributes within Brentwood and traffic data is used within standard junction modelling packages to look at the impact at specific locations in Brentwood.

Local Plan Developments

Details of the development included within the Local Plan Growth Scenario were provided by BBC in the form of a spreadsheet on the 19th January 2018. This included information on the numbers of dwelling to be provided at each of the proposed sites and the site area in hectares and projected employment numbers for employment sites. These feed into the modelling process and population figures are based on household size obtained from Office for National Statistics (ONS) data. The sites include Dunton Hills, the major residential site and Brentwood Enterprise Park, the major employment site.

Modelling Process

A four-stage transport modelling process has been undertaken, which calculates the number of trips generated by developments (Trip Generation), how many trips there will be between different areas (Trip Distribution), how many travel by different modes (Mode Share) and how trips travel on a network (Trip Assignment).

The model produces trip numbers for trips produced outside of the Local Plan to produce a Reference Case, which is then used to compare the impact of the Local Plan development.

Both the Reference Case and Local Plan Models are produced for 2034 and for the AM and PM peak hours only.

The Reference Case Model includes trips developments within neighbouring authorities, as well as additional background trips associated with population growth predictions for future years. The trips from population growth predictions are adjusted to make sure there is no double counting.
To determine trip numbers, National Travel Survey (NTC) data and Census Travel to Work (CTTW) data have been used to calculate the number of trips per household for a number of purposes, including commuting, education. leisure and shopping. The same data is also used to split the trips by mode, based on trip distances.

Trips are grouped together in the model into zones, which represent a geographical area. These zones are smaller in the urban areas of Brentwood and larger in rural areas. The model area includes neighbouring areas. A matrix of trips is produced which has trips between each of the zones, which are distributed based on land use information and the distance information and trip generation from NTS data. This is known as an origin and destination matrix.

For car trips a road network, which includes all roads, is used. Each link within this network has a time associated with it, which comes from car GPS systems. The car trip origin and destination matrix is then connected to the network and trips are assigned to the quickest route between zones.

Turning flows for junctions are then taken from the model and used within individual models for junctions. In total 23 individual junctions are modelled.

Sustainable Travel

The Local Plan will provide an opportunity for greater investment in sustainable travel interventions and these will be necessary in the future to enable people to move about more easily. The report includes information on specific Brentwood measures that are considered. These are a mixture of measures to reduce car trips and increase walking, cycling and public transport use.

The Department for Transport undertook a study of the implementation of Sustainable travel measures in three towns and evidence from this study has been used within the modelling to provide a reduction in car trips, before junction modelling has been assessed to determine if additional highway mitigation is required.

Conclusion

The transport work identified within this report has demonstrated that through sustainable transport measures and in some cases, limited physical highway improvement works, the impact of the Local Plan can be mitigated and that there are no major residual impacts that might prevent the delivery of the Local Plan development. The table below sets out an overall summary of the position of each of the junctions assessed, as part of this Local Plan Transport study.

Junction No.	Junction Location	Conclusion
1	A1023 Chelmsford Rd / A129 Hutton Rd / A1023 Shenfield Rd	Implementation of MOVA (or similar) as a mitigation should provide adequate capacity
2	A129 Rayleigh Road / Hanging Hill Lane	Impact not deemed severe – no mitigation required
3	A128 Ongar Road / Doddinghurst Road	Town Centre junction where sustainable transport mitigation will be required
5	A128 Ongar Road / William Hunter Way	Town Centre junction where sustainable transport mitigation will be required
6	A128 Ongar Road / A1023 Shenfield Road / A128 Ingrave Road / A1023 High Street	Operates below capacity - No mitigation required

Junction No.	Junction Location	Conclusion
7	A128 Ingrave Road / B186 Queens Road	Town Centre junction where sustainable transport mitigation will be required
8	A128 Ingrave Road / Middleton Hall Lane / Seven Arches Road	Operates below capacity - No mitigation required
10	A1023 High Street / B185 Kings Road / A1023 London Road / Weald Road	Implementation of MOVA (or similar) as a mitigation should provide adequate capacity
12	Western Road / William Hunter Way	Town Centre junction where sustainable transport mitigation will be required
13	A127 / A128 Brentwood Road / A128 Tilbury Road	Mitigation Scheme Provided
14	A127 / Childerditch Lane	Operates below capacity - No mitigation required
15	A128 Ingrave Road / The Avenue	Mitigation Scheme Provided
16	A128 Brentwood Road /Running Waters	Mitigation Scheme Provided
17	A1023 Brook Street /Mascalls Lane	Implementation of MOVA (or similar) as a mitigation should provide additional capacity
18	B186 Warley Hill / Eagle Way / B186 Warley Rd / Mascalls Lane	Implementation of MOVA (or similar) as a mitigation should provide additional capacity
19	B186 Warley Street / A127 eastbound	Funded ECC Scheme Provides adequate capacity
20	B186 Warley Street / A127 westbound	Funded ECC Scheme Provides adequate capacity
22	A1023 Chelmsford Road / Alexander Lane	Operates below capacity - No mitigation required
23	A12 Junction 12	Operates below capacity - No mitigation required
24	Roman Road / A12 Slip	Mitigation Scheme Provided
25	M25 Junction 28	Further work required with HE and other authorities
26	M25 Junction 29	Further work required with HE and other authorities
27	A128 Tilbury Road/Station Road	Mitigation Scheme Provided

The evidence provided in this report show that the Local Plan can be delivered and any impact can be mitigated, through either sustainable travel interventions or physical highway mitigation. Through concentrating investment on improving sustainable transport, this will benefit all residents within the borough, not just those in the new developments.

There are still some elements related to the Strategic Road Network, where the impact is wider than from Brentwood, where there will be a need to work with Highways England and other authorities to examine these issues further.

1 Introduction

1.1 Overview

1.1.1 Peter Brett Associates now part of Stantec (PBA) have been commissioned by Brentwood Borough Council (BBC) to support the development of the transport evidence base to support the borough's Local Plan (LP). The specific work being undertaken by PBA is to provide transport modelling support, to assess the impact of the LP on the local and strategic highways in the borough, up to the end of the proposed plan period in 2034.

1.1.2 This work follows on from the previous work undertaken by PBA where several options for development have been tested[1]. This work now pertains to the modelling of a single Local Plan Development option. The modelling work has been undertaken in line with the National Planning Policy Guidance "Transport evidence bases in plan making and decision taking", March 2015.[2]

1.1.3 BBC are in the process of developing their Local Plan which will provide the planning framework for the future growth and development for the Borough up to 2034

1.1.4 This Transport Assessment (TA) sets out the approach to the modelling work, the results of the modelling and junction assessments, highlights those worse performing junctions that may require mitigation, the sustainable measures that are proposed and the impact this has on the junction assessments, to enable the development sites to come forward. The assessment requires that sustainable transport should be the main emphasis of the local plan infrastructure requirements and this aligns with both the Guidance detailed above and the National Planning Policy Framework. In transport terms, there is a need to demonstrate that the plan is sustainable and that transport will play a key role, with emphasis on sustainable mobility, including virtual mobility, which is being made possible through advances in wider technology, enabling more flexible working patterns and lifestyles, including greater tele-working and internet based shopping for example.

1.1.5 The purpose of this work is to understand how the highway network within BBC copes at a strategic level as a result of the new Local Plan Development. The appraisal considers the broad impact on the local and strategic junctions of a preferred development allocation. Any detailed assessment of development impact and mitigation associated with any specific development would be expected to be undertaken by promoters of individual sites at a later date. Assumptions made regarding the development size and quantum are understood to be correct as of September 2018.

1.2 Other Key Studies, Projects and Travel Influences

1.2.1 This assessment reviews the impact of development up to the end of the Local Plan period. There are a number of schemes and projects that have been identified below that will have an impact on the operation of the highway network, whether it be through reduced car travel or physical improvements and changes to the use of the network in the Borough. At this stage the impact of these and what they will entail, is unknown, therefore there will be a need to undertake regular reviews during the Local Plan period to understand how these have influenced travel and ensure that any mitigation coming forward is 'fit for purpose' as the local plan developments progress and come forward individually.

[1] Brentwood Local Plan Modelling Report 2016

[2] https://www.gov.uk/guidance/transport-evidence-bases-in-plan-making-and-decision-taking

1.2.2 In addition to these projects and schemes which are more advanced, there will be other influences which will have an impact on travel, such as technological improvements, whether this be the development of connected and autonomous vehicles, changes to how and when people travel, in particular for work based trips (commuting and in the course of business) or technological advances which reduce the need to travel e.g. through increased home working. At this time these aspects cannot be assessed, therefore, again during the course of the plan period, there would be a need to review network and travel performance.

A127 Corridor for Growth

1.2.3 A number of studies have been progressing, being led by Essex County Council, on the A127 corridor between Southend-on-Sea in the East to the M25 in the west. The final section of this road is within the Borough, including M25 junction 29. The study involves all local authorities, as well as Highways England.

1.2.4 Within the Borough, this route is of strategic importance and much of the proposed growth is proposed along this corridor.

1.2.5 Within the A127 Corridor for Growth study[3] there are individual pieces of work which are currently at various stages of planning and development, which are focussed on interchange capacity and/or safety improvements. Where information is available, this has been used to inform the modelling. The final outcomes from the study are not yet known and continued joint working with ECC and other neighbouring authorities will be important, so any outcomes from this study can feed through to the corridor study and consideration given to demonstrate this within a Statement of Common Ground with the highway authorities and neighbouring authorities. Where funding is known to exist for a scheme, these are included within the reference case modelling, otherwise these are included within Local Plan mitigation schemes.

M25 Junction 28 Study

1.2.6 Highways England are currently undertaking work to develop improvements at M25 Junction 28[4]. A preferred option has been developed for the junction which involves provision of an additional loop which removes northbound M25 to eastbound A12 traffic from the junction. This has been looked at in the context of the local plan development.

Elizabeth Line

1.2.7 The Elizabeth Line is a major infrastructure project, which will provide rail services between Reading in the west to Shenfield in the East and which will provide services across London. The project is expected to be completed by late 2018 and will provide very frequent services from both Shenfield and Brentwood Stations, to and through London. At peak times the current planned timetable includes 12 services per hour from both stations to London[5], on top of the existing services that serve these two stations. This will provide a very large increase in capacity for rail travel, as well as the improved service frequencies. In addition, the Elizabeth Line will provide improved access to parts of London and beyond, including Heathrow, which were not previously served directly.

1.2.8 At this stage the impact of the scheme is unknown and there will be a need to monitor and review the situation once the services are operational. This will assist in providing a better understanding of how the introduction of additional services, to new destinations, will impact

[3] https://www.essexhighways.org/uploads/docs/nevendon-a127-corridor-for-growth-paper2.pdf

[4] https://highwaysengland.co.uk/projects/m25-junction-28-improvements/

[5] http://www.crossrail.co.uk/route/eastern-section/

on car travel, both to through a potential mode change from car to rail, but also in terms of potential impact of local car trips to Brentwood and Shenfield Stations.

1.2.9 Early passenger demand modelling for Crossrail indicated that passenger growth at Shenfield and Brentwood was likely to be in the region of 10%, this would indicate that there would be minimal impact on the operation of the local highway networks surrounding these stations. Any impacts identified should be addressed through the implementation and promotion of sustainable transport measures, for example promote use of non-car modes and the implementation of parking restrictions in the area could mitigate this. Limited information is available on the likely impact of the scheme at Shenfield and Brentwood stations.

Lower Thames Crossing

1.2.10 The Lower Thames Crossing is a proposed new road crossing of the River Thames which will connect the counties of Essex (north) and Kent (south). The scheme is being developed by Highways England, a decision on the preferred route for the crossing was made on 12 April 2017.[6]

1.2.11 The planned route is expected to run from the M25 near North Ockendon, cross the A13 at Orsett before crossing under the Thames east of Tilbury and Gravesend. A new link road will then take traffic to the A2 near Shorne, close to where the route becomes the M2.

1.2.12 At this stage, information on the impact on the highway network in Brentwood is limited. The impact of the scheme on travel in the borough will need to be reviewed as the scheme progresses, in particular if delivery of the scheme comes forward during the plan period.

1.2.13 The Lower Thames Crossing Statutory Consultation commenced on October 10th 2018[7]. The main changes in flows, during the peak period, in Brentwood are on the A127 between M25 junction 28 and the A128 and the A128 south of the A127 junction. The forecast reporting released as part of the consultation evidence, does not provide detailed analysis of flow changes on the A128 and A127, however within the non-technical summary flow difference plots indicate that in both the AM and PM peak, the flows on these links will decrease by 100 to 500 PCU’s. This is a result of trips to/from Thurrock now using the new link from the A13 to the new toe in south of Junction 29, rather than the A128/A127.

Neighbouring Authority Local Plans

1.2.14 The neighbouring authorities to Brentwood are in various stages of developing their Local Plans and where information on these is available and within the overall model area, these have been considered and discussed further in Section 2.

1.2.15 Neighbouring authority growth is likely to have an impact on strategic routes through the Borough. As far as practicable this has been considered, either by directly allowing for proposed local plan development within Neighbouring Boroughs or through the application of growth factors. In addition, there will be opportunities to work with neighbouring local authorities to further address cumulative impacts as detailed proposals come forward This is likely to be the case, particularly on the A127, A12 and M25 junctions within the Borough.

1.2.16 Additional information on growth from other authorities has been explained in section 2.5.

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[6] https://www.gov.uk/government/news/new-lower-thames-crossings-to-cut-congestion-and-create-thousands-of-jobs

[7] https://highwaysengland.citizenspace.com/ltc/consultation/

1.3 Sustainable Mobility

1.3.1 The starting point for mitigating the impact of the Local Plan must be consideration of sustainable mobility. This will therefore align with the requirements of the Local Plan Guidance and NPPF. It is recognised that highway capacity can only facilitate a certain level of growth and in most cases the answer should not be to provide additional highway capacity, as this will move away from the sustainable aims.

1.3.2 Through investment in and promotion on sustainable mobility much of the extra demand for travel can be accommodated, in particular for short distance trips, which may currently be made by car, but could feasibly be made on foot or bike for example.

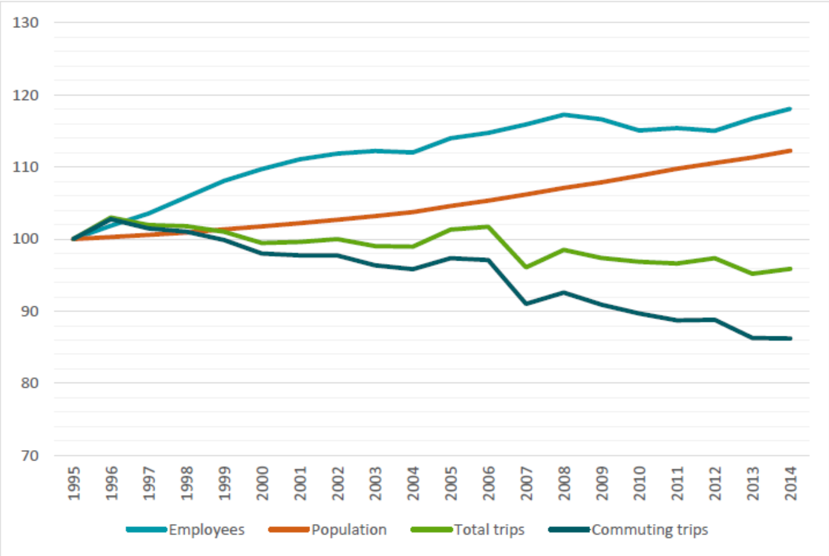
1.3.3 Technology advances can also influence how and when we travel and have an impact on capacity. This can have an impact on virtual mobility, as well as actual travel. Virtual mobility has led to a reduction in demand for travel at peak times, as more people are seen to take advantage of improvements in technology and more acceptance of agile working, which has resulted in increases in tele-working (or working from home) on a regular or irregular basis.

1.3.4 Analysis of NTS data shows that the number of commute trips and the number of commute trips per person per week is reducing over time (from 1995 to 2014). Figure 1-1 shows that whilst population and the number of employees has increased, the number of commute trips has declined. National Travel Survey data has also indicated that the number of commute trips per person per year has fallen from 85 to 80 between 2011 and 2016. Whilst some of this can be put down to changes in demographics and an aging population, DfT have undertaken some research[8] that has indicated that the reduction in commute trips can, at least in part be put down to increased home working, both on a regular and occasional basis. Part time working has also increased.

1.3.5 All the above will likely have had an impact on traffic growth in the peak hours and with ever increases in technology and more acceptance of agile and flexible working patterns, this will influence the number of trips made during peak hours and people are likely to react in response to increasing congestion, in such a way to avoid travelling at peak times where possible.

Figure 1-1: Employees, Total Population, Total Journeys and Commuting Journeys in England

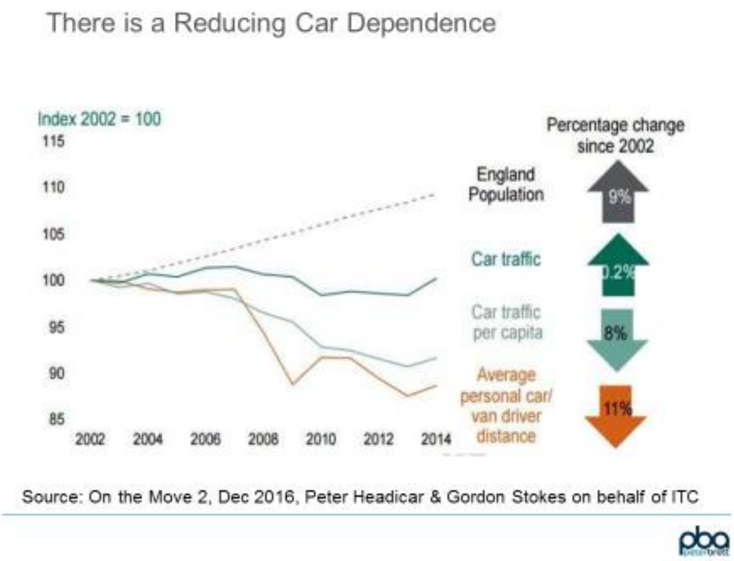
[8] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/657839/commuting-in-england-1988-2015.pdf



(100 = indexed to 1995 Levels). Sources: Labour Force Survey, ONS, Population Estimates, National Travel Survey

1.3.6 There have been indications that the reliance on private car overall is also falling in recent years. Figure 1-2 shows that whilst population has increased between 2002 and 2014, car traffic has remained static and car traffic per capita and average distance travelled has decreased over the same period. Whilst the past may not be a full indication of future trends, this should be considered important in the context of Local Plan growth.

Figure 1-2: Traffic and Travel Trends 2002 to 2014



1.3.7 Further information on sustainable transport and the local plan strategy to promote sustainable mobility is provided within Section 7.

1.4 Report Structure

1.4.1 Following this introduction this document is set out as follows:

- Section 2 sets out details of the Local Plan Development to be included within the Local Plan Transport Assessment;
- Section 3 sets out the approach to the spreadsheet modelling;
- Section 4 sets out the approach to the junction modelling and junction assessments;
- Section 5 provides the modelling results for the baseline scenario;
- Section 6 and 7 provide the results of the junction assessments;
- Section 8 sets out results of the assessment at M25 junctions 28 and 29;
- Section 10 sets out the sustainable measures;
- Section 11 provide the results of the junction assessments with the inclusion of sustainable measures:
- Section 12 sets out results of the assessment at M25 junctions 28 and 29 with the sustainable measures;
- Section 13 sets out a summary of the results included within the assessment

2 Local Plan Development

2.1 Overview

2.1.1 Details of the development included within the Local Plan Growth Scenario were provided by BBC in the form of a spreadsheet on the 19th January 2018. This included information on the numbers of dwelling to be provided at each of the proposed sites and the site area in hectares and projected employment numbers for employment sites.

2.2 Housing

2.2.1 For residential developments, the modelling process utilises population data by different age groups, rather than dwelling numbers. To calculate forecast residential population by age band for each site, the mean numbers by age group per household, for all of Brentwood, from Census 2011 was used. The resultant persons per household are:

- 0 – 16 years 0.475 residents per dwelling
- 17 -64 years 1.469 residents per dwelling
- 65+ years 0.458 residents per dwelling

2.2.2 Details of the housing sites which are included within the local plan Local Plan Growth Scenario including dwelling numbers and population by age group are shown in Table 2-1.

Site Ref.	Site Description	Dwellings	Estimated Residential Population (By Age Group)			
			0-16	17-64	65+	Total
041	Land at Hunter House, Western Road	48	23	70	22	115
311	Eagle and Child Pub, Shenfield	20	9	29	9	48
040	Chatham Way / Crown Street Car Park	31	15	46	14	74
039	Westbury Road Car Park	45	21	66	21	108
186	Land at Crescent Drive, Shenfield	55	26	81	25	132
003	Wates Way Industrial Estate	80	38	117	37	192
081	Council Depot, Worley	123	58	181	56	295
117A & 117B	Ford Headquarters, Warley	350	166	514	160	841
002	Brentwood railway station car park	100	47	147	46	240
102	William Hunter Way	300	142	441	138	720
044 & 178	Land at Priests Lane	95	45	140	44	228
020	West Horndon Industrial Estate	200	95	294	92	480

Site Ref.	Site Description	Dwellings	Estimated Residential Population (By Age Group)			
			0-16	17-64	65+	Total
021 & 152	West Horndon Industrial Estate	380	180	558	174	913
010	Sow and Grow, Ongar Road, Pilgrims Hatch	38	18	56	17	91
027	Land adj. to Carmel, Mascalls Ln	9	4	13	4	22
083	Land west of Warley Hill	43	20	63	20	103
032	Land East of Nags Head Lane, Brentwood	125	59	184	57	300
022	Land at Honeypot Lane	200	95	294	92	480
023	Land off Doddinghurst Road	200	95	294	92	480
263	Land east of Chelmsford Rd, Shenfield	215	102	316	99	516
034, 087, 235, 276	Officer's Meadow	510	242	749	234	1225
158	Land North of A1023 Chelmsford Road, Shenfield	100	47	147	46	240
128	Ingatestone Garden Centre	120	57	176	55	288
079A	Land adjacent to Ingatestone By-pass	57	27	84	26	137
106	Former A12 Work Site	41	19	60	19	98
076	Land South of Redrose Lane	40	19	59	18	96
077	Land South of Redrose Lane	56	27	82	26	134
075	Land off Stocks Lane, Kelvedon Hatch	30	14	44	14	72
194	Brizes Corner Field, Blackmore Road, Kelvedon Hatch	23	11	34	11	55
294	Chestnut Field, Blackmore Road	10	5	15	5	24
085B	Land adj. Tipps Cross Community Hall, Blackmore Rd	10	5	15	5	24
200	Dunton Hills Garden Village (plan period)	2500	1186	3672	1146	6004

Table 2-1: Housing Sites

2.3 Employment

2.3.1 Details of the employments sites are shown in Table 2-2.

Site Ref.	Site Description	Area (Ha.)	Workplaces
101A	Brentwood Enterprise Park (M25 Junction 29 works site)	25.85	3041
079C	Land adjacent to Ingatestone by-pass (part bounded by Roman Road)	2.6	306
112D and 112E (a)	Childerditch Industrial Estate (extension 3 - southern growth to tree line)	3.53	122
101C	Brentwood Enterprise Park (Codham Hall Extension)	0.61	72
200	Dunton Hills Garden Village	5.5	647
109 and 187	Land at East Horndon	5.5	647
158	Land north of A1023, Shenfield	2	235
101B	Brentwood Enterprise Park (Codham Hall)	6.03	709
108	The Old Pump Works, Great Warley Street	0.79	27
111	Upminster Trading Estate	2.6	306
228	PERI site, Warley Street, Great Warley	5.36	631
112E (b)	Childerditch Industrial Estate (extension 2 - farm area)	3.62	125
321	McColls, Ongar Road	1.6	188
112A, 112B & 112C	Childerditch Industrial Estate	11.25	388
113A & 113B	Hallsford Bridge Industrial Estate	3.41	118
114	Hubert Road Industrial Estate	3.78	130
45	Hutton Industrial Estate	10.48	361
115	Brook Street Employment Area	1.25	147
118	BT Offices, London Road	3.5	412
119	Canon Offices. Chatham Way, Brentwood	0.45	53
117	Ford Offices	2	235
020, 021 & 152	West Horndon Industrial Estate	2	69
121	Mellon House, Berkley House and 1-28 Moores Place, Brentwood	0.35	41
116	Warley Business Park (ex. Regus)	2.5	294

Table 2-2: Employment Sites

2.4 Redeveloped Employment Sites

2.4.1 There are some sites which are proposed for development, which have existing uses. These are currently employment sites, and thus the trips associated with the current development needed to be removed. These sites are shown in Table 2-3.

Site Ref.	Site Description	Area (Ha.)	Workplaces
117	Ford Offices, Eagle Way, Brentwood	-3.25	-382
003	Wates Way Industrial Estate, Ongar Road	-0.96	-33
020, 021, 152	West Horndon Industrial Estate	-15.06	-519
081	Council Depot	-1.71	-201
110	Town Hall, Brentwood	-0.55	-65
114A	Regent House	-0.98	-115
121	Mellon House	-0.17	-20
013B	Warley Training Centre	-1.71	-201
120	47-57 Crown Street	-0.12	-14
125	North House	-0.18	-21
116	Warley Business Park	-0.72	-85

Table 2-3: Employment Sites Removed

2.5 Neighbouring Authority Developments

2.5.1 In addition to BBC LP developments it was necessary to include any LP or committed developments within adjacent local authorities that would likely have an impact on BBC highways. These are added into the Reference Case Scenario which will be the future base on which the Brentwood Local Plan developments will be tested. A number of developments within Basildon and Havering have been included as detailed below, however no information has been made available for Thurrock, therefore this growth is only included in background growth, rather than for specific sites.

Basildon Developments

2.5.2 The following developments within Basildon have been included within Reference Case Forecasts:

- Land West of Gardiners Lane South, Basildon – 660 Dwellings
- Land North of Dry Street, Basildon – 725 Dwellings
- West Basildon Urban Extension – 1000 Dwellings
- Land West of Steeple View, Dunton Road, Laindon – 140 Dwellings
- Land East of Noak Bridge, Wash Road, Basildon – 360 Dwellings
- East of Basildon – 2000 Dwellings

- Land North of Potash Road, Billericay - 150 Dwellings
- Land West of Tye Common Road, Billericay – 160 Dwellings
- Land south of London Road, Billericay – 180 Dwellings
- Land west of Mountnessing Road, Billericay – 280 Dwellings
- Land East of Frithwood Lane, Billericay – 330 Dwellings
- Land South of Windmill Heights, Great Burstead and South – 70 Dwellings
- Land west of Kennel Lane, Great Burstead and South Green – 70 Dwellings
- Land East of Greens Farm Lane, Billericay – 280 Dwellings
- Land east of Southend Road, Great Burstead and South Green - 220 Dwellings

Havering developments

2.5.3 The following developments in Havering have been included:

- Romford Strategic Development Area - 5,300 Dwellings
- Rainham and Beam Park Strategic Development Area – 3,000 Dwellings

Other Authorities

2.5.4 Specific developments in other authorities have not been included directly, however population growth has been included to incorporate other growth in the modelling. For example, whilst Chelmsford developments are not directly included within the modelling the growth is included using ONS population projections which would allow for any traffic from Chelmsford along the A12 to be modelled within the Reference Case.

Population Data

2.5.5 Details of the population estimates within Brentwood, for each modelled scenario are shown in Table 2-4.

Scenario	Population
2017 Base Year	77357
2033 Reference Case	80975
2033 Local Plan	95755

Table 2-4: Population Estimates by Scenario

3 Transport Modelling Methodology

3.1 Introduction

3.1.1 This Section sets out the approach to modelling the impact of the proposed Local Plan development on the local and strategic highway network within the Brentwood Borough.

3.1.2 In the absence of a suitable and up to date strategic modelling tool, a methodology was developed that is deemed to be a robust approach to assessing the impact and to inform the development of the Local Plan.

3.1.3 To derive traffic volumes for the assessment, a three-step approach has been used. This allows the highway impact to be assessed. The three stages are:

- Obtaining base data from observed counts – The Base Case Scenario
- Applying background growth – The Reference Case Scenario
- Adding on trips associated with the Local Plan proposals – The Local Plan Growth Scenario

3.2 Overview of Modelling Approach

3.2.1 The modelling has been undertaken using a spreadsheet model, which then provides outputs for a series of junction models.

3.2.2 The junction models form the basis of the Base Case Scenario, with each model using observed traffic count data, feeding into models which are then calibrated to represent base conditions as far as possible. The base year is 2017 and the data used for this is detailed further in Section 3.3.

3.2.3 The spreadsheet model is used to derive future year flows for both the Reference Case and Local Plan Growth Scenarios, which are then extracted at junction level to feed into the forecast modelling and assessment process.

3.2.4 The modelling approach also allows for non-highway mitigation and sensitivity tests to be undertaken to indicate how sustainable travel measures may impact on the highway network performance at junction level.

3.2.5 The study area covers the whole of the Brentwood Borough area, with the model coverage discussed in Section 3.4.

3.3 Junctions Modelled and Base Year Traffic Data

Review of Junctions Modelled

3.3.1 Models for a number of junctions were previously developed in 2012, to inform the modelling work undertaken, looking at different development scenarios within the Borough. The junctions modelled at that time were agreed with Essex Highways. This is reported within Brentwood Borough Local Plan Development Options – Highway modelling 2016.

3.3.2 As part of this updated study, a review of the junctions that were assessed in the previous 2012 assessment has been undertaken, along with a review of the traffic data used. The purpose of the review is to show that the junctions to be modelled are adequate and that any data used is suitable for the modelling of the Local Plan.

3.3.3 As part of the previous work, a total of 23 junctions were modelled. This included junctions on the Essex highway network, but at that time excluded the M25 junctions 28 and 29.

3.3.4 The previous work undertaken has been used to inform the selection of the junctions to be modelled within the new study, along with TrafficMaster data showing the percentage of free flow speed achievable during the AM and PM peak periods as a measure of congestion, these were provided to PBA by Essex County Council.

3.3.5 The first stage of the modelling was to review the outputs from the previous Local Plan study. The outputs from this analysis is reported in 'Brentwood Local Plan – Development Options – Highway Modelling', Peter Brett Associates, February 2018. Following a review of this work, several junctions were shown to work well within capacity within the development option that most closely replicated the proposed Local Plan Growth Scenario which is being tested within this assessment and are thus excluded from this study.

3.3.6 The junctions that have been removed from the new study are shown in Table 3-1, along with the highest RFC (Ratio of flow to capacity).

Junction ID	Location	AM Peak Highest RFC	PM Peak Lowest RFC
4	A128 Ongar Road/ Western Avenue	0.65	0.71
9	B185 Kings Road/B186 Queens Road	0.76	0.84
11	Weald Road/Western Road	0.49	0.69
21	A127 Westbound/Thorndon Avenue	0.64	0.49

Table 3-1: Omitted Junctions from New Study

3.3.7 The next step has been to review the remaining junctions against the Teletrac Navman (previously TrafficMaster) plots and the location of the development within the Local Plan Growth Scenario. These plots do not specifically show congestion and are based on link speeds during the peak periods, this gives an indication of junctions that may have issues but other external factors such as school drop off traffic or deliveries could influence link speeds.

3.3.8 Following a review of the location of the development sites and the Teletrac Navman (previously Traffic Master), plots, three additional junctions have been identified, numbered 23, 24 and 27 in the table. The full list of junctions that are to be modelled are summarised within Table 3-2, and are shown on Figure 3-1 and 3-2.

ID	Junction	Junction Type
1	A1023 Chelmsford Road / Hutton Road / A1023 Shenfield Road	Signalised Junction
2	A129 Rayleigh Road / Hanging Hill Lane	Mini Roundabout
3	A128 Ongar Road / Doddinghurst Road	Mini Roundabout
5	A128 Ongar Road/William Hunter	Priority Junction
6	A128 Ongar Road / A1023 Shenfield Road / A128 Ingrave Road / A1023 High Street	Double Mini Roundabout
7	A128 Ingrave Road / B186 Queens Road	Mini Roundabout
8	A128 Ingrave Road / Middleton Hall Lane / Seven Arches Road	Signalised Junction
10	A1023 High Street/ B185 Kings Street	Signalised Junction
12	Western Road/William Hunter Way	Priority Junction
13	A127 / A128 Brentwood Road / A128 Tilbury Road	Roundabout
14	A127 / Childerditch Lane	Priority Junction
15	A128 Ingrave Road / The Avenue	Double Mini Roundabout
16	A128 Brentwood Road /Running Waters	Double Mini Roundabout
17	A1023 Brook Street /Mascalls Lane	Signalised Junction
18	B186 Warley Hill / Eagle Way / B186 Warley Road / Mascalls Lane	Signalised Junction
19	B186 Warley Street / A127 eastbound	Priority Junction
20	B186 Warley Street / A127 westbound	Priority Junction
22	A1023 Chelmsford Road / Alexander Lane	Priority Junction
23	A12 Junction 12	Roundabout
24	Roman Road / A12 Slip	Priority Junction
27	A128 Tilbury Road/Station Road	Priority Junction

Table 3-2: Junctions to be Modelled

Figure 3-1: Junction Locations for Assessment – AM Peak

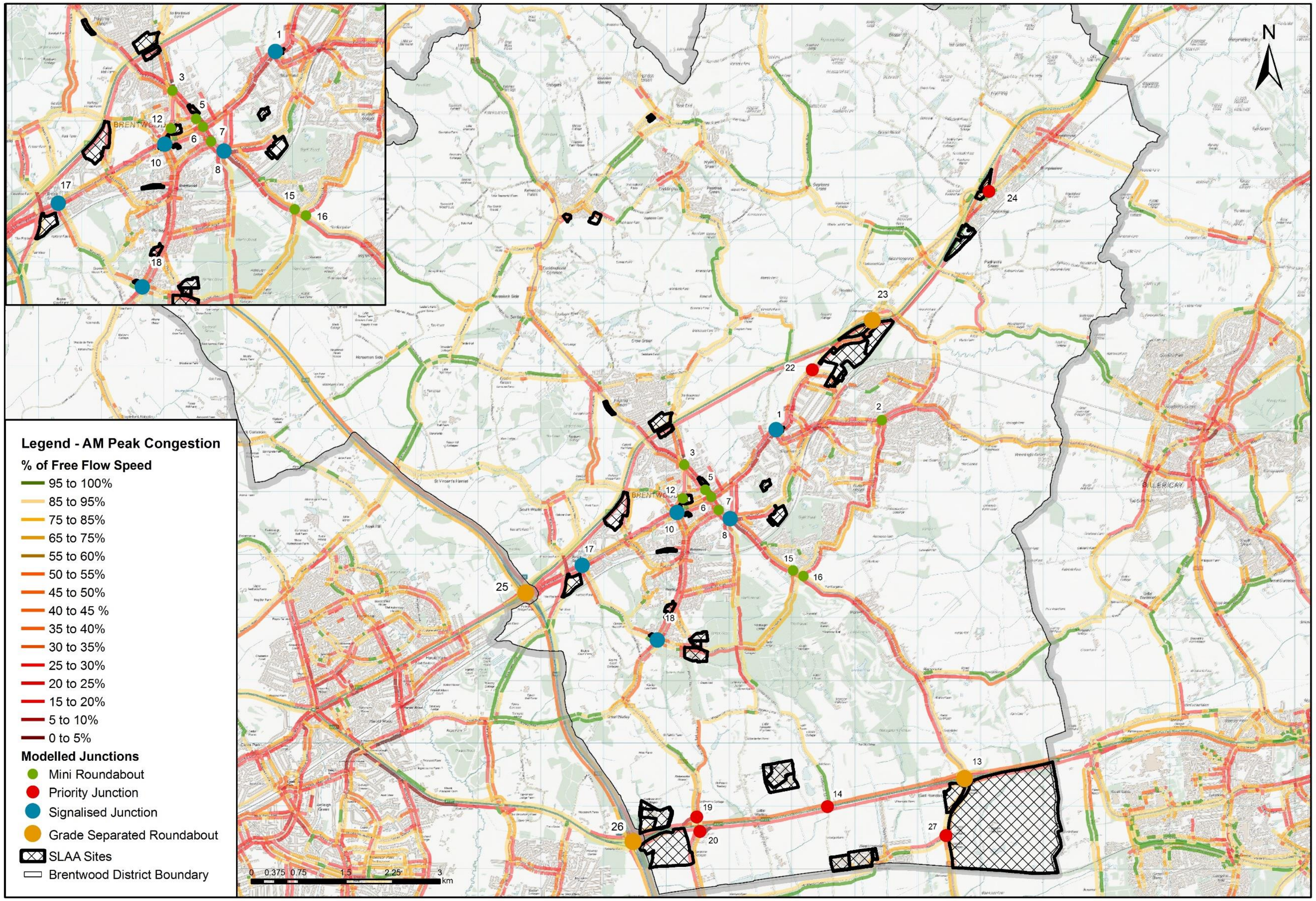


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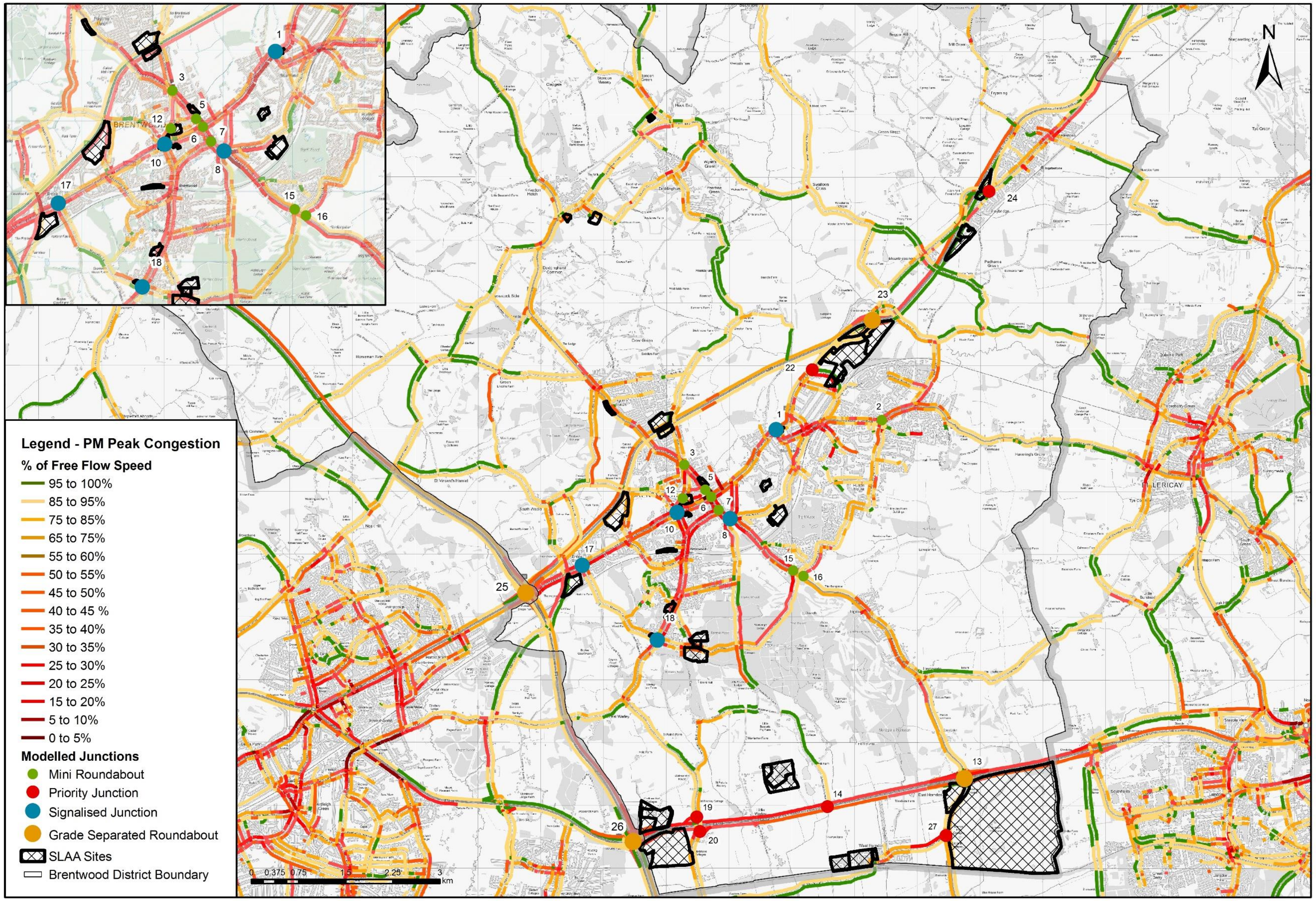
Figure 3-2: Junction Locations for Assessment – PM Peak



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Traffic Data Review

3.3.9 A review of the traffic data used within the previous models has been undertaken. To do this more up to date traffic data has been used to confirm the suitability of the 2012 data or to provide new data to be used within the updated modelling.

Recent Traffic Surveys

3.3.10 For some junctions, new data has been identified at a number of junctions which has been used within the assessments.

3.3.11 At some junctions, more recent 2017 traffic survey data was made available either directly provided from Essex County Council or obtained from local Transport Assessments. Table 3-3 outlines the attributes of the 2017 data sources and which junctions will utilise this most up to date traffic counts for use in the junction assessments.

Junction ID	Date of survey	Location	Source	Junction Type
6	Thursday 2nd March 2017	Wilsons Corner, Brentwood	Essex County Council	Double Mini-Roundabout
8	Tuesday May 23rd 2017	Ingrave Road/Middleton Hall Lane/Seven Arches Road	Brentwood Preparatory School, Transport Assessment, Waterman Ltd	Signalised Junction
13	Wednesday 1st March 2017	A128 Halfway House, West Horndon	Essex County Council	Grade Separated Junction
24	Thursday 6th July 2017	A12 Junction 12	Residential Development, Ingatestone, Transport Assessment, WSP	Grade Separated Junction
27	2017 (no date given in TA)	A128 Tilbury Road/Station Road	East Horndon Industrial Park, Supplementary Transport Report, Redwood Partnership	Priority Junction

Table 3-3: New Traffic Counts

Updating Data

3.3.12 The previous assessments used traffic count data surveyed in 2012. It is noted that within DMRB Volume 12, Section 1, Part 1 states "*[w]here trip information used in a traffic appraisal relies largely upon observations taken more than about 6 years ago it will be necessary to ensure that this information is still valid….*". Thus, a pragmatic approach was taken to produce new junction flows where applicable which is considered appropriate given the high-level nature of Local Plan assessment. Where no recent data was available but appropriate trend data was available nearby then this was used to derive factors to apply to the 2012 count data. Otherwise, factors were applied based on TEMPro.

TEMPro Growth

3.3.13 Table 3-4 below outlines the TEMPro growth rates that were applied to the previous 2012 data where no more recent count data was available. One more recent count is available for 2014, hence a factor is provided for 2014 to 2017, again based on TEMPro

Base Year	Future Year	Area	AM	PM
2012	2017	Brentwood	1.074	1.071
2014			1.043	1.041

Table 3-4: TEMPro Growth Rates

Additional Analysis

3.3.14 Additional analysis has been undertaken to identify the suitability of the counts for use in the base junction models. The following section summarises the analysis undertaken for the junctions within Brentwood Town Centre and those in the outer areas. In the absence of time-series ATC data, which would identify trends, each junction has been looked at on a case by case basis, using comparison data that is available near the junction. Details of the approach is provided in Appendix A.

3.3.15 ECC has provided PBA with 11 counts of which 7 were identified as being suitable for the analysis. Through the examination of traffic counts and junction turning flows it was identified that there was no clear pattern of traffic growth in the region.

3.3.16 The following sections summarise the methodologies used for each junction, split between geographical areas.

Brentwood Town Centre

3.3.17 Table 3-5 below summarises the junctions located within Brentwood Town Centre that are to be modelled. Where traffic data has been updated. a factor has been applied to the junctions based on analysis undertaken if a newer comparable junction or ATC flows were available to produce a relevant factor. The final two columns indicate what the factor is and the count used to derive this, where applicable. At locations where flows were identified to significantly differ between a comparable site or if no comparable site was available TEMPro growth has been applied. Further detail on derivation of data is provided in Appendix A.

Junction ID	Location	Source	Junction Type	Junction used for analysis	Factor Applied
3	A128 Ongar Road / Doddinghurst Road	Essex County Council	Mini Roundabout	Junction 6	AM and PM 2012 flows increased by 3%
5	A128 Ongar Road/William Hunter	Essex County Council	Priority Junction	-	AM and PM 2012 flows increased by 3%
7	A128 Ingrave Road / B186 Queens Road	Essex County Council	Mini Roundabout	Junction 6	AM 2012 flows increased by 3% PM 2012 flows increased by 10%
10	A1023 High Street/ B185 Kings Street	Essex County Council	Priority Junction	-	TEMPro growth for both peaks applied at 7% (2012 to 2017).
12	Western Road/William Hunter Way	Essex County Council	Priority Junction	-	TEMPro growth for both peaks applied at 7% (2012 to 2017).
15	A128 Ingrave Road / The Avenue	Essex County Council	Double Mini Roundabout (linked with J16)	-	AM 2012 flows decreased by 11 and PM growth of 3%
16	A128 Brentwood Road /Running Waters	Essex County Council	Double Mini Roundabout (linked with J16)	-	AM 2012 flows decreased by -11 and PM growth of 3%

Table 3-5: Brentwood Town Centre Junctions Assessments – Derivation of 2017 Base Year data

3.3.18 Through the analysis undertaken at junction 6 where a more recent turning count from 2017 was available it was concluded that there was an average increase in flow of approximately 3% for both peak periods for arm A (junction 3 and 5), 3% for the AM peak and 10% for the PM peak for arm C (junction 7).

3.3.19 Additional analysis at junction 8, where 2017 turning count information was also made available identified that traffic flows decreased by 11% in the AM peak when compared with 2012 turning movements, the PM peak showed a slight increase of 3%. As such junctions 15 and 16 will have these factors applied.

Brentwood Outer Area

3.3.20 Tables 3-6 to3- 8 summarise the junctions outside of Brentwood Town Centre that will have junction assessments undertaken.

3.3.21 Table 3-6 shows the group of junctions to the east of Brentwood, through analysis of the comparison of 2012, 2014 and 2017 junction turning counts taken at junction 6 it was identified that during the AM peak Arm A, A1023, Shenfield Road witnessed an increase of approximately 2%, whilst the PM peak flows remained flat. As a result, the junctions to the east, (junctions 1 and 2) will have their respective AM peak flow factored by 2%, whilst the PM peak will have no growth applied. For junctions 22 and 24 where no direct comparable data was available both have been factored from 2014 to 2017 using TEMPro growth for their respective peak periods.

Junction ID	Location	Source	Junction Type	Junction used for analysis	Factored
1	A1023 Chelmsford Road / A129 Hutton Road / A1023 Shenfield Road	Essex County Council	Signalised Junction	Junction 6	AM 2012 flows by 2% PM 0% growth.
2	A129 Rayleigh Road / Hanging Hill Lane	Essex County Council	Mini Roundabout	Junction 6	AM 2012 flows by 2% PM 0% growth.
22	A1023 Chelmsford Road / Alexander Lane	Essex County Council	Priority Junction	Junction 6	AM and PM flows by 2014 TEMPro growth of 4% (2014 to 2017)
23	A12/B1002/Roman Road	Mountnessing Scrapyard Transport Assessment,	Grade Separated Junction	-	AM and PM flows by 2014 TEMPro growth of 4% (2014 to 2017)

Table 3-6: East of Brentwood Town Centre Junction Assessments – Derivation of 2017 Base Year data

3.3.22 Table 3-7 below shows details for both junctions 17 and 18 but with the lack of any comparison data it was concluded that these assessments will continue to use the 2012 turning flows, growthed up by TEMPro to 2017.

Junction ID	Location	Source	Junction Type	Factored
17	A1023 Brook Street /Mascalls Lane	Essex County Council	Signalised Junction	TEMPro Growth for Both Peaks of 7% (2012 to 2017)
18	B186 Warley Hill / Eagle Way / B186 Warley Road / Mascalls Lane	Essex County Council	Signalised Junction	TEMPro Growth of For Both Peaks 7% (2012 to 2017)

Table 3-7: West of Brentwood Town Centre Junctions Assessments – Derivation of 2017 Base Year data

3.3.23 Table 3-8 shows the junctions focussed on the A127 corridor. Where available Highways England ATC counts were compared to enable a comparison between 2012 and 2016 ATC flow data on the A127 and between the relevant arm at junction 14. The analysis showed a decrease in flows for both directions along the A127 as such the data at junction 14 has been factored down accordingly, both junctions 19 and 20 had no direct comparable data available and as such have used TEMPro growth from 2014 to 2017 to factor the original flows. The fall in trips is consistent with recent evidence from DfT studies, which indicate that trip rates i.e. the number of trips made per person is actually declining for commute trips for example.

Junction ID	Location	Source	Junction Type	Junction used for analysis	Factored
14	A127 / Childerditch Lane	Essex County Council	Priority Junction	Junction 14 and A127 ATC	AM 2012 flows by -5 and PM of -2%
19	B186 Warley Street / A127 eastbound	Essex County Council	Priority Junction	Junction 14 and A127 ATC	TEMPro Growth for Both Peaks of 4% (2014 to 2017)
20	B186 Warley Street / A127 westbound	Essex County Council	Priority Junction	Junction 14 and A127 ATC	TEMPro Growth of 4% (2014 to 2017)

Table 3-8: South Brentwood Town Centre Junction Assessments – Derivation of 2017 Base Year data

M25 Junction Data

3.3.24 As the M25 junctions 28 and 29 were not included within the previous study, new data was sought for these two junctions.

3.3.25 No data was identified for junction 29, therefore new traffic count data was collected, to a specification agreed with Highways England, over three days from Tuesday 19th to Thursday 21st June 2018.

3.3.26 Data for Junction 28 was provided by Highways England and this data was collected on 15th and 16th November 2016. This data was not adjusted following checks with 2017 data adjacent to the junction, from the Highways England database, which indicated there had been no growth.

4 Spreadsheet Modelling

4.1 Overview of Approach

4.1.1 A bespoke modelling approach has developed that utilises excel spreadsheets to inform three steps of the traditional four-step modelling approach. The spreadsheet tools have been developed to include trip generation, trip distribution and mode choice which are three of the four steps.

4.1.2 To inform the fourth step for highway trips, trip assignment, an 'all-or-nothing approach' utilising speed data from Teletrac Navman (previously Traffic Master), overlaid onto an OS network and utilising OmniTRANS software to provide a graphical interface. Link speeds were calculated for each link in the network using the mean travel time across all records of cars/light vehicles having travelled on the link, for each modelled time-period, by direction. This data was extracted from the Traffic Master data (as provided) and processed to gain mean link speeds using MS Access. The analysis used the appropriate records for the time-period under consideration. An assessment was made as to whether the link speeds were reasonable by assessing the resulting routes and times for a range of OD pairs in the Brentwood area in the constructed OmniTRANS project.

4.1.3 The method proposed for this work uses a hybrid spreadsheet modelling approach with the use of OmniTRANS to provide some inputs into the spreadsheet along with allowing for graphical outputs to be produced at the end of the modelling process. The outputs from the spreadsheet modelling will then be used to provide turning flows that feed into individual junction assessment models.

4.1.1 Whilst not being a true strategic modelling tool which allows for the reassignment impacts to inform route choice, in the absence of such a modelling tool, this method is felt to be a robust (albeit worst-case) appraisal and proportionate both in terms of outputs and cost, for local plan testing. As part of the latter stages of the work, consideration is given to potential of peak spreading, particularly where congestion is prevalent in the base year, for example in central Brentwood.

4.2 Advantages of the Proposed Methodology

4.2.1 The advantages of the application of the bespoke modelling approach are set out below:

a. The spreadsheet-OmniTRANS hybrid model allows trip rates derived from National Travel Survey (NTS) data to be used so that trip generation by purpose can be generated, thus allowing the trips for each purpose to be distributed separately using trip attractors and distance weights that are appropriate for each trip purpose. This is an advantage over merely using Census journey-to-work trip distribution data, which is only valid for work-related trips, to distribute trips for all purposes.

b. The gravity-modelling approach used in a hybrid model is sensitive to the amount and proximity of attractors (e.g. workplaces), including attractors that are components of development sites (e.g. employment sites), which any pre-defined existing distribution (such as Census journey-to-work) cannot consider.

c. Similarly, by first conducting the distribution stage on person trips (all modes) then conducting the mode share stage, the hybrid model ensures that an appropriate proportion of pedestrians and cyclists will make short-distance trips, including trips to/from development attractors. This would not be the case if a pre-defined distribution of vehicle trips is used.

d. Use of the OmniTRANS network for the assignment of development trips, by-passes the need for a time-consuming manual assignment of development trips through junctions with large trip matrices as the starting point. The use of OmniTRANS also allows turning flows to be extracted efficiently and for graphical outputs from assignment to be produced.

4.2.2 The assignment within the OmniTRANS tool distributes traffic, between all origin and destination points, solely based on the quickest route. The link speeds are supplied from TrafficMaster, to provide average speeds on all links for the desired time-period. The modelling does not take account of congestion within the network, beyond that implicit within the TrafficMaster data, therefore not accounting for future traffic congestion. Effectively a single iteration of an 'all or nothing' assignment is undertaken.

4.2.3 To show the model is representative, a comparison between average speed data within GIS and the OmniTRANS model has been undertaken on a number of routes a summary can be found below in Table 4-1. Route plots, identifying the routes used for this can be found within Appendix B.

Route	OmniTRANS Journey Time (AM)	Journey Time Planner (AM) 08:30	Journey Time (PM)	Journey Time Planner (PM) 5:30
A1023 Westbound	11 mins	7-12 mins	8 mins	7-14 mins
A1023 Eastbound	8 mins	7-14 mins	7 mins	7-12 mins
Ongar Rd/Ingrave Rd Northbound	10 mins	8-16 mins	10 mins	8-10 mins
Ongar Rd/Ingrave Rd Southbound	10 mins	8-14 mins	10 mins	8-12 mins
B186/A1023 Northbound	10 mins	9-14 mins	9 mins	9-12 mins
B186/A1023 Southbound	10 mins	8-14 mins	10 mins	9-12 mins
Hutton Football Club/A1023 Westbound	14 mins	12-20 mins	12 mins	12-16 mins
Hutton Football Club/A1023 Eastbound	14 mins	12-18 mins	12 mins	12-18 mins

Table 4-1: Journey Time Route Comparison

4.2.4 Overall this shows that the model is representing, in the most part, a similar journey time to that shown within the journey time planner demonstrating that the model is fit for purpose.

4.2.5 The network used for the purposes of the assessment is the Ordnance Survey Integrated Transport Network (ITN), which is imported into the OmniTRANS suite to allow the assignment process to be undertaken and for geographically based graphics to be produced for trip distribution. The routing patterns associated with the developments included were checked to determine that they were sensible.

4.2.6 OmniTRANS then also allows for turning flows, from each development scenario, to be extracted for each of the junctions to be modelled.

4.2.7 Within the spreadsheet approach, sets of spreadsheets for the trip generation, distribution and mode share of person trips were created.

4.2.8 The method has six stages, as follows:

- Determining the zoning system
- Trip generation by zone for all trips within the study area at person trip level
- Trip distribution at person trip level
- Mode Choice – broken down into Walk/cycle, PT and car trips
- Assignment of road based trips
- Junction modelling

4.2.9 The choice of options modelled within the spreadsheets and available to the user are:

- 2017 Base Year
- 2034 Reference Case Scenario
- 2034 Local Plan Growth Scenario

4.2.10 The choice of time periods modelled and available to the user were:

- AM Peak (0800-0900)
- PM Peak (1700-1800)
- 24 hours

4.3 Model Zoning System and Road Network

Zoning

4.3.1 The study requires the identification of the number of trips generated by development along the major road network links within the study area. This involves first identifying the origin of the trip, then identifying the destination and then deciding which route (road links) the trip is likely to take to travel between the origin and destination.

4.3.2 For the purposes of this strategic-level study, trip origins and destinations have been grouped into zones. This enables the magnitude of the flow of trips between zones to be calculated, with flows then being distributed onto the road network. This approach of identifying broad zones of origins/destinations and the flow of trips between them rather than identifying the flow of trips between individual origins and destinations is considered suitable for this study.

4.3.3 The zoning system that formed the geographical basis for the modelling work was constructed in a GIS and constituted proposed development zones and Census-based zones for the existing population. The Census-based zones were at single and multiple Output Area level within Brentwood BC, at Census ward level for neighbouring local authorities, and at local authority level to cover the wider area of London, Essex, Hertfordshire, and Kent. This is shown in Figure 4-1.

4.3.4 Additional zones were created to represent the proposed Local Plan development sites. By creating separate zones for each of the sites allows for additional analysis. The additional zones are shown in Figure 4-2 represented as points. Further information on Trip Generation in relation to the Local Plan development sites can be found in section 4.2.

Figure 4-1: Census-based Zones

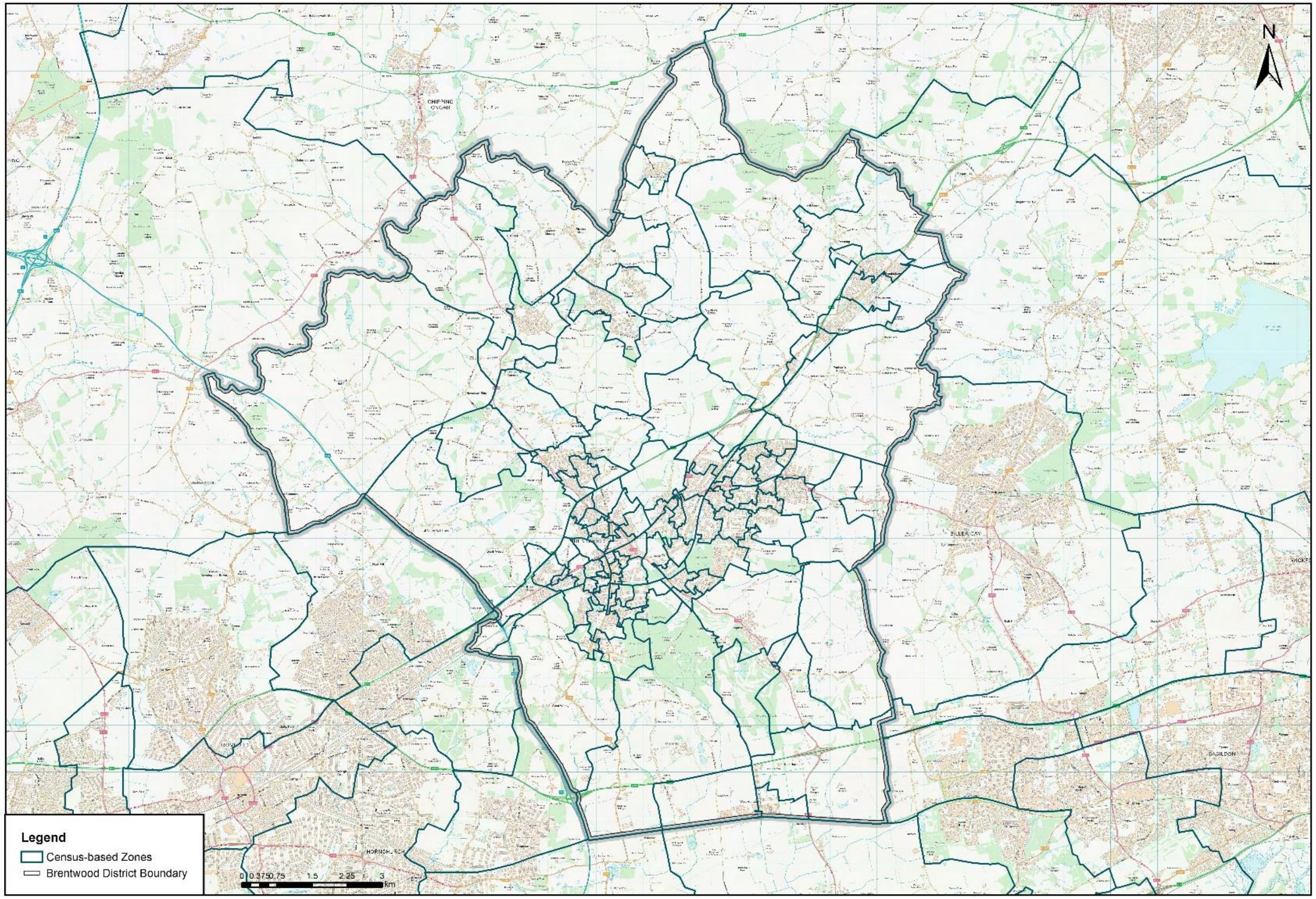

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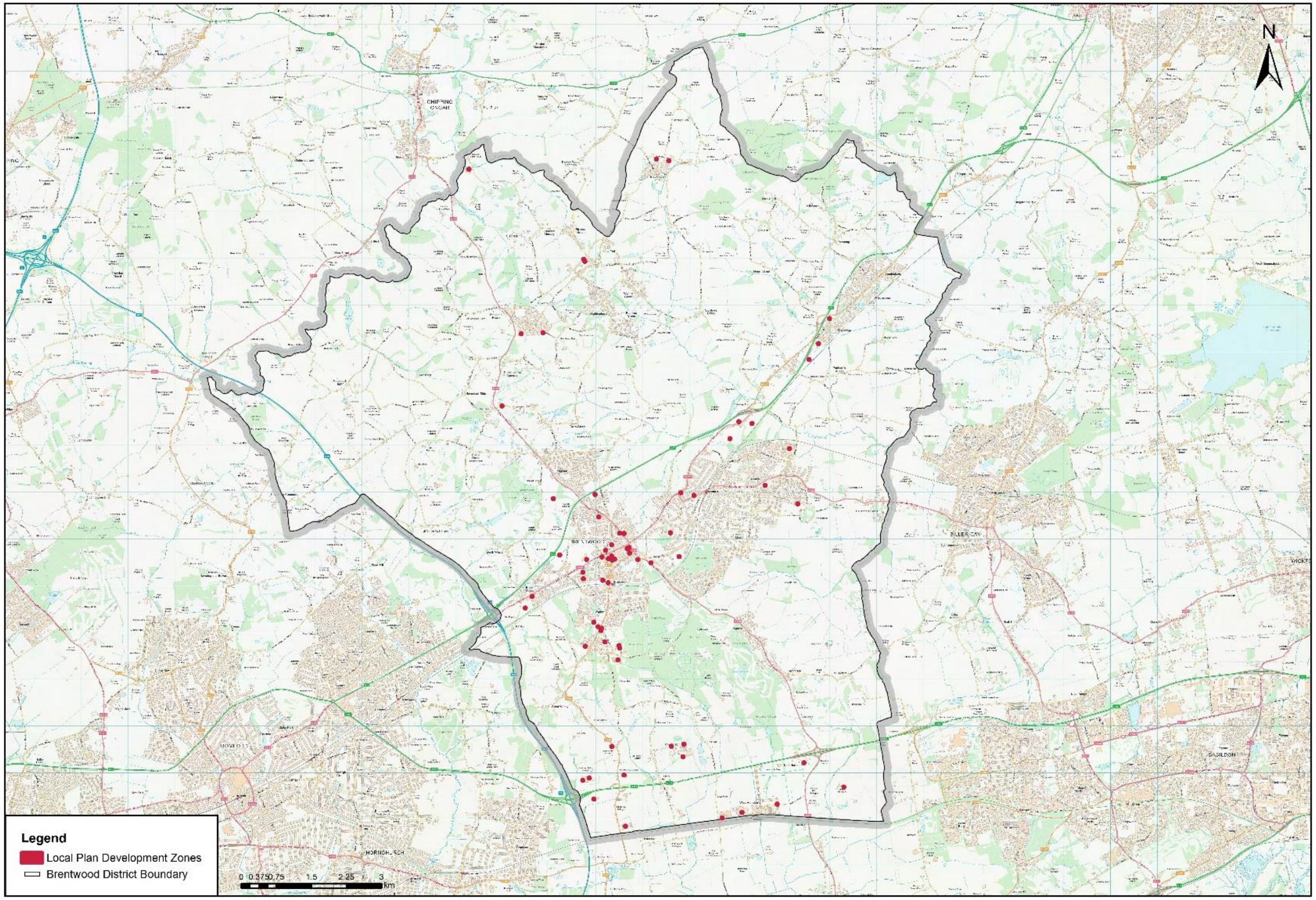
Figure 4-2: LP Development Zones



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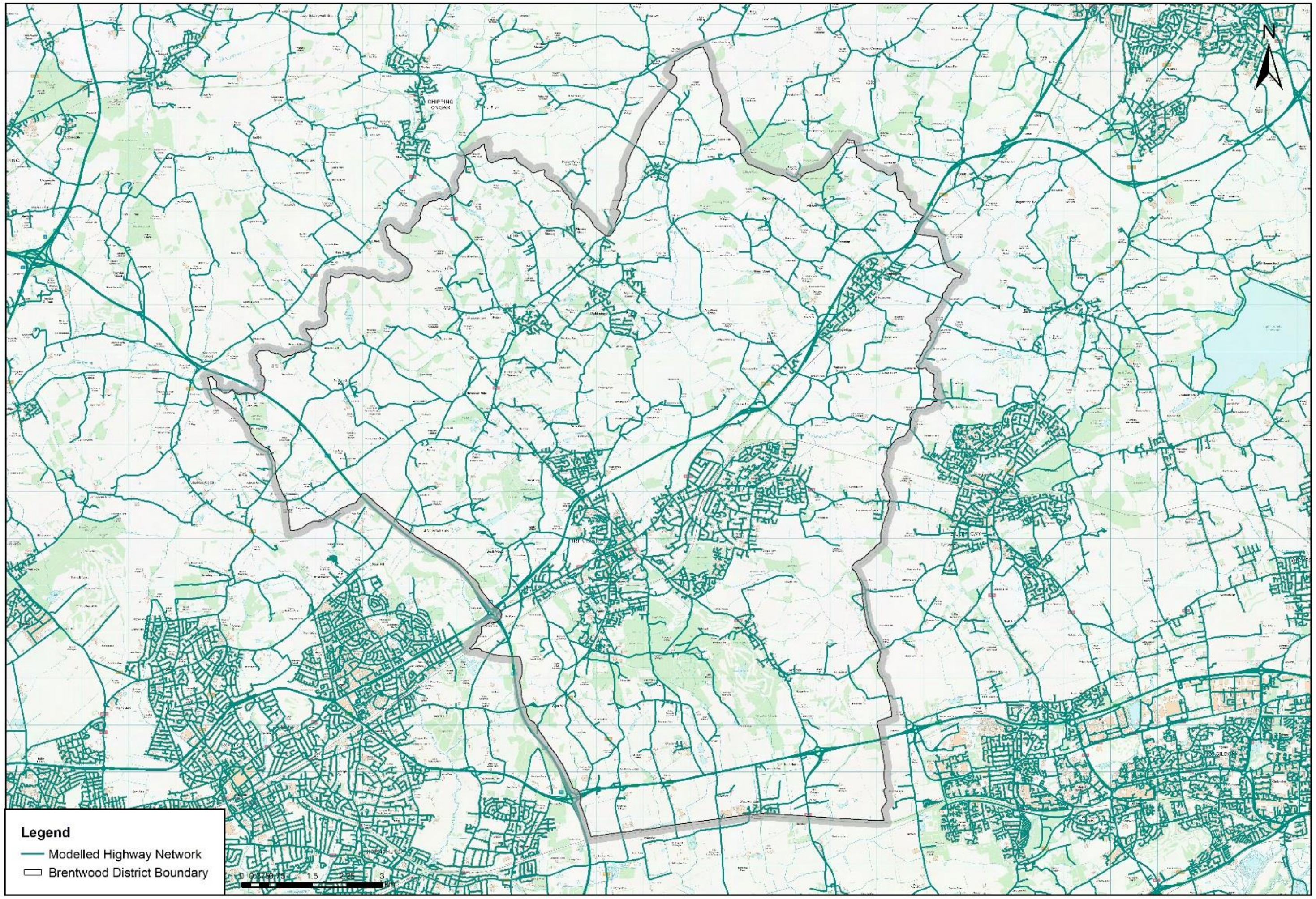
Road Network

4.3.5 Within GIS, the road network was extracted from the ITN digital road network for all of Essex, with mean link speeds derived from TrafficMaster GPS data. Zone connectors were generated between each zone centroid(s) and its nearest node on the road network, then the road network and zoning system were imported into the OmniTRANS specialist transport modelling software. This was used to generate travel-time and distance matrices for use in the trip distribution and mode share elements of the spreadsheet-based trip modelling, and, after trip matrices had been calculated, assigning the trip matrices to the network to determine link flows and turning flows at junctions.

4.3.6 Except for the Dunton Hills development all development zones have one zone connector accessing to the highway network the locations were deemed apocopate for the quantum of development. For Dunton Hills two connectors have been used to represent two access points. One to the west, directly onto the A127 and one to the east onto West Mayne.

4.3.7 Figure 4-3 illustrates the modelled highway network within the boundary of Brentwood District.

Figure 4-3: Modelled Highway Network



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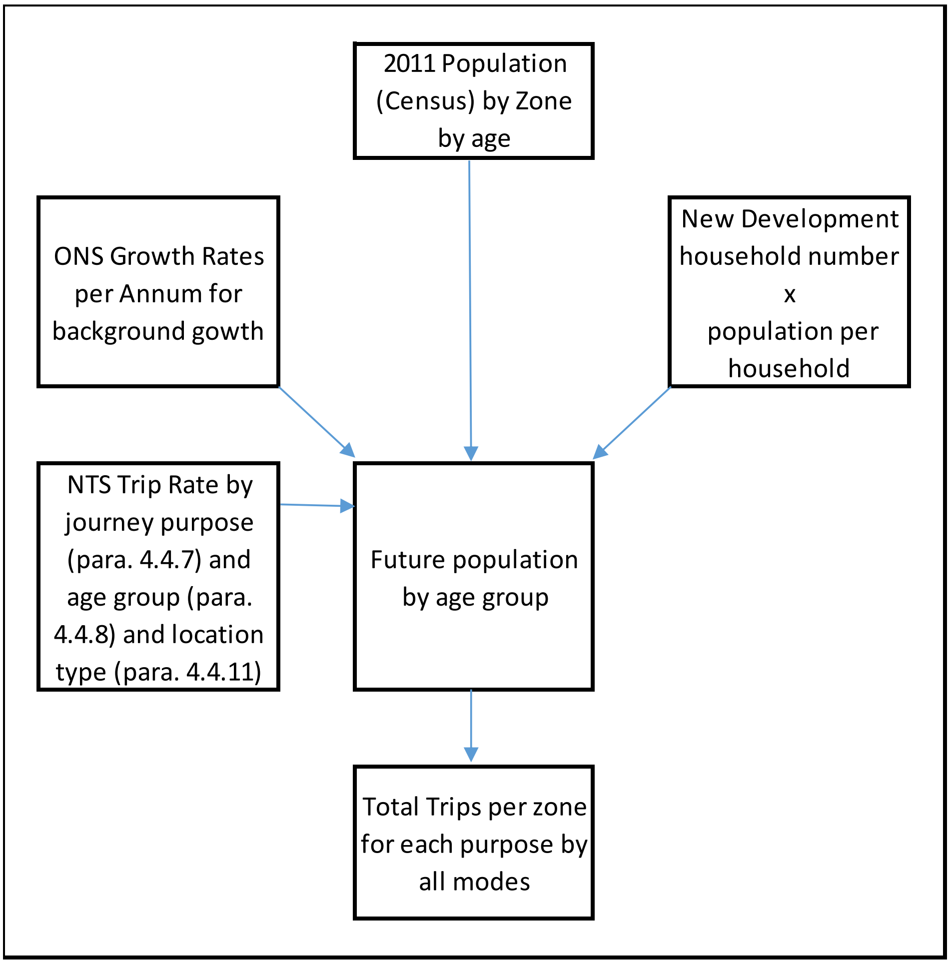
4.3.8 The 2017 base for the testing of the options included existing residential and workplace data from Census 2011 which was growthed to 2017 using Office for National Statistics (ONS) population projections. The projections were applied at a Local Authority level and were adjusted for fuel and income growth to account for fuel cost changes and growth in income.

4.4 Trip Generation

4.4.1 The trip generation approach described here is undertaken in a consistent manner between base year trips and forecast trips and is undertaken at a person trip level using population data as the basis of the assessment.

4.4.2 The origin of trips is assumed to be residential dwellings. The number of trips generated by each zone will therefore be calculated by first determining how many people live in each zone and then considering how many trips each person is likely to make. The process is summarised in the flow chart and further detail provided below.



Identifying Residential Population Figures

4.4.3 Since the zones are set by the Census boundaries, the residential population figures in the Census 2011 have been used to determine the existing population of each zone.

4.4.4 In the case of the zones created to represent the future major development sites, for which population figures are not available, the residential population will be calculated by applying the mean number of residents per household for Brentwood (from Census 2011) to the number of proposed residential units for each site.

4.4.5 The growth in resident population to the required base and forecast years has been calculated using the Office for National Statistics (ONS) residential population projections (available for all years by local authority area), allowing for the increases in population from developments so as not to double-count the growth.

Person Trip Rate Assumptions

Residential trips

4.4.6 The trip generation starting point is total person trips. Person trip rates from the National Travel Survey (NTS) are applied to the residential population figures. Person trip rates appropriate to the area (level of urbanisation) have been extracted from the NTS.

4.4.7 Generated trips will be categorised by broad trip purpose as follows:

i. Trips to/from work

ii. Trips to/from education establishments made by the student

iii. Trips to/from education establishments made by people escorting students

iv. Trips to/from food retail outlets,

v. Trips to/from non-food retail outlets,

vi. Trips made for 'other' purposes, i.e. leisure, visiting friends, religious worship.

4.4.8 For each trip category, the number of trips generated by each of the following three age groups will be identified using Census age-group splits.

vii. 0 to 16 years,

viii. 17 to 64 years,

ix. 65 years+

4.4.9 A 'Zone Data' sheet collated the number of proposed housing units and their estimated number of residents (by age band) for each residential development zone, and the estimated forecast number of employees for each employment development zone. Similarly, the number of residents (by age band) and workplaces was collated for each Census-based zone, using Census 2011 data.

4.4.10 Within sheet 'Trip Generation' the number of home-based trips generated by each zone was calculated for the selected option and time-period. This used the zone data for the required user-option in conjunction with trip rates from the National Travel Survey (NTS). All NTS data used in this project was extracted using population selection criteria appropriate for the size and location of Brentwood. This provided all-mode trip numbers generated for each broad purpose by the resident population of each zone (as home-to-purpose, purpose-to-home and non-home-based). The home-based trip purposes modelled were work, education, escort-education, shop food, shop non-food and 'other'. Similarly, the non-home-based trip purposes modelled were work and other (non-home).

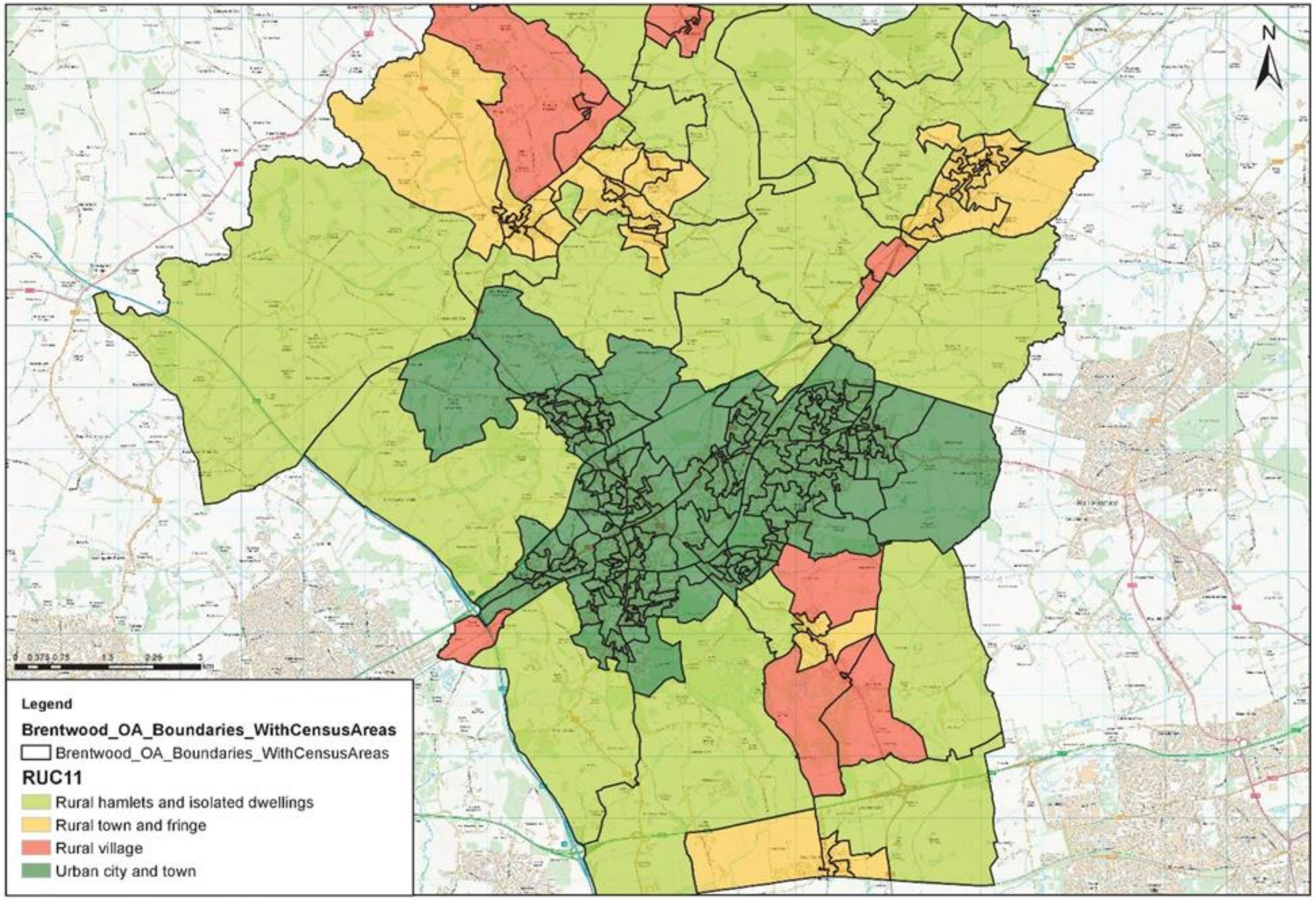
4.4.11 To account for different accessibility levels, depending upon the geographical of the proposed developments NTS data has been extracted for the following area classifications:

- Major Conurbation

- Urban City or Town
- Rural Town or Fringe
- Rural Village
- Rural Hamlet or Isolated Dwelling

4.4.12 Figure 4-4 shows the categories that were assigned to each of the census Output Areas (OA) based on the 2011 census.

Figure 4-4: 2011 Census OA area classifications



4.4.13 The accessibility trip rates are detailed further in technical note 'Use of NTS to inform Trip Rates by Accessibility Level' which is included as Appendix C. This note sets out the derived NTS trip rates by accessibility level.

4.4.14 At the trip distribution stage (described below), the employment elements of the tested sites attracted trips from existing (non-development) residential areas as well as the tested development sites. Therefore, it was necessary to calculate trips generated by all zones in the zoning system, and to include these in the 'Base' and 'Reference Case' options. Vehicular trip results from the 'Base' option was subtracted from the 'Reference Case' results and, similarly, results from the 'Reference Case' option were subtracted from results from each of the tested options to gain the net increase due to the baseline above 'existing' and the net increase due to each of the tested options above the baseline.

4.4.15 The initial model setup uses a trip rate based on trips per person for commuting which is based on NTS data from 2016, but then calibrated to 2011 (base year for population data used).

4.4.16 To reflect a reduction in commute trips per person over time, NTS data has been reviewed to understand how trip frequency over time has declined for commute trips. Between 2011 and 2016 the number of car commute tips made per person per year has fallen from 85 trips to 80 trips. An equivalent reduction for trips per person per day shows that the current rate used in the model of 0.1289 trips per person in the AM peak would drop to 0.1213 trips. This reduction has been applied within the model.

NTS and TRICS Trip Rate Comparison

4.4.17 As discussed above, trip rates for residential based trips are derived from NTS, similarly employment trips are derived within the distribution process.

4.4.18 A comparison of both residential and outcome employment trip rates has been compared with TRICS and this comparison is presented in Appendix D.

Local Plan Sites – Trip Generation

4.4.19 The Local Plan development site trip generation is summarised below within Table 4-2. It should be noted that where there are negatives in the table, this indicates that the development site has an existing use with flows associated with it and the new development, will result in a reduction in trips.

Zone	Development	AM		PM	
		Inbound	Outbound	Inbound	Outbound
1	041 Land at Hunter House, Western Road	3	16	12	4
2	311 Eagle and Child Pub, Shenfield	1	6	5	2
3	040 Chatham Way / Crown Street Car Park	1	9	8	2
4	039 Westbury Road Car Park	2	13	11	3
5	186 Land at Crescent Drive, Shenfield	3	19	15	5
6	003 Wates Way Industrial Estate	-5	22	19	-2

Zone	Development	AM		PM	
		Inbound	Outbound	Inbound	Outbound
7	081 Council Depot, Warley	8	46	37	11
8	117A & 117B Ford Headquarters, Warley	-9	131	103	1
9	002 Brentwood railway station car park	6	32	26	8
10	102 William Hunter Way	15	89	73	20
11	044 & 178 Land at Priests Lane	6	34	26	8
12	020 West Horndon Industrial Estate	12	65	60	18
13	021 & 152 West Horndon Industrial Estate	-76	96	90	-66
14	010 Sow and Grow, Ongar Road, Pilgrims Hatch	2	13	10	3
15	027 Land adj. to Carmel, Mascalls Ln	1	3	3	1
16	083 Land West of Warley Hill	2	13	12	4
17	032 Land East of Nags Head Lane, Brentwood	9	53	40	12
18	022 Land at Honeypot Lane	14	79	62	18
19	023 Land off Doddinghurst Road	13	72	62	17
20	263 Land East of Chelmsford Rd, Shenfield	11	66	53	16
21	034, 087, 235, 276 Officer's Meadow	28	161	126	38
22	158 Land North of A1023 Chelmsford Road, Shenfield	68	46	37	59
23	128 Ingatestone Garden Centre	6	38	31	9
24	079A Land adjacent to Ingatestone By-pass	80	37	32	66
25	106 Former A12 Work Site	2	13	11	3
26	076 Land South of Redrose Lane	2	12	10	3
27	077 Land South of Redrose Lane	2	17	15	4
28	075 Land off Stocks Lane, Kelvedon Hatch	2	11	10	3

Zone	Development	AM		PM	
		Inbound	Outbound	Inbound	Outbound
29	194 Brizes Corner Field, Blackmore Road, Kelvedon Hatch	1	9	7	2
30	294 Chestnut Field, Blackmore Road	1	3	3	1
31	085B Land adj. Tipps Cross Community Hall, Blackmore Rd	1	3	3	1
32	200 Dunton Hills Garden Village (plan period)	259	711	645	319
33	101A Brentwood Enterprise Park (M25 Junction 29 works site)	908	112	169	951
34	112D and 112E (a) Childerditch Industrial Estate (extension 3 - southern growth to tree line)	23	5	4	19
35	101C Brentwood Enterprise Park (Codham Hall Extension)	22	3	4	23
36	109 and 187 Land at East Horndon	153	21	31	160
37	101B Brentwood Enterprise Park (Codham Hall)	211	26	40	222
38	108 The Old Pump Works, Great Warley Street	9	1	2	9
39	111 Upminster Trading Estate	70	8	13	68
40	228 PERI site, Warley Street, Great Warley	141	16	27	136
41	112E (b) Childerditch Industrial Estate (extension 2 - farm area)	24	3	4	23
42	321 McColls, Ongar Road	48	6	9	49
43	112A, 112B & 112C Childerditch Industrial Estate	74	9	14	72
44	113A & 113B Hallsford Bridge Industrial Estate	24	3	4	24
45	114 Hubert Road Industrial Estate	36	5	7	36
46	45 Hutton Industrial Estate	92	21	18	72
47	115 Brook Street Employment Area	40	5	8	41

Zone	Development	AM		PM	
		Inbound	Outbound	Inbound	Outbound
48	118 BT Offices, London Road	119	16	23	121
49	119 Canon Offices. Chatham Way, Brentwood	16	2	3	15
50	121 Mellon House, Berkley House and 1-28 Moores Place, Brentwood	12	2	2	11
51	116 Warley Business Park (ex. Regus)	70	9	14	68
52	081 Council Depot	-47	-6	-9	-46
53	110 Town Hall, Brentwood	-18	-2	-4	-16
54	114A Regent House	-33	-4	-6	-34
55	121 Mellon House	-6	-1	-1	-6
56	013B Warley Training Centre	-52	-7	-10	-52
57	120 47-57 Crown Street	-4	0	-1	-4
58	125 North House	-6	-1	-1	-5
59	116 Warley Business Park	-22	-3	-4	-22

Table 4-2: Local Plan Development Peak Hour Trip Generation

4.5 Trip Distribution

4.5.1 The home-based generated trips were distributed separately for each trip purpose using appropriate trip attractors and the distance matrix from the OmniTRANS model.

4.5.2 The normalised matrix of weights was applied to the generated work trips to distribute them across all zones. For trip purposes, other than work trips the Census data could not be used for the distance weightings, so a gravity modelling approach was used instead.

4.5.3 For the education trips, matrices of weights were calculated separately for each level; assuming education trips by the age 0-16 band was split 50-50 between primary school trips and secondary school trips, and Age 17-64 trips were to/from tertiary education.

4.5.4 The location of local stores was a component of the weights of both the shop-food trips and the shop-non-food trips. In addition, the shop-food trips used supermarket locations and the shop-non-food trips used various non-food retail locations, namely town centres, local retail parks, and larger shopping centres (Lakeside, Bluewater, Westfield).

4.5.5 For work trips a matrix of weights was calculated using distance weights (which reduce as the distance increases) derived from Census journey-to-work data for Brentwood, in conjunction with the number of workplaces in each zone.

4.5.6 Non-home based trips were generated and distributed using a similar method to that of the home-based trips. However, a ‘double-distribution’ approach was necessary, where trips were distributed firstly to find the trip origins (using the origin-purpose’s weights), then distributed again to find the trip destinations (using the destination-purpose’s weights). The non-home-based modelled trip purposes were simply ‘work’ and ‘other’ (hence matrices were calculated for work-to-work, work-to-other, other-to-work and other-to-other).

4.6 Mode Share

4.6.1 The trip distribution stage (above) resulted in trip matrices for each purpose (home-based and non-home-based) for the selected option and time-period, for all transport modes combined. The next stage involved deriving the car-driver matrices from the all-mode matrices.

4.6.2 Walking and cycling trips were separated from the all-mode trip matrices to form non-walk-cycle matrices. The walk and cycle shares of trips for each distance band and trip purpose were derived from NTS data and used in this exercise. The NTS data provides a trip rate for cycle and walking trips by trip purpose and distance bands e.g. the number of people walking for home based education will be split into distances, with a higher trip rate for short distance trips, falling as distance increases.

4.6.3 Table 4-3 shows the percentage of work and employers business trips that walk / cycle in the various distance bands.

Dist. Band (km)			HB Work and EB		
No.	Lower	Upper	Walk	Cycle	Other
1	0	0.5	74.8%	5.7%	19.5%
2	0.5	1	47.0%	7.9%	45.1%
3	1	2	27.5%	6.7%	65.8%
4	2	3	14.0%	8.4%	77.6%
5	3	4	3.2%	6.3%	90.5%
6	4	5	1.3%	2.1%	96.6%
7	5	7	0.4%	3.8%	95.7%
8	7	10	0.0%	1.6%	98.3%
9	10	15	0.0%	0.6%	99.4%
10	15	20	0.0%	0.4%	99.6%
11	20	30	0.0%	0.0%	100.0%
12	30	50	0.0%	0.0%	100.0%
13	50	80	0.0%	0.0%	100.0%

Dist. Band (km)			HB Work and EB		
No.	Lower	Upper	Walk	Cycle	Other
14	80	-	0.0%	0.0%	100.0%

Table 4-3: Walk and Cycle NTS distance bands and percentages for work and EB

4.6.4 For work-related trips, the car-driver trips were separated from the non-walk-cycle trips using the corresponding Census 2011 journey-to-work mode share for that origin-destination combination. For this modelling exercise, the development zones inherited the car-driver shares of the Census zones that they were located within. PT trips can be derived in the same way using the PT modes shares.

4.6.5 For the other trip purposes (not work related), the car-driver trips and PT trips were separated from the non-walk-cycle trips using the appropriate NTS mode shares for each time-period and trip purpose (including non-home-based purposes).

Resultant Car Driver Trip Matrices

4.6.6 Following the mode share stage of the spreadsheet-based exercise, resultant vehicle (car-driver) trip matrices were formed by aggregating the car-driver matrices across all trip purposes, for each required time-period and modelling option. The vehicle matrices were assigned to the road network in OmniTRANS. It should be noted that the OmniTRANS model uses a simple, time-based assignment and does not include any algorithms to represent the effects of increased congestion on traffic routing or mode share. The methodology will therefore provide a worst case (robust) assessment of impacts on individual junctions. In this instance the worst case means that the model will not take account of any impact of congestion in the future and how it would affect comparative journey times, therefore still assigning trips based on current levels of congestion. This is dealt with further in Section 6.5.

4.6.7 A spreadsheet was compiled presenting the net increases in vehicular flow resulting from the tested options, for each turning movement of each junction that required junction modelling, for the AM and PM peaks. For simple junctions, this information could be acquired by viewing the node data in OmniTRANS following the assignment stage, and for more complex junctions, cordon matrices were generated after defining a cordon around the junctions in OmniTRANS. This turning flow data for each junction was used as input data for the modelling of the individual junctions.

5 Junction Modelling

5.1 Overview

5.1.1 As stated previously, the outputs from the spreadsheet approach are used within junction models to provide an understanding of the performance of each junction being considered with the Local Plan development.

5.1.2 In total 23 junctions were modelled and assessed using the relevant software packages. The junctions modelled are shown in Figure 5-1 and details of each junction provided in Table 3-10.

5.1.3 It should be noted that, whilst the junction modelling will show how individual junctions within Brentwood perform based on a capacity assessment and demand flows, there are some locations where it is known that other interactions impact on traffic flows on links.

5.1.4 With the junction modelling tools used for this assessment, that of LinSig, ARCADY, PICADY and TRANSYT the modelling of interaction between parked vehicles, buses and delivery vehicles is not possible, additionally in some cases there are also interactions between other junctions as a result of capacity issues at other types of junctions. Where these factors are identified, it is expected that these issues will be more fully addressed at the detailed application stage.

5.1.5 For all junctions, the following peak periods have been used for the assessment and the same periods will be maintained in the study update. A review of traffic flows was undertaken to determine the peak hour flow, and whilst this varied across junctions, it was generally found that the following peak hours were appropriate for modelling. These have been agreed with the highway authority.

- AM Peak: 08:00 to 09:00
- PM Peak: 17:00 to 18:00

No.	Junction	Junction Type	Modelling Software
1	A1023 Chelmsford Rd / A129 Hutton Rd / A1023 Shenfield Rd	Signalised Junction	LINSIG
2	A129 Rayleigh Road / Hanging Hill Lane	Mini Roundabout	JUNCTIONS 9
3	A128 Ongar Road / Doddinghurst Road	Mini Roundabout	JUNCTIONS 9
5	A128 Ongar Road / William Hunter Way	Mini Roundabout	JUNCTIONS 9
6	A128 Ongar Road / A1023 Shenfield Road / A128 Ingrave Road / A1023 High Street	Double Mini Roundabout	JUNCTIONS 9
7	A128 Ingrave Road / B186 Queens Road	Mini Roundabout	JUNCTIONS 9
8	A128 Ingrave Road / Middleton Hall Lane / Seven Arches Road	Signalised Junction	LINSIG

No.	Junction	Junction Type	Modelling Software
10	A1023 High Street / B185 Kings Road / A1023 London Road / Weald Road	Signalised Junction	LINSIG
12	Western Road / William Hunter Way	Mini Roundabout	JUNCTIONS 9
13	A127 / A128 Brentwood Road / A128 Tilbury Road	Grade Separated Roundabout	JUNCTIONS 9
14	A127 / Childerditch Lane	Priority Junction	JUNCTIONS 9
15	A128 Ingrave Road / The Avenue	Double Mini Roundabout (linked with J16)	JUNCTIONS 9
16	A128 Brentwood Road /Running Waters	Double Mini Roundabout (linked with J15)	JUNCTIONS 9
17	A1023 Brook Street /Mascalls Lane	Signalised Junction	LINSIG
18	B186 Warley Hill / Eagle Way / B186 Warley Rd / Mascalls Lane	Signalised Junction	LINSIG
19	B186 Warley Street / A127 eastbound	Priority Junction	JUNCTIONS 9
20	B186 Warley Street / A127 westbound	Priority Junction	JUNCTIONS 9
22	A1023 Chelmsford Road / Alexander Lane	Priority Junction	JUNCTIONS 9
23	A12 Junction 12	Grade Separated Roundabout	JUNCTIONS 9
24	Roman Road / A12 Slip	Priority Junction (Staggered)	JUNCTIONS 9
25	M25 Junction 28	Grade Separated Roundabout	LINSIG
26	M25 Junction 29	Grade Separated Roundabout	TRANSYT
27	A128 Tilbury Road/Station Road	Priority	JUNCTIONS 9

Table 5-1: Junctions Modelled and Modelling Software Used

5.2 Assessment Matrix Input Type for Junction Models

5.2.1 Junctions 9 and LinSig require different matrix inputs to accurately model different types of junctions. As such modelling undertaken within Junctions 9 will use direct matrix input, inserting the matrices in four 15-minute profiles, except for junctions 23 and 27 where only hourly data was available. These methods are standard and will allow comparable results based on the data available.

5.2.2 Where junctions are required to use LinSig, such as junctions 1, 8, 10, 17 and 18 flat hourly profile matrices will be used, this is because LinSig does not allow for direct matrices to be used within the junction modelling software.

5.2.3 Table 5-2 shows what Demand Matrix Profile was used for each junction in the assessment.

Junction Number	Matrix Profile	Junction Number	Matrix Profile
1	Flat	15	Direct
2	Direct	16	Direct
5	Direct	17	Flat
3	Direct	18	Flat
6	Direct	19	Direct
7	Direct	20	Direct
8	Flat	22	Direct
10	Flat	23	Flat
12	Direct	24	Direct
13	Direct	27	Flat
14	Direct		

Table 5-2: Junction Input Matrix Profiles

Model Calibration and Validation

5.2.4 As stated within PBA technical note 28085-BLPTM-TN01, Junctions 1 to 22 have previously been calibrated and validated based upon count data collected in 2012. For these junctions, quality assurance checks were undertaken to review the calibration of the models against the available data with changes made to the models when required.

5.2.5 Teletrac Navman (previously Traffic Master) data for Brentwood has been used to identify which arms of the junctions show delay and used to assist in the calibration of the models with observed traffic conditions. The use of Teletrac Navman shows general delay at junctions but not necessarily the cause of, for example, delay resulting from road works, unloading of vehicles or traffic situations which aren't directly related to the operation of the junctions.

5.2.6 Previous 'General Observations' comments from Essex County Council (ECC) have been incorporated into this process where possible. It was raised previously that "*No account has been taken of uneven lane usage on approaches to junctions*". As part of the review of the previously created junction models, it was identified that following junctions should be created using Junctions 9 Lane Simulation Models to better anticipate the usage of lanes:

- Junction 6;
- Junction 7;
- Junction 13;
- Junction 15;
- Junction 16; and
- Junction 22.

5.2.7 Although Junctions 6, 13, 15 and 16 were identified as part of this review to require a Junctions 9 Lane Simulation Model, due to limitations within both PICADY and ARCADY, the results of the modelling did not reflect the on-site conditions and were discounted. For this reason, standard simulation models have been used for these junctions.

5.2.8 For Junction 23 and 24, new junction models were created based upon the information found within respective Transport Statement located on the ECC planning portal. A review of these inputs was undertaking to ensure they were fit for purpose.

5.2.9 An element of validation was undertaken on the signalised junctions by reviewing the signal data sheets provided by ECC as well of analysis of the available video data. For this reason, no further validation process has been undertaken for the signalised junctions within the modelling scope.

5.2.10 Two models were provided to PBA by Atkins us for Junction 28 and 29 of the M25. Junction 28 is a LinSig model, whilst Junction 29 was created within TRANSYT. Both required an update and check to ensure the models were still fit for purpose.

6 Initial Modelling Outputs

6.1 Overview

6.1.1 Through using OmniTRANS as a GIS type tool, it is possible to assign the matrices described in Section 4, to a highway network. Initial assignments have been undertaken for the Reference Case model to get an understanding of the flows on the network.

6.1.2 The reference case flows demonstrate the traffic growth that would be expected between 2017 and 2034, without the Local Plan developments.

6.1.3 As this is an unconstrained model, these outputs are seen as the worst-case. The unconstrained flows have been used in the initial junction modelling tests. This exercise gives an idea on how an unconstrained network and junctions would perform and to inform the level of background growth that would be expected to maintain a reasonable level of service.

6.1.4 It would be expected that within a congested network, travellers would only accept a certain level of 'pain' from a congested network and would ultimately look to change behaviour, if a threshold is reached. Within this section, this is considered in the absence of a variable demand modelling approach which can reflect these behaviours.

6.2 Link Flow Checks

6.2.1 Tables 6-1 and 6-3 show the changes in flows on some key links within Brentwood for the AM and PM peaks respectively. This shows the base flows derived from observed counts and the reference case flows produced from the spreadsheet model. These flows shown are the unconstrained growth and do not take account of link capacities, which would influence the actual flow within the peak hours.

Road	Westbound			Eastbound		
	Base	Ref.	% Change from Base	Base	Ref.	% Change from Base
A12 East of M25 Junction 28	2887	3822	32%	2438	3271	34%
A127 East of M25 Junction 29	2773	3592	30%	2774	3806	37%
Brook Street East of M25 Junction 28	814	990	22%	1017	1413	39%

Table 6-1: Traffic Flow Comparisons – AM Peak

Road	Westbound			Eastbound		
	Base	Ref.	% Change from Base	Base	Ref.	% Change from Base
A12 East of M25 Junction 28	2707	3322	23%	3265	4358	33%
A127 East of M25 Junction 29	2881	3845	33%	2654	3794	43%
Brook Street East of M25 Junction 28	1121	1585	41%	1049	1233	18%

Table 6-2: Traffic Flow Comparisons – PM Peak

6.3 Congested Link Analysis

6.3.1 The outputs from the modelling represent the unconstrained background growth that could be expected between the base year and Local Plan horizon year.

6.3.2 As the growth in traffic is unconstrained, the flow plots show the worse-case scenario, without considering the link capacities, as well as current travel trends which seem to indicate that overall traffic is in fact not growing, as indicated in Section 3. The modelling showed that the link capacities at the A127, A12 and Brook Street were above their operational capacity. Due to the link capacity issues, trip distribution would change, WebTAG Unit M2 Section 4.5 outlines the Hierarchy of Choice Responses. The hierarchy of choice responses are route choice, time of day choice, mode choice and trip frequency.

6.3.3 As part of review of the network operation, link capacities have been checked. Theoretical link capacities are taken from the Design Manual for Bridges Volume 5, Section 1, Part 3 'Traffic Capacity on Urban Roads'.

6.3.4 Table 6-3 below again illustrates the existing base flows and the additional flows associated with the Reference Case and Local Plan scenarios for the AM and PM peak periods, with the theoretical link capacity included.

Road	AM				PM				Theoretical Link Capacity
	Westbound		Eastbound		Westbound		Eastbound		
	Base	Ref	Base	Ref	Base	Ref	Base	Ref	
A12	2887	3822	2438	3271	2707	3322	3265	4358	4000
A127	2773	3592	2774	3806	2881	3845	2654	3794	4000
A1023 Brook Street	814	990	1017	1413	1121	1585	1049	1233	900-1140

Table 6-3: Link Flows on A12, A127 and A1023

6.3.5 In the AM peak, the A1023 Brook Street is already close to capacity in the eastbound direction, and close to capacity in the PM peak in both directions. The modelling indicates that additional demand from background traffic in the reference case, show flows in most cases well above the theoretical capacity of the link.

6.3.6 The A12 remains within capacity in most cases, however it is close to capacity in the westbound direction in the AM peak and eastbound in the PM peak.

6.3.7 For the A127 all flows during the Reference Case are just below the maximum link capacity.

6.4 Junction Capacity Checks

6.4.1 As stated above, initial junction modelling has been undertaken with the worst-case flows. This exercise highlighted a number of junctions where, in the reference case, the outputs were unrealistic and demonstrated excessive delays, which are well beyond what would be deemed a reasonable level of service, in terms of time delays and queues. In this instance, junctions which have a delay of 3 minutes or greater have been deemed to operate at an unrealistic level and have been highlighted.

6.4.2 The worst junctions are detailed below:

- A128 Ongar Road/William Hunter Way
- A128 Ingrave Road /B186 Queens Road
- A128 Ingrave Road / The Avenue / A128 Brentwood Road / Running Waters
- A1023 Brook Street/Mascalls Lane
- Warley Hill/Eagle Way
- M25 Junction 28
- M25 Junction 29

6.4.3 The A127/B186 junction is not included within this list, as there is a committed scheme which provides adequate capacity for the reference case growth.

6.5 Approach to Reflect Change in Behaviour Due to a Congested Network

6.5.1 The modelling work undertaken for the Brentwood Local Plan uses a trip generation and assignment approach which predicts future traffic based on current trip rates for peak hour travel and then assigns all traffic to the quickest route. There are some locations where this predictive method would lead to unsustainable and unrealistic levels of traffic, where the network would not be able to cope, either due to link capacity constraints or significant levels of congestion inherent in the delay and queue outputs from the modelling. The main locations are A12 and Brook Street and M25 junction 28.

6.5.2 An approach is put forward that will use existing evidence to help predict more realistic levels of traffic. This has been supported by WebTAG approach on variable demand modelling, where the hierarchy of choices has been used in the absence of a variable demand model. Evidence where available has been used which are influencing the way travel is undertaken and potentially how this may influence future movements.

6.5.3 The prediction of future travel is very difficult and uncertain, but the approach is a pragmatic and proportionate one, which will determine a level of reduction in background traffic.

6.5.4 The modelling undertaken does not take account of variable demand, which would enable the modelling of choice responses as a result of a congested network.

6.5.5 As stated in paragraph 6.4.2, the WebTAG guidance discusses how travel is influenced by congestion. Therefore, in the above cases it is likely that travellers would be influenced in their choice by the congestion on the links, with the hierarchy of choices as set out above.

6.5.6 The following elements have been considered in order to reflect how car travel may be influenced by congestion in the future and how this may change driving habits.

6.5.7 As part of looking at forecast traffic flows, the analysis has looked at the following:

- Route Reassignment
- Peak spreading
- Trip Frequency (Sensitivity)

Route Reassignment and Traffic Growth

6.5.8 A limitation of the model is that it does not do route choice or reassignment that could come about because of traffic congestion on the network. Between any origin and destination within the model, all trips are assigned to the quickest route, based on current levels of traffic and conditions. This is known as all-or nothing assignment.

6.5.9 Some traffic would use alternative routes. In the area around Brentwood, this is particularly the case for trips using the A12 and A1023 Brook Street, where the assignment assumes that all trips will use these roads in the case of many origin and destination movements, where in fact some would use alternative routes and the future traffic flows on these links are far higher than would be realised. Table 6-1 showed the traffic growth predicted within the model on these routes and demonstrated that the level of growth was high.

6.5.10 To determine a potential level of traffic that could be seen to reassign, a standard online route planner has been used to understand some typical journey times between competing routes in the peak hours between some key origin and destination routes where either congested links or junctions have been identified. For each of these routes the current model will assign all trips to the quickest route regardless of the level of congestion. It would be expected that at least some of the traffic would re-assign because of a congested network. Details of the key route comparisons, where reassignment has been considered.

6.5.11 The analysis shows that there are several potential alternative routes that could feasibly be taken to avoid the heavily congested areas around Brook Street and M25 Junction 28. As an example, a car trip with an origin in Romford and a destination in Brentwood town centre in the AM Peak for a trip departing at 7:55 on a typical weekday, has the following options:

- Option A: Via A12, through to M25 junction 28 and Brook Street – Journey Time Range: 14-35 minutes Distance: 10.3km
- Option B: Via Gallows Corner/A127 and Warley Road – Journey Time Range: 18-30 minutes Distance: 12.6km
- Option C: Via Noak Hill and Weald Road – Journey Time Range: 18-28 minutes Distance 12.6km

6.5.12 In the above example, all traffic within the model will be assigned on Option A, whilst this is the shortest route and at the lower end of the range, is the quickest, it has the greatest variation in time and the upper range is higher than the other two routes. It is likely that some travellers would route on each of these options.

6.5.13 Through the DfT's TEMPro software, it is possible to obtain traffic growth figures by area and by road type. The data uses the National Trip End Model (NTEM), with growth adjusted using the National Transport Model (NTM). Between 2016 and 2033 the expected growth on rural trunk roads in Brentwood is expected to be 17.63% in the AM peak and 17.46% in the PM Peak. As shown in Tables 6-1 and 6-2, within the model growth is as high as 34%, which can at least in part be explained by the limitation in the model relating to reassignment, The National Transport Model will take account of this when determining the level of growth.

6.5.14 To reflect this the background growth on the A12 will be capped within the junction modelling within the reference case using the NTEM/NTM growth for Brentwood rural trunk roads detailed in the previous paragraph.

6.5.15 Similarly, NTM shows that growth on urban principal roads within Brentwood is expected to be 13.1% in the AM peak and 12.93% in the PM peak. The modelling again shows that growth on the A1023 Brook Street, which is a principal route within Brentwood, is far higher than this as shown in Table 6-1 and 6-2. Therefore, a similar approach will be taken to reduce the level of growth in the Reference Case.

Peak Spreading

6.5.16 For some locations, the impact of peak spreading has been considered. This will allow for changes in timing of trips to be reflected within the assessment, where it has been identified that within the peak hour that there is a peak within the peak and the junction assessment indicates that the junction is at capacity now.

6.5.17 As stated within DMRB Volume 12 Section 2 Part 1 – Traffic Appraisal in Urban Areas, peak spreading occurs because of a congested network during the usual peak hour times of 08:00 to 09:00 and 17:00 to 18:00, thus resulting in people travelling earlier or later in the peak period to avoid being delayed and subsequently traffic becomes more spread in the peaks.

6.5.18 The effect of peak spreading can be reflected in a traffic model, where profiling is used across the peak, by adjusting the proportions of traffic allocated to each profiled period in the peak hour i.e. where 15-minute profiles have been used, these may be adjusted to reflect a flatter traffic profile across the peak hour. Alternatively, in junction modelling the effect of peak spreading can be simulated by inputting a flat profile to replicate the effects of traffic being evenly distributed throughout the modelled period.

6.5.19 In addition, where the peak hour is shown to already be congested and the flow profile already flat, a review of data has been undertaken to see if in future, this will indicate peak spreading into the shoulders, thus dampening growth in the actual peak hour.

6.5.20 Where peak spreading has been accounted for, at specific junctions this is indicated within the results outputs in Section 8.

Trip Frequency

6.5.21 As stated in Section 1, there is evidence to suggest that trip frequency is declining, despite increases in population and the number of people in employment. Whilst some of this is due to changing demographics and an aging population, there are other reasons which the research suggests are behind this.

6.5.22 Advances in technology have enabled changes in how people work, with the increase in home working, both on a regular and occasional basis. Also, there has been an increase in part time working.

6.5.23 As the highway network becomes more congested the technological advances have facilitated the ability to change when people travel or not travel at all to avoid the worst congested periods. People can work from home prior to going to work later for example.

6.5.24 Whilst there is uncertainty around the continued trend, it is very likely that as technology improves, this will facilitate even greater flexibility and acceptance of agile working practices, which would result in lower trips, for commuting and business travel in the future. Due to the uncertainty, no reductions have been applied to reflect this within the modelling.

7 Sustainable Transport Infrastructure Assessment and Mitigation

7.1 Overview

7.1.1 To reduce the impact of developments on the overall road network within Brentwood Borough alternative methods of transport other than the car should be promoted to lessen the impact of strategic development sites. As required within NPPF and the Local Plan Transport Evidence base guidance, sustainable transport interventions will form the main part of any mitigation required to provide additional mobility capacity within the system.

7.1.2 It is recognised that providing additional highway capacity will only have a short-term impact and may be quickly taken up by suppressed traffic. Therefore, investment in providing alternatives is important.

7.1.3 This section considers potential sustainable transport measures that could be implemented within the local area to assist in reducing this impact. Whilst encouraging modal shift and healthier choices because of reduction in car usage, some measures could also be considered as alternatives to, or supporting physical improvements to highway mitigation. A qualitative desktop study has been undertaken to identify where possible any measures that could be developed regarding bus routes and improvements to cycling and pedestrian accesses.

7.1.4 Census travel to work data for Brentwood indicates that currently 36.3% of travel to work trips are by car drivers, of which around 30% of these car commute trips made by residents of Brentwood, take place within the Brentwood/Shenfield urban area. These trips are likely to be well under 8 kilometres or 5 miles, which demonstrates that there is potential for removing quite a few short distance trips from the network, through promotion of sustainable travel. It should also be noted, that car use for travel to work by Brentwood residents, is the lowest of all the Essex boroughs and districts. The figure for Essex is 40.4%, for Chelmsford it is 40.6% and Basildon it is 38%. The lower car use is mainly a reflection of higher rail use, which is discussed later in this section.

7.1.5 For Brentwood town centre, the Borough is in the process of developing a sustainable transport strategy to help address traffic and associated air quality issues and this emerging strategy is outlined below. Elsewhere, this assessment focuses on the strategic development sites at the south of the Borough which have the greatest impacts on the operation of the highway network due to their scale.

7.1.6 Within this section, an overview of Brentwood specific sustainable travel ideas is discussed. Whilst these have not been explicitly modelled as part of the assessment, such measures would bring about changes required to help support delivery of the Local Plan and the developments can help facilitate delivery of a packages of measures similar to that discussed in Section 7.2.

7.1.7 For the purposes of the modelling, specific evidence from the DfT Sustainable Travel Towns study has been used and this is detailed in Section 7.3.

7.2 Brentwood Specific Sustainable Transport Ideas

7.2.1 The potential to create an integrated sustainable transport network, linking railway stations, places of employment, new residential developments and existing development in the wider Brentwood area is key to assist in achieving a reduction in car dependency and influence other travel, where there is capacity already available or where it can be created through various travel initiatives. These will have an impact on travel, both related to specific Local Plan sites, but also the wider community, as the Local Plan facilitates the investment required.

7.2.2 Table 7-1 identifies a package of sustainable mitigation measures which it is considered could specifically mitigate the direct and indirect impacts of the new development proposed in the draft Local Plan. Other measures were initially identified but were less certain in terms of their deliverability within Local Plan timescales and, following discussions with ECC were excluded from consideration. These measures are being incorporated into the emerging Brentwood sustainable transport strategy. These are shown in Appendix E.

7.2.3 A key consideration of this strategy is to influence school travel, which is adding to congestion within Brentwood town centre in the AM peak. This creates not just issues with junction capacity, but impacts on the ability of traffic to travel smoothly through the area, as parked vehicles cause conflicts. One example of how improvements could be achieved in a relatively cheap and achievable way is through the provision of a School Clear Zone which is a key element is reducing peak hour trips within Brentwood town centre. The concept is described in more detail later but seeks to remove school related trips from the town centre and to encourage greater use of non-car modes for such trips.

7.2.4 The south of the Borough is comparatively very currently poorly served by sustainable transport options. Therefore, the substantial quantum of residential and commercial development proposed in the Draft Local Plan to the South of the Borough requires a level of financial investment in sustainable transport measures beyond that proposed around Central Brentwood.

7.2.5 The Second Primary sustainable measure proposed is to transform the current West Horndon station and car park in phases into a sustainable transport interchange. The phased changes will bring new regular buses services, plus secure cycling and walking infrastructure within 2 mins walk to a rail service connecting Southend and its Airport to the East and to Central London and Fenchurch Street to the West.

7.2.6 The development phases of the new interchange will be aligned to Development Management agreements for investments from the development sites in Brentwood and potentially in the future from North Thurrock.

7.2.7 Like the School Clear Zone, the West Horndon Interchange proposal will require several other items outlined in Table 7-1 to work optimally.

Item	Description	Timeline	Comment
1	Create School Clear Zone to restrict all vehicles from stopping, parking for drop off during AM/PM peaks from a specific area(s).	SHORT - MEDIUM	Parking allowed in legally designated car parks and spaces on the High St within the zone. Should reduce congestion at AM peak. Additional benefit of improving air quality at Wilson Corner. Public Transport exempt.
2	Deliver Park, Ride or Stride facilities for workers within Brentwood T.C. or drop/pick up off points for parents to drop off their children.	MEDIUM	Impact on local traffic patterns would need to be understood. Work needed with schools to re-educate parents. Consider an electric and ordinary bicycle hire scheme hub. Additional option to include bus service for schools from these hubs.
3	Plan and deliver in phases 'Quietway' cycle routes in Brentwood initially connecting	MEDIUM	Segregated routes where possible. Where not consider contra-flow cycling routes by creating new one-way streets. Consider 20mph in the zone.

	Transfer Hubs to Town Centre schools		
4	Ban all large freight vehicle from stopping deliveries within the Central Brentwood zone and A128 corridor during AM/PM peaks.	MEDIUM	New developments sites won't compete with Central Brentwood as the retail centre. The larger population could lead to more large vehicles stopping for extended periods to service new developments and a busier High Street.
5	Policy requiring all new developments dependent on location to be 'Car light' and/or encourage e-vehicles.	SHORT	Difficult given political situation Consider partnership with car club company providing electric cars or low emission hybrids
6	Introduce a pedestrian wayfinding system like Legible London.	SHORT / MEDIUM	Residents and employees of new developments and the existing population should be encouraged to walk more.
7	Create and/or promote a multiple service App making access to smart car hire/ community buses/ booking bikes (including e-bikes) etc. easier.	SHORT	Partner with software organisation that creates community-based apps. Pays for itself through advertising
8	Introduce electrical parking points to encourage use of such vehicles and plan and deliver other IT infrastructure redundancy to allow future implementation of emerging SMART systems.	SHORT / MEDIUM	All new residential and commercial developments should include e-charging spaces for car clubs using e-vehicles and charging hubs for e-bikes. Important to facilitate sustainable north/south movements from DHGV to Central Brentwood.
9	Create through phases a new multi-modal interchange at West Horndon Station	MEDIUM	This interchange will serve the DHGV, Childerditch, West Horndon and Enterprise Development sites, plus any future Northern Thurrock developments.

Table 7-1: Sustainable Transport Measures

School Clear Zones

7.2.8 To mitigate the impact of additional vehicular trips from Local Plan development and beyond on central Brentwood, a School Clear Zone could be provided. It would be enforced by a combination of traffic wardens, new CCTV and new traffic signage to restrict stopping and parking. Fines could be imposed for those vehicles caught breaking the restriction.

7.2.9 To facilitate a positive impact of this policy and therefore reduce traffic loading from the new development, the following deliverables have been identified (and are outlined graphically in Appendix F).

- Clear Zones would be defined by TRO, around each School based on at minimum within a 10-minute walk (400m) or a maximum within a 20-minute walk but easy cycle (800m). New signage and CCTV will be installed, and an information initiative undertaken with the parents in partnership with the schools affected. A 20mph speed limit will also be imposed within the Zone.

- Transfer/drop-off hubs. – Parking sites will be adapted to create new transfer hubs. These will offer Parents, Children and town centre workers/visitors, Cycle Hire Facilities with access to enhanced bus services and normal and electric bikes for to encourage 'Park and Ride or Stride' to their destination. Additional cycle parking facilities will be added to schools within the zone where required. A commercial contract will be tendered for the provision of the bikes to encourage all ages and abilities to use the service. Parents would sign up to a usage policy and their Children can pay and unlock the bikes for short trips to school and around the local area. The scheme would also be available to workers and visitors

- New bus stops where feasible will be incorporated within or relocated near to the entrance/exit to these facilities. If required existing bus service it, will be made more frequent given the guaranteed customer base these facilities will offer.

- A Pedestrian Wayfinding system - will be installed to encourage walking from the Stations within the borough and the new transfer hubs, given the Elizabeth Line opening in 2019

- Quiet Routes for cyclists will be identified running from the Transit Hubs. Where possible segregated routes will be created, or alternatively, contra-flow cycle lanes will be delivered on new one-way residential roads. Central Brentwood has a network of interconnected lanes which could also be restricted to pedestrian and cyclist use. Any deliveries to shops in these lanes to be undertaken outside of school peak hour.

- Community App – developed and delivered to make access to Sustainable Transport alternatives and community events easier. New development residents and workers will also find such an app invaluable to learn about the area, upcoming activities etc.

7.2.10 The measure has the added benefit of encouraging more physical activity for children their parents, and all other users to walk or cycle from a reasonable distance. That distance being a maximum of a 20 minutes' walk from the schools or central Brentwood. In addition, air quality will improve and residents living on private and adopted roads close to the schools will no longer have to complain about cars parking illegally.

7.2.11 Brentwood high schools and some primary schools are very attractive not only to residents within the Borough, but also for many children from the surrounding Essex and London authorities. Traffic generated by future developments from these surrounding authorities are considered within the background growth outlined in the modelling and we should therefore take the impact of the children growth into consideration as well as that from within the Borough itself. The five High School (each with student numbers of more than 1000 pupils) located in Central Area of Brentwood generate a significant volume of parents dropping off and picking up their children. Each of these schools operate Sixth Forms some of whose pupils, due to the affluence of the area, drive to school during the peak hours.

7.2.12 Figure 7-1 below demonstrates the origin of pupils by postcode which has been summarised to show those travelling: from within the Borough; from other Essex Authorities; and from London Boroughs which are the Eastern Boroughs of Barking & Dagenham, Redbridge, Newham and Havering. Within the data source there was no information for the private Brentwood School, the largest by area of the five.

Figure 7-1: Origin of Pupils by Postcode

7.2.13 This activity shown above has a significant impact on the capacity of the local road network within the AM peak. A similar volume of traffic also appears later but before the usual PM peak. While schools generally have a restricted parking zone adjacent to their entrances, they are proving insufficient to stop parents' parking on nearby streets. This parking takes place on private roads and/or causing blockage of public roads and resident complaints. The surrounding roads to the schools will therefore be protected within both school peak traffic times by enforceable 'stopping, parking and 20mph speed' restrictions.

Rail

7.2.14 There are three key railway stations that currently serve Brentwood and the wider area all of which have the potential to assist in providing additional benefits to sustainable travel in the area.

7.2.15 Brentwood and Shenfield stations are located on the Great Eastern Mainline. Currently Brentwood station is served by six TfL Rail services operating between Shenfield and London Liverpool Street per hour throughout the week and two Abellio Greater Anglia services operating between Southend Victoria and London on Sundays only.

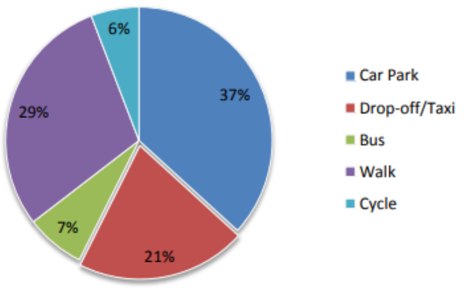
7.2.16 Shenfield is served by Abellio Greater Anglia with three trains per hour to Southend Victoria, and one train per hour to Colchester Town, Ipswich, Braintree and Clacton-on-Sea. TfL Rail also operatives quarter hourly services to London Victoria and from late 2018 it will be the terminus of the Elizabeth Line which will run between Reading and Heathrow Airport in the west through London.

7.2.17 During 2014 JMP Associates undertook a station parking study for Shenfield prior to the development of the Elizabeth line. From the Rail User Survey carried out as part of the study, it was identified that the largest modal split of respondents parked their car at the station. With 37% of the respondents, whilst walking had a 29% share, arriving to the station by Bus was 7%.

7.2.18 Figure 7-2 shows the modal split of users undertaken for that study. This demonstrates that with the introduction of better bus services to the station, a reduction in the number of people who park at Shenfield who live in the vicinity as well as from any future Local Plan developments in the region could be witnessed, reducing overall traffic on the local network.

Figure 7-2: Modal Split of Rail User Respondents

Figure 5-4: Modal split of Rail User Respondents



7.2.19 West Horndon station is on the London, Tilbury and Southend Railway line and is served by C2C with two trains per hour to London Fenchurch Street and Shoeburyness. It is currently identified that parking capacity is fully utilised most weekdays for commuters into London from the A127/A13 corridors. It is proposed that this station will form an integrated transport hub supporting the new sites in the south of the Borough and future sites from Thurrock.

Census Travel to Work – Rail Mode Share in Brentwood

7.2.20 Rail travel plays an important role within Brentwood. The 2011 census indicated that 15.8% of commute trips by residents within Brentwood were by car, which compares to just 7% for Essex and 10.8% for Basildon and 9% for Chelmsford. This is reflective of the level of rail services in Brentwood and the importance of travel to London. The opening of the Elizabeth line will only assist in delivering extra capacity for rail use in the future and the Local Plan is an opportunity to further enable growth and moves away from the private car, through improving access to stations from developments and the wider area.

The Elizabeth Line

7.2.21 The new Elizabeth Line is a 118km railway under development crossing through the heart of London, enabling access between Reading and Heathrow in the west, through central London to Shenfield and Abbey Wood in the east. The full route is expected to be fully operational by December 2019.

7.2.22 The scheme will improve the station environment at both Brentwood and Shenfield stations, specifically in terms of non-motorised users and will provide enhanced public transport access, with new forecourt and pedestrian crossing facilities being installed at Brentwood. At Shenfield, additional bus facilities will be installed to cope with an increase in demand for public transport usage.

7.2.23 It is expected that the introduction of this new railway will assist in the reduction of some longer distance car trips within the Brentwood area and thus reducing capacity issues at some of the identified junctions on the strategic network including, for example, on the M25 and the A12. The attractiveness of the services may also result in some instances where some junctions local to the stations witness an increase in delay, because of increased car travel to the stations. However, the emphasis on accessibility to both Shenfield and Brentwood stations will be on sustainable travel as a means of access, with improvements to pedestrian and cycle infrastructure and bus services, linking both new and existing developments near the stations, and on introducing new parking controls where needed to discourage parking around the stations, therefore reducing car travel.

7.2.24 Whilst it is expected that the Elizabeth line will have positive impacts on the highway network serving the Borough, there is no adequate data available to assist with modelling these impacts. It would be expected that through promotion of sustainable travel to access the station, any local impact on the highway, locally can be managed accordingly.

West Horndon Public Transport Interchange

7.2.25 Within the Local Plan there is a recognition that provision of sustainable transport in the South of the Borough is poor. To mitigate the impact of the two employments sites and two residential sites new area specific sustainable transport measures will be implemented centred around West Horndon which is centrally located between the four sites. These measures will seek to deliver a minimal traffic impact for these sites on the existing the Highway infrastructure i.e. the A127, A128, and M25 J29. The measures would also seek to reduce the need for northward movements into central Brentwood. Where northward movement happens, it is planned that they are undertaken by electric car club vehicles, electric bikes (to deal with the topography) or Bus. These means of travel will be exempted from entering the restricted clear zone.

7.2.26 It is proposed that over the lifetime of this Plan that the improvements to the station and associated bus and cycle infrastructure are phased to create a new interchange. An increased capacity on the existing train service will be central to the new cycling, walking and bus movements of the new residents and employees accessing the four sites.

7.2.27 While a new Railway station would be the ultimate delivery goal it will only happen if sufficient development also comes forward from Thurrock to make the business case for a new station viable. To support the developments within Brentwood's draft Local Plan, it will be enough to:

- Alter and extend the existing Station building to include more Gate-lines and provide a new disabled bride.
- Make vehicular and cycle site access and egress from the Interchange safer through alterations to the existing adjacent Highways
- Implement segregated cycle routes to all the surrounding developments.
- Ensure an interim bus service(s) connecting the developments sites to the interchange is built into the development agreements to be funded for a minimum of 5 years. This should allow time for enough customer demand for a commercial operator to take on the routes.

7.2.28 Appendix G shows the proposed option for the sustainable connections from the four sites to West Horndon Interchange and to the North.

Bus Services

7.2.29 Brentwood and the surrounding area are served by multiple bus operators the most frequent are that of First Bus, Stagecoach and Ensign Bus.

7.2.30 In the immediate area and most relevant to the Local Plan sites, First Bus routes 9, 351, 565 offer the potential to extend the routes to provide a service to the future developments. Route 9 currently offers a half hourly services between Brentwood Railway Station and Basildon Bus Station via Billericay. 351 is a half hour service between Brentwood Railway Station and Chelmsford Bus Station, and route 565 an approximate half hourly service between Brentwood Railway Station and Bulphan. Any route amendments are unlikely to occur in the short term but potential for existing routes to serve new developments currently off route. Any future route development could be incorporated within the planning application for associated developments.

7.2.31 Additional services operated by Stagecoach between Brentwood and Romford of a half hourly service and Ensign Bus between Warley and Ongar, stopping at Brentwood Railway Station operates an hourly frequency.

7.2.32 There is potential in future, with the pattern of development to provide improved bus services, which link key residential areas, both existing and those proposed through the local plan, employment and railway stations. There is an opportunity to provide services that will link Dunton Hills (and Basildon), West Horndon Station, Brentwood Enterprise Park, Childerditch Business Park and Brentwood (including the station), which if providing a high quality express service between these key origins and destinations would provide a realistic alternative to the private car.

7.2.33 Where appropriate and new services could be provided by commercial operators, this will have an impact on mode share and potential reduction in future car travel, both for those that would directly benefit from new services in the new developments, as well as existing residents who would benefit from service improvements as well.

7.2.34 There is a longer-term aspiration for a Mass Rapid Transit System within South Essex, which is shown

Other Sustainable Transport Opportunities

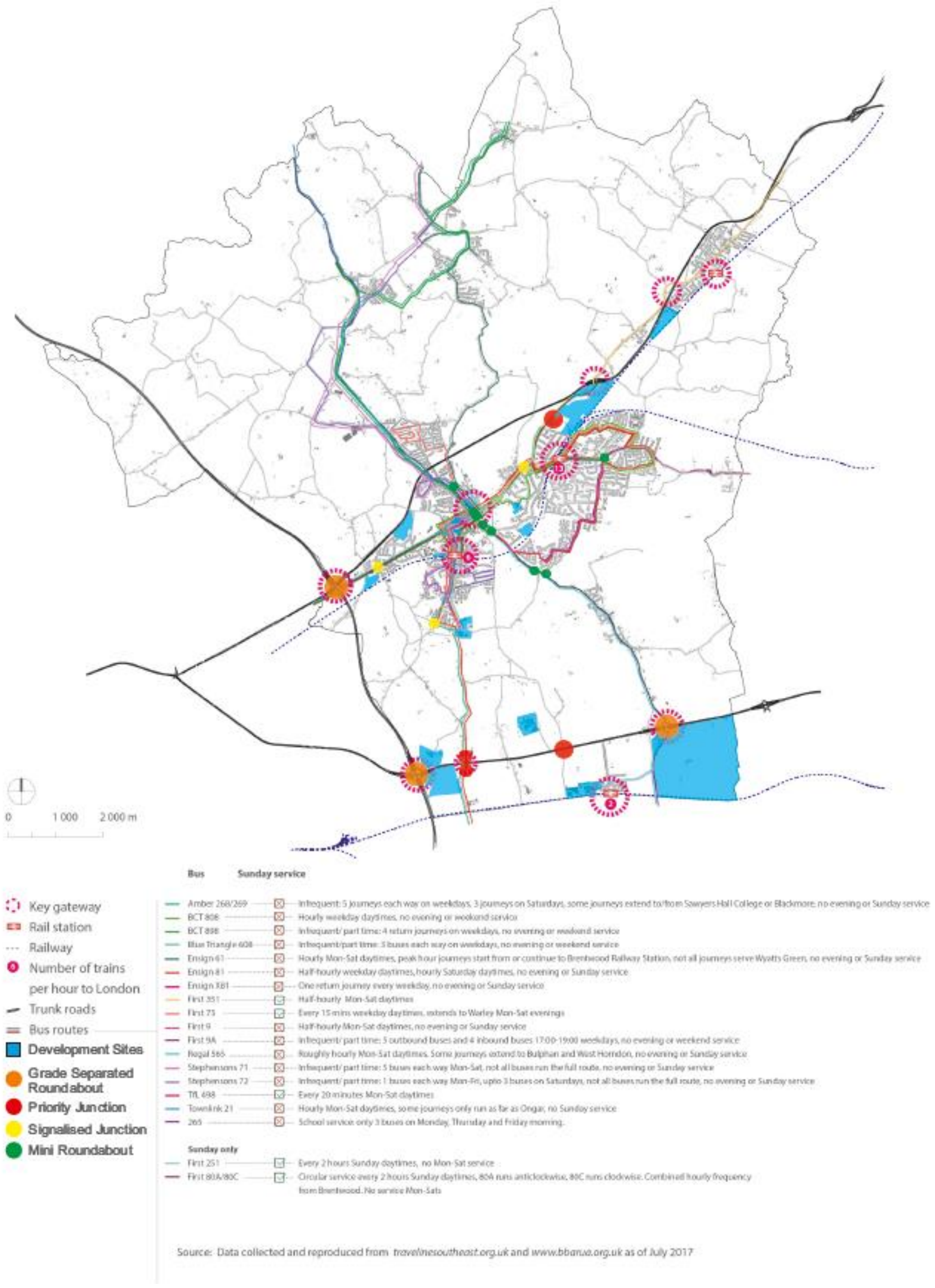
7.2.35 Figure 7-3 illustrates the key public transport routes in relation to the Local Plan development sites. The availability to better connect the railway stations of Brentwood, Shenfield and West Horndon to the existing population centres and new areas of residential and employment development such as Brentwood Enterprise Zone or Dunton Hills, opens the opportunity for developing better bus links between these sites. Additionally, there is an opportunity to encourage walkability for education trips and for existing people who live in the town, using Legible London type wayfinding infrastructure as an example.

7.2.36 There will be a need, as development progresses, to work closely with ECC, bus operators and developers of individual sites to identify these opportunities as development progresses. This can assist in encouraging people to consider using alternative modes of transport to the private car.

7.2.37 In addition, the proximity of new housing developments close to railway stations can provide the opportunity to improve cycling and walking infrastructure for shorter distance trips, to access rail services. This is particularly the case with Dunton Hills where new opportunities will exist, as well as improving links to Brentwood and Shenfield stations, which will benefit both existing population, as well as the new Local Plan developments, within easy access of the stations.

7.2.38 Additionally, the development of other schemes such as school drop-off zones can encourage people to park outside of Brentwood town centre to walk, cycle or get an alternative mode of transport to school resulting in a reduction of congestion and delay during the peak periods within the town centre.

Figure 7-3: Public Transport Routes and Services



7.3 Application of Sustainable Transport Measures in the Model

7.3.1 The sustainable travel interventions discussed above provide examples of measures that could be introduced within Brentwood within the plan period, to mitigate the impacts. With the type of interventions proposed, these would be able to influence both travel associated with the Local Plan Developments and wider society. The suggested improvements for these in Brentwood include bus services between new developments and existing developments, school travel interventions such as creation of school drop off zones away from congested town centre, improved accessibility to stations through better interchange for buses (West Horndon), and improved cycle/walking facilities/signing/way marking (West Horndon, Brentwood and Shenfield). The model will be used to provide an indicative reduction in these elements where appropriate.

7.3.2 Research published by the DfT demonstrates that there is a benefit from implementing Travel Plans and sustainable travel measures to achieve a mode shift from car use. This includes the following research:

- 'Making Personal Travel Plans Work' (DfT, 2007) – this reports a reduction in single occupancy vehicle trips of 12% across 12 DfT areas following to implementation of Personalised Travel Planning; and
- 'Smarter Choices – Changing the Way We Travel' (DfT, 2005) reports a reduction of between 5% and 9% in single occupancy vehicle trips in non-urban areas for commuting journeys following the implementation of a Workplace Travel Plan. The sites considered in this research included a wide range of employers in differing locations implementing a variety of measures.
- The report on "The Effects of Smarter Choice Programmes in the Sustainable Travel Towns": Full Report (Sloman et al., 2010);

7.3.3 Some of the headline results from the last of these listed above, include:

- Car driver trips per resident of the three towns taken together fell by 9% between 2004 and 2008.
- Car driver distance per resident fell by 5% to 7% (for trips of 50km or less). (Car use per head also fell nationally in comparable (medium-sized) urban areas during this period, but by a much smaller amount: a change of -1.2% for car driver trips and -0.9% for car driver distance.)
- Overall reductions in car traffic (based on counts) of the order of 2%, and more substantial reductions in inner areas, of the order of 7 to 8% overall.
- Bus use grew substantially in Peterborough and Worcester during the period of the Sustainable Travel Town work, whereas it declined in Darlington. Bus trips per resident of the three towns taken together increased by 10% to 20% (for trips of 50km or over) whereas there was a national decline of bus trips in medium-sized towns of 0.5% over the same period.
- There were positive results for cycling in all three towns, with particularly substantial growth in Darlington. Cycle trips per resident of the three towns taken together increased by 26 to 30%, whereas, according to the National Travel Survey, there was a national decline of cycle trips in medium-sized towns over an approximately similar period.
- Walking trips by residents grew in all three towns during the period of the Sustainable Travel Town work. Walk trips per resident of the three towns taken together increased by

10% to 13%, whereas, according to the National Travel Survey, there was a national decline in walk trips in medium-sized towns of at least 9% over an approximately similar period.

- The growth in bus use, cycling and walking cannot be explained by trip generation. In fact, at the aggregate level, the total number of trips per capita by all modes, as recorded in household surveys, fell by 1.1%.

- Although the largest behaviour changes were seen in short car driver trips, the largest reductions in distance travelled as a car driver came from medium and longer distance trips. Of the reduction in distance travelled for trips of <50km, about 45% of the reduction in car driver kilometres came from trips of 10 to 50km; about 40% from trips of 3 to 10km; and about 15% from trips of less than 3km. Table 7-2 shows the car trip reductions by distance from the Sustainable Travel Towns study.

	Up to 1km	1.1 – 3km	3.1 – 5km	5.1 – 10km	10.1 – 50km	Over 50km	Total
Car Trip Reduction	-22%	-14%	-10%	-6%	-3%	0%	-9%

Table 7-2: Change in Car Driver Trips from Sustainable Measures by Trip Distance[9]

7.3.4 The above evidence indicates that through a targeting approach to promoting and providing opportunities for sustainable travel, then there would be a resulting reduction in car distance travelled.

7.3.5 To meet the requirements of NPPF and to be consistent with the guidance for Local Plans, the emphasis needs to be on sustainable transport and promoting this. The Local Plan offers up this opportunity within Brentwood to provide a comprehensive sustainable transport strategy, aligned with growth, that will provide greater opportunities for all and move away from the emphasis being on physical highway mitigation, which is shown to only provide a short-term solution, if nothing else is done.

7.3.6 Based on the above study, Table 7-3 sets out the level of achievable reductions that have been applied to the modelling to reflect sustainable transport measures for Local Plan sites. The set of measures set out should be able to achieve a level of trip reduction which equates to around half of that in the Sustainable Travel Towns research, but more could be achieved, therefore the modelling reflects a worse case assumption.

	Up to 1km	1.1 – 3km	3.1 – 5km	5.1 – 10km	10.1 – 50km	Over 50km
Car Trip Reduction	-11%	-7%	-5%	-3%	-1.5%	0%

Table 7-3: Trip Reductions Applied to Local Plan Sites

7.3.7 In addition to an expected reduction in Local Plan associated car trips, the sustainable travel measures will also provide a level of reduction for trips within the Brentwood and Shenfield urban areas, particularly for short distance trips. The introduction of sustainable travel interventions, which are made possible because of new development, is likely to have an impact on how existing users travel. For example, improved way marking, cycle and walking

[9] Taken from Table 13 of https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/4420/chap13.pdf

infrastructure and signing and improved public transport provision, could benefit those amongst the existing population.

7.3.8 Therefore, trip reductions shown in Table 7-4 have been applied to trips with an origin in the Brentwood and Shenfield built up areas.

	Up to 1km	1.1 – 3km	3.1 – 5km
Car Trip Reduction	-5%	-3%	-2%

Table 7-4: Trip Reductions Applied to Existing Brentwood and Shenfield Trips

7.3.9 This seems a proportionate and pragmatic approach and the reduction in trips is at a level which should be achievable in the future in the context of the modelling. A comparison of the car trips by distance within the model for Brentwood are shown in Table 7-5 and 7-6 for the AM and PM Peak respectively.

	Up to 1km	1.1 – 3km	3.1 – 5km	5.1 – 10km	10.1 – 50km	Over 50km
No Sustainable Measures	735	3123	2121	3284	12935	301
With Sustainable Measures Applied	703	3025	2077	3258	12896	301

Table 7-5: Change in Car Driver Trips from Sustainable Measures by Trip Distance – AM Peak

	Up to 1km	1.1 – 3km	3.1 – 5km	5.1 – 10km	10.1 – 50km	Over 50km
No Sustainable Measures	290	2093	1953	3234	14609	305
With Sustainable Measures Applied	275	2024	1911	3210	14565	305

Table 7-6: Change in Car Driver Trips from Sustainable Measures by Trip Distance – PM Peak

8 Assessment Outputs and Results

8.1 Overview

8.1.1 This section summarises the outputs from the modelling process and includes link flow comparisons and trip distribution plots from the matrix assignment process and results from the junction tests undertaken for the junctions identified within Section 3. Three different sets of data have been used to assess each junctions' capacity relating to in the Base Case Scenario, how the junction will operate at 2033 in the Reference Case Scenario, and the 2033 Local Plan Growth Scenario.

8.1.2 In addition to the above scenarios, other scenarios have been tested within the reference case to reflect any committed mitigation identified at the junctions and the impact on trip making as a result of congestion as discussed in Section 6.

8.1.3 Within the Local Plan Model tests, the impact of the sustainable travel measures has been considered.

8.1.4 Section 9 then goes on to detail any additional highway mitigation that is identified to support the Local Plan, where it would be necessary to provide some additional highway capacity.

8.2 Traffic Flow Comparisons

8.2.1 Traffic flow plots have been produced which show the link flows at key locations on the network associated with the Reference Case. These take account of the reassignment analysis as detailed in Section 6. The flows represent the uplift in flows on each link and not the total flow. These are provided in Appendix H.

8.2.2 Traffic flow plots are also produced to show the traffic associated with the Local Plan development scenario. These plots include the reduction for sustainable travel as detailed in Section 7. These plots are provided within Appendix I.

8.3 Trip Distribution Plots

8.3.1 Distribution plots for trips associated with the Dunton Hills developments and for the Brentwood Enterprise Park for the AM and PM peaks are shown in Appendix J. The flow distributions look sensible.

8.4 Junction Modelling - Base Case Scenario

8.4.1 The Base Models have been developed from observed traffic counts. These have been collated from the most recent data available as detailed in Section 3.

8.5 Junction Modelling - Reference Case Scenario

8.5.1 The Reference Case model flows have been extracted directly from the spreadsheet model. These flows are added directly to the base flows used in the Base Case Scenario at each junction.

8.5.2 The Reference Case flows are for the forecast year of 2033 and include all growth which is not associated with the Local Plan. This is to enable a direct comparison between the effects of the trips generated by the Local Plan developments and the expected growth that is forecast to occur in the same year.

8.5.3 As stated above and detailed in Section 6, the impacts of reassignment and peak spreading have been considered within the Reference Case Scenario. This is reflective of the fact that locations have been identified, where the worst-case traffic growth could not be accommodated and where therefore a proportion of drivers would make other choices.

8.5.4 Whilst there is some uncertainty around future travel behaviour, it is considered that this is a pragmatic approach in the absence of a Variable Demand Model, as it would not be expected for all drivers to choose to travel at peak times on certain routes, where these routes are shown to operate well beyond a reasonable level of service.

8.5.5 Peak spreading has been included for specific junctions during defined peak periods, further detail on this process has been summarised within section 5. Table 8-1 below identifies which junctions and for which peak period a flat hour matrix has been included within the modelling to represent the effects of peak spreading.

8.5.6 The junctions below are those that were identified where there was the greatest need to consider the likelihood for additional peak spreading to occur in response to increasing junction delay.

Junction No.	Junction Location	Peak Spreading Period
2	A129 Rayleigh Road / Hanging Hill Lane	PM
3	A128 Ongar Road / Doddinghurst Road	PM
5	A128 Ongar Road / William Hunter Way	PM
6	A128 Ongar Road / A1023 Shenfield Road / A128 Ingrave Road / A1023 High Street	AM and PM
7	A128 Ingrave Road / B186 Queens Road	PM
13	A127 / A128 Brentwood Road / A128 Tilbury Road	AM
15	A128 Ingrave Road / The Avenue	AM and PM
16	A128 Brentwood Road /Running Waters	AM and PM
24	Roman Road / A12 Slip	AM

Table 8-1: Junctions Modelled with A Flat Demand Matrix to Represent Peak Spreading

8.6 Junction Modelling - Local Plan Growth Scenario without mitigation

8.6.1 The Local Plan Growth Scenario, are the developments identified by BCC which are likely to form the allocations in the Local Plan up to 2033, the development trips from these have been added on top of the trips generated by the Reference Case. The flows are taken directly from the spreadsheet models. These represent the worst-case prior to allowance for any sustainable transport mitigation.

8.7 Junction Modelling - Local Plan Growth with Sustainable Travel Mitigation

8.7.1 The junction modelling has been undertaken to reflect the sustainable travel measures, which was discussed in Section 7. The reductions stated have been applied to the modelling at this stage.

8.8 Committed Schemes

8.8.1 Two schemes have been identified which have been included within the junction modelling which are deemed to be committed and will be funded through other means. These are:

i. M25 Junction 28 provided by Highways England as the preferred option from a study for this junction; and

ii. A127/B186 Scheme provided by ECC

8.9 Consideration of Lower Thames Crossing

8.9.1 The information available from the Statutory Consultation identifies that flows on the A127 and A128 route between the M25 junction 29 and A13 are likely to decrease by 100 to 500 vehicles. These flow changes are not considered directly within the modelling, but will need to be considered when looking at mitigation.

8.10 Summary of Individual Junction Outputs

8.10.1 The following section summarises the findings from the junction modelling for each of the scenarios undertaken for each junction, as outlined previously within Table 5-2 and 5-3. The full summary results for each junction are shown within Appendix K and the junction modelling files are included as Appendix L.

8.10.2 The summary takes the following format, a brief description of the junction followed by a summary of the worst performing arms of the junction for the Base, the Reference Case (including trip changes) and Local Plan with Sustainable travel mitigation considerations.

8.10.3 The outputs from the modelling have been expressed as a factor, which refers to the ratio between flow and capacity. A figure of 1.00 represents the position where an arm or movement at the junction has reached the capacity of that arm or movement,

8.10.4 Within the urban area any reductions in delay may be sought by improving public transport and developing key non-motorised user routes between key centres of employment/other attractors and areas of residential development. Tables 8-2 and 8-3 give a summary of these junction tests for the AM peak and PM peak respectively, with the worst performing arm or movement identified.

Junction No.	Junction Location	Type	Baseline	Reference	Local Plan + Sustainable Measures
1	A1023 Chelmsford Rd / A129 Hutton Rd / A1023 Shenfield Rd	Signalised	83.1%	85.0%	90.0%
2	A129 Rayleigh Road / Hanging Hill Lane	Mini-Roundabout	0.98	1.02	1.04

Junction No.	Junction Location	Type	Baseline	Reference	Local Plan + Sustainable Measures
3	A128 Ongar Road / Doddinghurst Road	Mini-Roundabout	1.00	1.04	1.11
5	A128 Ongar Road / William Hunter Way	Mini-Roundabout	0.96	1.11	1.21
6	A128 Ongar Road / A1023 Shenfield Road / A128 Ingrave Road / A1023 High Street	Double Mini-Roundabout	0.78	0.84	0.90
7	A128 Ingrave Road / B186 Queens Road	Mini-Roundabout	1.06	1.23	1.35
8	A128 Ingrave Road / Middleton Hall Lane / Seven Arches Road	Signalised	96.3%	88.9%	97.5%
10	A1023 High Street / B185 Kings Road / A1023 London Road / Weald Road	Signalised	86.1%	93.1%	108.8%
12	Western Road / William Hunter Way	Mini-Roundabout	0.84	0.82	0.86
13	A127 / A128 Brentwood Road / A128 Tilbury Road	Grade Separated Gyratory	0.85	0.94	1.03
14	A127 / Childerditch Lane	Double Priority	0.12	0.12	0.15
15	A128 Ingrave Road / The Avenue	Double Mini-Roundabout	1.06	1.15	1.24
16	A128 Brentwood Road /Running Waters	Double Mini-Roundabout	1.08	1.14	1.25
17	A1023 Brook Street /Mascalls Lane	Signalised	95.2%	100.8%	106.3%
18	B186 Warley Hill / Eagle Way / B186 Warley Rd / Mascalls Lane	Signalised	102.4%	108.3%	108.8%
19	B186 Warley Street / A127 eastbound	Priority (committed scheme - signalised)		88.2%	92.4%
20	B186 Warley Street / A127 westbound	Priority (mitigation signalised)		85.9%	87.6%
22	A1023 Chelmsford Road / Alexander Lane	Priority	0.08	0.09	0.09
23	A12 Junction 12	Grade Separated Gyratory	0.82	0.89	0.94
24	Roman Road / A12 Slip	Staggered Priority	0.79	0.91	1.14
25	M25 Junction 28	Grade Separated Gyratory	0.89	1.24	1.56

Junction No.	Junction Location	Type	Baseline	Reference	Local Plan + Sustainable Measures
26	M25 Junction 29	Grade Separated Gyratory	See para. 8.10.6 to 8.10.8		
27	A128 Tilbury Road/Station Road	Priority	0.54	0.62	0.97

Table 8-2: Junction Modelling Summary Results – AM Peak

Junction No.	Junction Location	Type	Baseline	Reference	Local Plan + Sustainable Measures
1	A1023 Chelmsford Rd / A129 Hutton Rd / A1023 Shenfield Rd	Signalised	0.91	0.96	1.03
2	A129 Rayleigh Road / Hanging Hill Lane	Mini-Roundabout	0.89	0.97	0.99
3	A128 Ongar Road / Doddinghurst Road	Mini-Roundabout	0.95	0.97	1.02
5	A128 Ongar Road / William Hunter Way	Mini-Roundabout	0.98	1.06	1.15
6	A128 Ongar Road / A1023 Shenfield Road / A128 Ingrave Road / A1023 High Street	Double Mini-Roundabout	0.78	0.71	0.72
7	A128 Ingrave Road / B186 Queens Road	Mini-Roundabout	0.90	0.93	1.01
8	A128 Ingrave Road / Middleton Hall Lane / Seven Arches Road	Signalised	0.88	0.90	0.95
10	A1023 High Street / B185 Kings Road / A1023 London Road / Weald Road	Signalised	0.71	0.83	0.95
12	Western Road / William Hunter Way	Mini-Roundabout	0.84	0.86	0.95
13	A127 / A128 Brentwood Road / A128 Tilbury Road	Grade Separated Gyratory	0.85	1.00	1.72
14	A127 / Childerditch Lane	Double Priority	0.16	0.20	0.24
15	A128 Ingrave Road / The Avenue	Double Mini-Roundabout	1.02	1.07	1.10
16	A128 Brentwood Road /Running Waters	Double Mini-Roundabout	0.86	0.90	1.21
17	A1023 Brook Street /Mascalls Lane	Signalised	0.89	0.99	1.12

Junction No.	Junction Location	Type	Baseline	Reference	Local Plan + Sustainable Measures
18	B186 Warley Hill / Eagle Way / B186 Warley Rd / Mascalls Lane	Signalised	0.90	0.98	1.04
19	B186 Warley Street / A127 eastbound	Priority (committed mitigation signalised)	0.61	0.71	0.80
20	B186 Warley Street / A127 westbound	Priority (mitigation signalised)	1.02	0.67	1.4%
22	A1023 Chelmsford Road / Alexander Lane	Priority	0.08	0.09	0.09
23	A12 Junction 12	Grade Separated Gyratory	0.75	0.79	0.82
24	Roman Road / A12 Slip	Staggered Priority	0.56	0.58	0.64
25	M25 Junction 28	Grade Separated Gyratory	0.84	1.22	1.76
26	M25 Junction 29	Grade Separated Gyratory	See para. 8.10.6 to 8.10.8		
27	A128 Tilbury Road/Station Road	Priority	0.66	1.00	1.22

Table 8-3: Junction Modelling Summary Results – PM Peak

A12 and M25 Merge Diverge Assessment

8.10.5 A merge diverge assessment has been undertaken at M25 junction 28 on the M25 and A12. The results of the assessment are shown in Table 8.4 and the output diagrams are shown in Appendix M.

8.10.6 The assessment determines what type of junction is required given a mainline and merge/diverge flow. The Type of merges are listed below and also shown in Appendix M are:

- A – Taper Merge
- B – Parallel Merge
- C – Ghost Island Merge
- D – 2 Lane Merge
- E – Lain Gain
- F – Lane Gain with Ghost Island Merge
- G – 2 Lane Gain with Ghost Island
- H – Alternative Ghost Island Merge with Auxiliary Lane

8.10.7 The types of diverge are:

- A – Taper Diverge
- B – Ghost Island Diverge
- C – Lane Drop at Taper Diverge
- D – Ghost Island Diverge for Diverge
- E – 2 Lane Drop

Arm	Existing Layout	AM Peak	PM Peak
M25 Northbound On-slip	F	F	F
M25 Southbound Off-slip	D	D	E
A12 Eastbound On-slip	F	F	F
A12 Westbound Off-slip	A	D	D
M25 Southbound On-slip	F	F	F
M25 Northbound Off-slip	C	D	D
A12 Westbound On-slip	A or D	E	E
A12 Eastbound Off-slip	A	B	B

Table 8-4: M25 Junction 28 Merge/Diverge Assessment – Results

M25 Junction 29

8.10.8 The Lower Thames Crossing consultation documents include a scheme at this junction which will include a left turn lane being provided from the westbound A127 onto the southbound M25. This would mean that the access for the Brentwood Enterprise Park could not be delivered at this point.

8.10.1 Highways England have indicated that they would be willing to work with the site promoters to work out a solution for accessing the Enterprise Park. Therefore, at this stage no modelling of this junction is included within this report. Alternative options for both access for the Enterprise Park and the M25 junction 29 scheme associated with the Lower Thames Crossing have not been modelled, but this is being examined further.

8.10.2 A junction assessment of the M25 junction 29 has been undertaken, however this has been based on the provision of an access to the Brentwood Enterprise Park directly on to the roundabout at the junction. This indicated that the junction did not operate within capacity and the likelihood of this access coming forward is very small.

8.11 Results Summary

8.11.1 The tables above show the performance of the junctions in the AM and PM peak hours, which are recognised as the worse-case, in terms of traffic congestion. The results highlight that there are some junctions which are already over capacity in the Reference Case and others that are only over capacity in the Local Plan scenario.

8.11.2 A list is provided below of any junction which has been shown to be over capacity in either the AM or PM peaks, in the Local Plan Scenario. Junctions are deemed to be over capacity if they have a V/C greater than 1.00 or a degree of saturation over 100%. In both cases these means that the flow on at least one arm, within the peak hour, is greater than the capacity of the junction:

- A1023 Chelmsford Road/A129 Hutton Road/ A1023 Shenfield Road
- A129 Rayleigh Road/Hanging Hill Lane
- A128 Ongar Road/Doddinghurst Road
- A128 Ongar Road/William Hunter Way
- A128 Ingrave Road/B186 Queens Road
- A1023 High Street/B185 Kings Road/A1023 London Road/Weald Road
- A127/A128
- A128 Ingrave Road/The Avenue
- A128 Brentwood Road/Running Waters
- B186 Warley Hill/Eagle Way/Warley Road/Mascalls Lane
- A12 Slip/Roman Road, Ingatestone
- M25 Junction 28
- A128 Tilbury Road/Station Road

8.11.3 Some of these junctions are shown to be only just over desirable capacity in what is recognised as the most congested time on the network and this is modelled at the end of the plan period. Therefore, when considering mitigation, the level at which it is over capacity and in line with NPPF the severity of any change should be considered. A pragmatic view should be taken as to whether physical highway mitigation is the best way forward in this situation or whether more emphasis should be put on the provision of alternative sustainable transport measures. This is also the case for many of the junctions which are within Brentwood town centre, where there are a large number of short distance trips which could reasonably be expected to shift to other more modes sustainable. Based on this criterion there is a need to consider the following junctions and discussed further in paragraph 8.11.5 onwards, below:

- A129 Rayleigh Road/Hanging Hill Lane

- A128 Ongar Road/Doddinghurst Road
- A128 Ongar Road/William Hunter Way
- A128 Ingrave Road/B186 Queens Road
- A128 Tilbury Road/Station Road

8.11.4 Physical highway mitigation has been identified at the following junctions and this is detailed further in Section 9:

- A1023 Chelmsford Road/A129 Hutton Road/ A1023 Shenfield Road
- A128 Ongar Road/William Hunter Way
- A1023 High Street/B185 Kings Road/A1023 London Road/Weald Road
- A127/A128
- A128 Ingrave Road/The Avenue
- A128 Brentwood Road/Running Waters
- B186 Warley Hill/Eagle Way/Warley Road/Mascalls Lane
- A12 Slip, Roman Road, Ingatestone
- A128 Tilbury Road/Station Road

A129 Rayleigh Road/Hanging Hill Lane

8.11.5 This junction is shown to only be operating just over capacity in the AM peak only, therefore physical mitigation has not been suggested. The modelling indicates that the largest delay is on Hanging Hill Lane, with maximum delay increasing from around 112 seconds in the Reference Case to 124 seconds in the Local Plan Scenario. This 12 second increase is not deemed Severe.

A128 Ongar Road/Doddinghurst Road

8.11.6 This junction is over capacity in both peaks, however, in the PM peak it is only just so. In the PM peak, the largest delay is on Ongar Road North, with delay increasing from 50 seconds in the Reference Case to 67 seconds in the Local Plan Scenario.

8.11.7 In the AM peak, the largest delays are experienced on Doddinghurst Road. Delays increase from 159 seconds to 237 seconds on this approach arm.

8.11.8 During the AM peak, it is recognised that school traffic forms a high proportion of traffic in Brentwood town centre. Therefore, through targeting school traffic through sustainable travel measures as identified in Section 7, it would be possible to reduce traffic levels to such that this junction could operate within its current capacity.

8.11.9 In addition, a sensitivity test has been undertaken for peak spreading in the AM peak. This shows that if peak spreading occurred, just in the peak hour, i.e. traffic arrival profiles were flatter, then the junction would operate within capacity. This also demonstrates that the provision of mitigation at this junction is only required for a very short period and this further suggests that there is no requirement for physical mitigation measures.

A128 Ongar Road/William Hunter Way

8.11.10 This junction is located within Brentwood town centre and it is recognised that there are traffic issues at this location, linked with interactions at Wilson's Corner and particularly in the AM peak, interactions associated with school drop-offs.

8.11.11 Further investigation is required to look at these interactions within the town centre and to develop solutions, as part of an over aching study within the town centre. However, solutions are likely to involve better management of traffic, including loading and unloading, and measures to encourage more sustainable travel choices, including parking management strategies rather than highway improvements.

A128 Ingrave Road/B186 Queens Road

8.11.12 As with the previous junction, this junction performs worse in the AM peak than it does in the PM peak. In the PM peak, it is shown to operate only just over capacity, with delays increasing from 67 to 101 seconds.

8.11.13 In the AM peak, Ingrave Road south experiences the largest delays.

8.11.1 A sensitivity test has been undertaken to understand the impact of a school travel planning measure such as the introduction of School Clear Zones, could impact on the junction in the AM peak. This test indicated, that whilst the junction would still operate over capacity, it would be better than the Reference Case Scenario.

8.11.2 In the PM peak, peak spreading within the peak hour has shown that the junction would then operate within capacity.

8.11.3 As a targeted sustainable travel campaign and investment in improvements to facilitate more sustainable travel to school is part of Brentwood's emerging overarching sustainable travel strategy, no further highway mitigation is considered.

M25 Junction 28

8.11.4 The outputs from the junction modelling in both peaks, highlight that the A12 westbound off-slip arm to the junction is well over capacity in the Reference Case with the Highways England preferred scheme for the junction. This is exacerbated in the Local Plan scenario.

8.11.5 In the AM this arm at the junction experiences an increase of 12% between the Base year and Reference Case and an additional increase of only 1%, with the addition of Brentwood Local Plan traffic. In the PM it is 14% and 2% respectively. This indicates that it is the additional background traffic which pushes the junction to operate over capacity.

8.11.6 In addition the outputs from the merge/diverge assessment show that some of the current junctions fall short of the requirement, based on forecast flows. Once again, this is reflective of the impact of background traffic, prior to the addition of Local Plan traffic.

8.11.7 Going forward, there will be a need for Highways England to work with all authorities, whose growth and associated traffic will impact on the operation if this junction, as the current mitigation scheme only provides a mitigation for the south to east strategic traffic movement.

9 Highway Mitigation

9.1 Overview

9.1.1 The following section summarises the proposed highway mitigation at junctions that were identified to operate well above operational capacity as a result of the Local Plan development and where other influences, such as peak spreading, would not have sufficient impact. It also provides detail of additional measures for those junctions that have existing mitigation provided but were still identified not to operate within capacity as a result of the Local Plan development.

9.1.2 This chapter sets out the potential high-level design and construction cost estimates for the possible scheme options put forward in the Brentwood Borough Local Plan to allow Brentwood Borough Council to include the options within their Forward Development Plan.

9.1.3 Where existing mitigation schemes are known to exist from other studies, these have been tested with both the Reference Case and Local Plan Growth flows. These include:

- A127/A128 Scheme provided by ECC
- M25 Junction 29 taken from emerging Transport Assessment work associated with the Brentwood Enterprise Park.

9.1.4 Where no current mitigation measures are proposed, PBA have identified locations for suitable measures which can reduce delay. Where applicable junction models have been reassessed to identify if the mitigation measures are enough to reduce delay sufficiently to achieve an acceptable level of service.

9.1.5 At this stage the mitigation measures are high level schemes which are to be taken forward for further detail design and assessment. Additionally, throughout the timeframe of the Local Plan all junctions should be reviewed to identify how they are operating, to show if further mitigation measures should be undertaken.

9.1.6 As outlined within Section 7 and Table 8-3 and illustrated on Figure 9-1 below four junctions have been identified to require mitigation. Existing mitigation measures are also included at orange locations, which have been assessed within the previous sections.

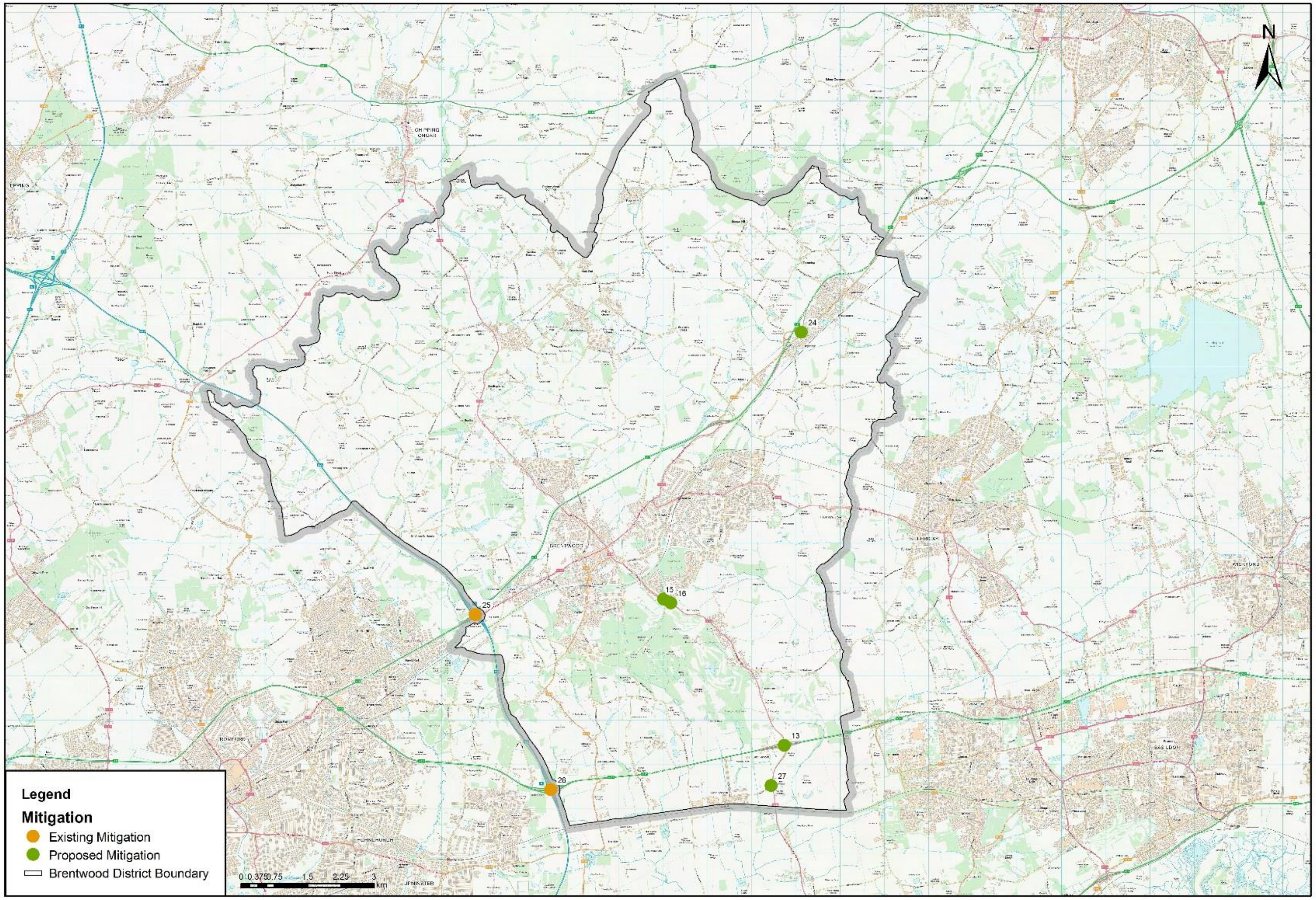
9.1.7 The new mitigation measures have been designed only for junctions 13, 15, 16, 24 and 27. A summary of what measures have been assessed are summarised within Table 9-1 below and illustrated within Figure 9-1. The subsequent results for the mitigation can be found within the following section.

Junction No.	Junction Location	Type	Mitigation to Be Considered
13	A127 / A128 Brentwood Road / A128 Tilbury Road	Grade Separated Gyratory	Installation of signals at the end of the A127 westbound off-slip
15	A128 Ingrave Road / The Avenue	Double Mini-Roundabout	Widening of exit taper onto A128 Ingrave Road, Widening to three lanes between Junction 15 and 16.

Junction No.	Junction Location	Type	Mitigation to Be Considered
16	A128 Brentwood Road /Running Waters	Double Mini-Roundabout	Widening of A128 Brentwood Road to increase stacking capacity up to the roundabout.
24	Roman Road / A12 Slip	Staggered Priority	A12 Slip road widening to provide dedicated left and right turn lanes. Traffic signals implemented
27	A128 Tilbury Road/Station Road	Priority	Station Road widening to provide dedicated left and right turn lanes.

Table 9-1: Junction Mitigation Measures

Figure 9-1: Junction Mitigation Locations



Service Layer Credits: Contains Ordnance Survey data (c) Crown copyright and database right 2018.

9.2 Methodology

9.2.1 A desk top study exercise was carried out by PBA to assess the potential options that could be put forward.

9.2.2 Requirements for each of the proposed tasks needed to undertake the works were identified and discussed, with possible physical constraints identified such as topography, watercourse and buildings and above ground statutory apparatus etc. via a “desk top study” utilising aerial maps and a “virtual drive through”. Environmental investigation and scoping was limited to reviewing the DEFRA “Magic” website only.

9.2.3 The construction requirements for each of the tasks were discussed and agreed upon. Mitigation designs are based on past-experience of highway design, understanding of similar projects within the area and knowledge of locality. Any substantial construction issues such as new embankments, new bridges, rail crossings etc. were highlighted at this stage.

9.2.4 No investigation was carried out into specific land ownership details, or into the location details or cost of moving Statutory Undertakers and Utility Apparatus within the areas of the scheme. No additional design work will be carried out past the high-level plans found within this chapter. No design assessments were carried out at this stage to ascertain the build-ability of the proposals except where any Health and Safety concerns were raised.

9.2.5 Level 1 cost estimates were produced, see Section 3 below for further details on cost estimates.

9.3 Costs

9.3.1 Costing at this stage are very high level based on professional judgement. All costs for each task have been based on the knowledge, skills and experience of the team and their understanding of similar recent projects and the locality. Therefore, no industry standard references (such as SPONS or similar) have been used at this stage of the design process.

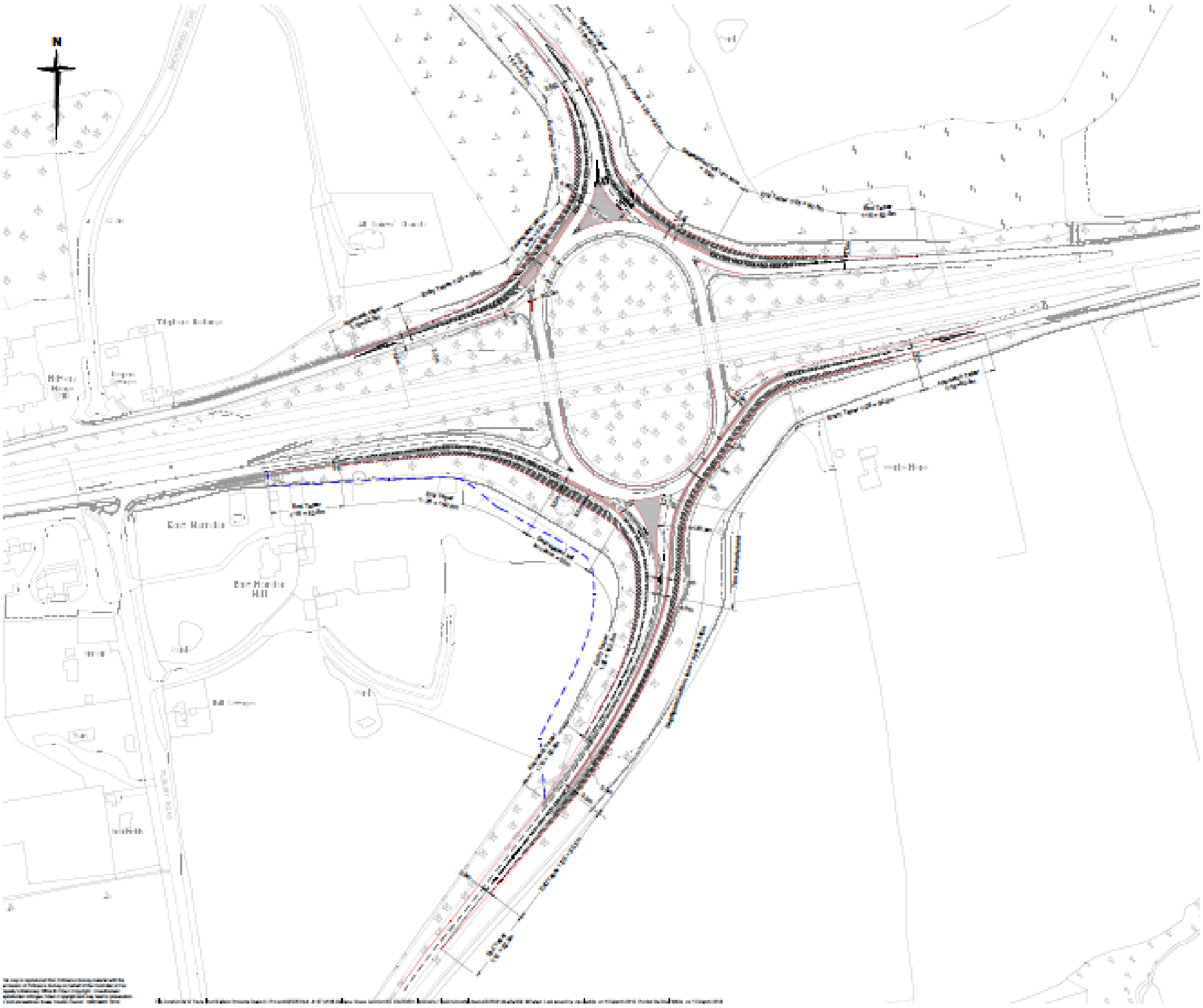
9.4 Summary of Junction Mitigation

Junction 13 – A127 / A128 Brentwood Road / A 128 Tilbury Road – Mitigation

ECC Mitigation Scheme

9.4.1 A mitigation scheme has been developed as part of the A127 Growth Study, this scheme is not currently committed or funded. Scheme details for the mitigation have been provided to PBA by ECC. The mitigation includes the introduction of dedicated left turning lanes on all arms, for the modelling of this junction, the left turns have been removed from the matrices. Additional analysis reviewing the merges has also been assessed. The scheme is shown in Figure 9-2.

Figure 9-2: A127/A128 Mitigation Scheme



9.4.2 The mitigation measures demonstrate that during the Reference Case scenario the junction operates just under capacity during the AM peak, with the maximum RFC being 0.94 on the A127 West, during the PM peak the same arm witnesses the highest RFC of 1.00.

9.4.3 The mitigation measures reduce the impact of the preferred Local Plan Development on the junction and reduce the RFCs on all arms significantly. There are however, still capacity issues on the A127 West with RFCs of 1.03 and 1.72 for the AM and PM peak respectively, showing the traffic using this arm is higher than the proposed mitigation is capable of handling.

9.4.4 A merge diverge assessment has been undertaken, the results can be found within Appendix M.

Further Mitigation

9.4.5 The mitigation proposed outlined in Figure 9-3 includes:

- Enhancing the existing mitigation scheme proposed by Ringway Jacobs and Essex County Council by adding traffic signals to A127 eastbound slip lane exit.

9.4.6 Key Constraints:

- Statutory Utility Apparatus

9.4.7 Approximate cost: £300,000. This cost is only for the addition of the Traffic Signals to the A127 Eastbound exit arm. Costs associated with the Ringway Jacobs and Essex County Council mitigation have not been included.

Figure 9-3: Junction 13 - A128 Ingrave Road / The Avenue / A128 Brentwood Road / Running Waters - Double Mini-Roundabout

Mitigation Modelling Results

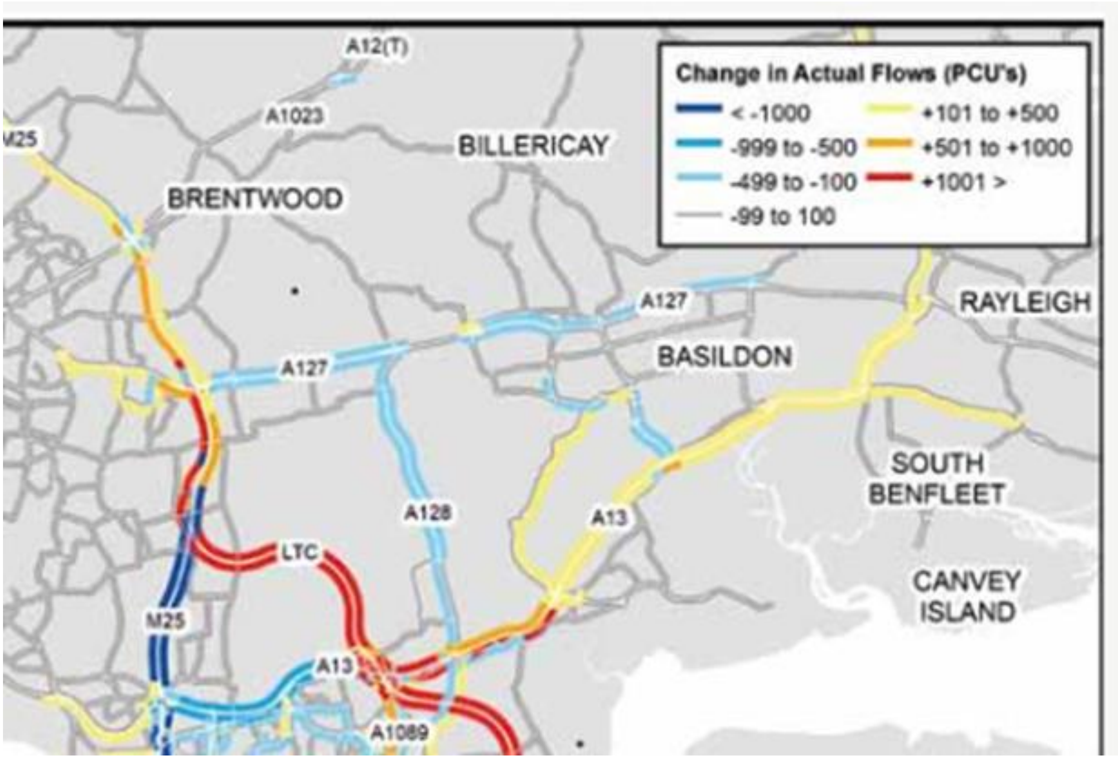
9.4.8 For the Local Plan Growth scenario, the modelling shows that during the AM peak this arm of the junction operates well within capacity with the A127 east arm showing the largest degree of saturation at 70%. During the PM peak, however, the arm shows a degree of saturation of 95%, although this is over capacity, the operation of this junction has improved significantly.

Lower Thames Crossing Impact

9.4.9 It should be noted that the impact of the Lower Thames crossing may result in a reduction in this movement from the A127 west to the A128 south (indicated within earlier HE modelling), which has been identified as the worst performing arm at this junction. However, at this time there is no certainty to if and when the Lower Thames Crossing will be delivered.

9.4.10 Figure 9-4 shows the output from the Lower Thames Crossing modelling, indicating the level of flow reductions expected in the AM peak.

Figure 9-4: Impact of Lower Thames Crossing in AM Peak



(Source: Lower Thames Crossing Statutory Consultation, Highways England, October 2018)

9.4.11 The modelling indicates that there is likely to be a reduction in flows of between 100 and 499 on both the A127 and A128.

9.4.12 Figures 9-5 and 9-6 show the model outputs for flow differences between the Base and Reference Case and between the Reference Case and the Local Plan Scenarios respectively.

Figure 9-5: Flow Differences between Base and Reference Case (AM Peak)

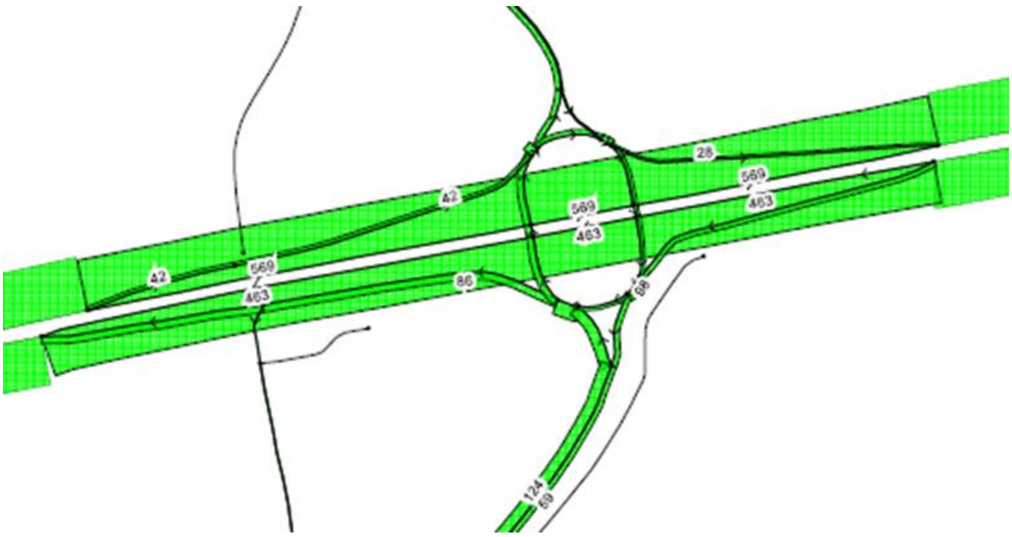


Figure 9-6: Flow Changes from Reference Case to Local Plan

9.4.13 The flows indicate that the level of increase associated with the Local Plan and more specifically in this case, traffic from Dunton Hills, shows that the level of increase could be similar to the level of traffic reduction expected with the Lower Thames Crossing. The main flow change in the AM peak in the Local Plan modelling is from the A128 south to the A127 west. The opposite movement will see a similar change in the PM peak. This indicates that if the Lower Thames Crossing comes forward, there may not be a need for the additional mitigation identified on the A127 eastbound off-slip.

Junction 15 and 16 - A128 Ingrave Road / The Avenue / A128 Brentwood Road / Running Waters - Double Mini-Roundabout - Mitigation

9.4.14 The mitigation proposed outlined in Figure 9-7 includes:

- Widening of A128 Brentwood Road to increase stacking capacity on approach to mini roundabout and provide additional left turn lane,
- Widening of A4128 Brentwood Road between the two mini roundabouts to facilitate three lane carriageway way with two lanes provided for westbound traffic,
- Widening of mini roundabout exit onto A128 Ingrave Road to facilitate merging taper.
- Removal of existing mini roundabout between The Avenue and A128 Ingrave Road/ Brentwood Road and replaced with proposed 3 – way Traffic Signals,

9.4.15 Key Constraints:

- Land Ownership
- Existing Road signs and street lighting
- Statutory Utility apparatus
- Land Drainage Ditch along southern edge of A128 Brentwood Road
- Existing trees and hedgerows

- Approximate Cost: £1.5m

Figure 9-7: Junction 15 and 16 - A128 Ingrave Road / The Avenue / A128 Brentwood Road / Running Waters - Double Mini-Roundabout

Mitigation Modelling Results

9.4.16 Modelling the Preferred Local Plan development flows in the mitigation scheme shows that overall delay on the junction decreases. In the AM peak period, the only remaining arm with high degree of saturation was Ingrave Road which was shown as 94%. In the PM peak period, Ingrave Road has a degree of saturation of 100% and on The Avenue, it is shown as 106%.

Junction 24 - B1002 / A12 Off-slip / Roman Road – Staggered Priority Junctions

9.4.17 The mitigation proposed outlined in Figure 9-8 includes:

- Widening of A12 Off-Slip Road to facilitate dedicated left and right turn lanes;
- Traffic signals proposed at A12 Off-Slip / Roman Road junction.

9.4.18 Key Constraints:

- Existing road signs and street lighting columns/ connections
- Land ownership and potential requirement for third party land
- Embankment remodelling on the western side of the A12 Slip Road

9.4.19 Approximate costs: £400,000

Figure 9-8: Junction 24 - B1002 / A12 Off-slip / Roman Road – Staggered Priority Junctions

Mitigation Modelling Results

9.4.20 Modelling the Preferred Local Plan development in the mitigation scheme shows that the junction operates within capacity. In the AM peak period, the highest degree of saturation shown was 47% on the Roman Road East and in the PM period 57% was shown on the A12 off slip.

Junction 27 - A128 / Tilbury Road / Station Road – Priority Junction - Mitigation

9.4.21 The mitigation proposed, outlined in Figure 9-9 includes:

- Widening of Station Road to facilitate dedicated left and right turn lanes;

9.4.22 Key Constraints:

- Land Ownership
- Existing signs and street furniture
- Existing Hedgerow and Trees

9.4.23 Approximate Cost: £400,000

Figure 9-9: Junction 27 - A128 / Tilbury Road / Station Road – Priority Junction

Mitigation Modelling Results

9.4.24 Modelling the Local Plan Growth, the junction operates just over capacity during the AM peak, with the highest RFC of 0.68 at the right turn of Station Road, whilst during the PM peak the RFC is 0.86, showing that although the RFC is showing there will still be delay at this junction, the mitigation has significantly improved its operation.

9.5 Highway Mitigation - Junction Assessment Summary

9.5.1 The results of the junction modelling for the junctions where highway mitigation has been provided are shown in Tables 9-2 and 9-3.

Junction No.	Junction Location	Type	Baseline	Reference	Local Plan + Sustainable Travel	Local Plan + Mitigation
13	A127 / A128 Brentwood Road / A128 Tilbury Road	Grade Separated Gyratory	0.85	0.94	1.03	0.70
15	A128 Ingrave Road / The Avenue	Double Mini-Roundabout	1.06	1.15	1.24	0.94
16	A128 Brentwood Road /Running Waters	Double Mini-Roundabout	1.08	1.14	1.25	0.89
24	Roman Road / A12 Slip	Staggered Priority	0.79	0.91	1.14	0.47
27	A128 Tilbury Road/Station Road	Priority	0.54	0.62	0.97	0.68

Table 9-2: Junction Modelling Summary Results where Highway Mitigation Required – AM Peak

Junction No.	Junction Location	Type	Baseline	Reference	Local Plan	Local Plan + Mitigation
13	A127 / A128 Brentwood Road / A128 Tilbury Road	Grade Separated Gyratory	0.85	1.00	1.72	0.95
15	A128 Ingrave Road / The Avenue	Double Mini-Roundabout	1.02	1.07	1.10	1.06
16	A128 Brentwood Road /Running Waters	Double Mini-Roundabout	0.86	0.90	1.21	0.87
24	Roman Road / A12 Slip	Staggered Priority	0.56	0.58	0.64	0.57
27	A128 Tilbury Road/Station Road	Priority	0.66	1.00	1.22	0.86

Table 9-3: Junction Modelling Summary Results where Highway Mitigation Required – PM Peak

9.5.2 The results in the table above indicate that for all junction where mitigation is provided, the junction operates better than within the Reference Case without the mitigation.

9.6 Signalised Junctions

9.6.1 The following signalised junctions are shown to be over-capacity in at least one of the peaks:

- A1023 Chelmsford Road/ A129 Hutton Road/A1023 Shenfield Road
- A1023 High Street/B185 Kings Road/ A1023 London Road/Weald Road

- B186 Warley Hill/Eagle Way/B186 Warley Road/Mascalls Lane
- A1023 Brook Street/Mascalls Lane

9.6.2 Each of these junctions are shown to operate close to or only just above a reasonable level of capacity. Therefore, implementing a more dynamic form of urban traffic control, is likely to provide the additional capacity to improve performance of these junctions.

9.6.3 Microprocessor Optimised Vehicle Actuation (MOVA) is one form of control which is shown to lead to significant increases in capacity at junctions, as it is more responsive to actual traffic conditions. It can provide up to 3% additional capacity and reduce delays by as much as 10% in some cases, which is far higher than would be required to operate each of the junctions at a reasonable level of service and under capacity.

9.6.4 The cost of implementing MOVA would be around £170,000 per junction.

10 Summary and Conclusions

10.1 Overview

10.1.1 PBA have been commissioned by BBC to support the development of the transport evidence base to support the Borough's Local Plan. The specific work being undertaken by PBA is to provide transport modelling support, to assess the impact of the LP on the local and strategic highways in the Borough, up to the end of the proposed plan period in 2033.

10.1.2 This work follows on from the previous work undertaken by PBA where a number of options for development have been tested[10]. This work now pertains to the modelling of a single Local Plan Development option. The modelling work has been undertaken in line with the National Planning Policy Guidance "Transport evidence bases in plan making and decision taking", March 2015.[11]

10.1.3 In preparing this assessment extensive consultation has been undertaken with the relevant highway and planning authorities. A Steering Group comprising officers of BBB, ECC and HE was formed to help guide the methodology and scope of the assessment work and to provide feedback on the outcomes of the junction assessments.

10.1.4 This Transport Assessment summarised:

- the approach undertaken for the modelling work,
- the results of the modelling and junction assessments,
- highlights those worse performing junctions that may require mitigation,
- identified sustainable measures that are proposed to reduce peak highway flows to enable the development sites to come forward.

10.1.5 The Local Plan modelling is at a high level considered appropriate to the strategic nature of the work. It is also considered to provide a worst-case assessment of proposed Local Plan development since it combines robust assumptions regarding background traffic growth and impacts arising from proposed local plan development within neighbouring authorities, with robust assumptions regarding trip generation. The purpose of the modelling work is to understand how the network copes at a strategic level. It is not intended to model the impact of individual access junctions for individual sites, as this would be expected to be undertaken by promoters of individual sites at a later date

10.2 Spreadsheet Modelling

10.2.1 The assignment within the OmniTRANS tool distributes traffic, between all origin and destination points, solely on the basis of the quickest route. The link speeds are supplied from TeletracNavman, to provide average speeds on all links for the desired time period. The modelling does not take account of congestion within the network, beyond that implicit within the TrafficMaster data, therefore not accounting for future changes to traffic congestion. Effectively a single iteration of an 'all or nothing' assignment is undertaken.

10.2.2 The network used for the purposes of the assessment is the Ordnance Survey Integrated Transport Network (ITN), which is imported into the OmniTRANS suite to allow the assignment process to be undertaken and for geographically based graphics to be produced

[10] Brentwood Local Plan Modelling Report 2016

[11] https://www.gov.uk/guidance/transport-evidence-bases-in-plan-making-and-decision-taking

for trip distribution. The routing patterns associated with the developments included were checked to determine that they were sensible.

10.2.3 OmniTRANS then also allows for turning flows, from each development scenario, to be extracted for each of the junctions to be modelled.

10.3 Junction Assessments

10.3.1 A total of 23 junctions have been modelled and assessed using a combination of Junctions 9, ARCADY and PICADY models for priority or roundabout junctions or LinSig for signalised junctions; additionally, TRYNSYT has been used to model J29 of the M25. Table 5-1 summarised what type of junction they are, priority, signalised or roundabout and what modelling software has been used for the assessment.

10.3.2 Where possible each base model has been calibrated and validated using available data to ensure the base models best represent on site conditions which have been taken forward for additional assessment.

10.3.3 Two additional core tests have been assessed. The first is the Reference Case scenario, which includes flows extracted directly from the OmniTRANS model for the forecast year of 2033 and include all growth which is not associated with the Local Plan and which have been added on top of the base flows used for the Base assessment. The second is the Local Plan Growth Scenario, this includes all known Local Plan developments identified by BBC which are likely to form the allocations in the Local Plan after 2033. These trips have been added on top of the trips generated in the Reference Case scenario.

10.3.4 From the assessments, it was identified that there were a number of junctions, specifically J13, J14, J19, J20, J25 and J26 (with the latter two being most effected by the Lower Thames Crossing scheme) that are likely to be influenced more by non-Local Plan development. These junctions will be required to be monitored throughout the Local Plan period to identify any additional impact from other schemes, such as the Lower Thames Crossing Project, the A127 study and any highway effect from the opening of the Elizabeth Line in 2019.

10.4 Sustainable Measures

10.4.1 The Local Plan Guidance for developing the transport evidence base for Local Plans, as well as National Planning Policy Framework, identify that the evidence should be built around sustainable travel and providing opportunities to enhance sustainable transport, through the Local Plan process and to assist in delivery of the plan.

10.4.2 A desktop study has been undertaken to assess potential sustainable transport measures that could be implemented within the local area to assist in reducing this impact. Whilst encouraging modal shift and healthier choices as a result of reduction in car usage, some measures could also be considered as alternatives or supporting mitigation measures other than infrastructure improvements proposed in the local area.

10.4.3 The approach to consideration of sustainable transport, has utilised evidence from the DfT Sustainable Travel Towns study, which identified the success of implementing measures in three demonstration towns and the level of switch from private car that was achieved. We have also highlighted within the report, Brentwood specific sustainable measures, which could come forward through the Local Plan process, which could have potential to bring about a greater shift from the private car to more sustainable measures.

10.4.4 The Local Plan Guidance notes that such measures should be considered prior to any consideration of physical highway mitigation, which may provide short term relief at junctions, for the short time period where after they may again be over capacity.

10.4.5 The Local Plan development, should be an opportunity to re-balance the investment in transport, with far greater emphasis on sustainable travel, from improved signing and way-marking to upgraded public transport, as well as travel planning measures, that will bring benefit to both new Local Plan sites and existing population within the Borough.

10.5 Physical Mitigation Requirements

10.5.1 Following the consideration of sustainable travel mitigation, it has been identified that a number of junctions may still require physical mitigation, as a result of the impact of the Local Plan developments.

10.5.2 Specific mitigation measures have been designed for the following junctions:

- A1023 Chelmsford Road/A129 Hutton Road/ A1023 Shenfield Road
- A1023 High Street/B185 Kings Road/A1023 London Road/Weald Road
- A127/A128
- A128 Ingrave Road/The Avenue
- A128 Brentwood Road/Running Waters
- B186 Warley Hill/Eagle Way/Warley Road/Mascalls Lane
- A12 Slip, Roman Road, Ingatestone
- A128 Tilbury Road/Station Road

10.5.3 A desktop study was carried out to assess the potential options that could be put forward for subsequent testing. Requirements for each of the proposals was identified and any physical constraints identified, no investigation to land ownership or costs involving the moving of Statutory Undertakers and Utility Apparatus was undertaken. The measures also include an initial cost.

10.5.4 The models including the mitigation measures on the Reference Case and Local Plan flows identified that they were successful in reducing predicted delay at the junctions. In some cases, the RFC or degree of saturation was still over capacity but showed significant decrease in comparison with the no mitigation scenarios.

10.6 Conclusion

10.6.1 The transport work identified within this report has demonstrated that through sustainable transport measures and in some cases, limited physical highway improvement works, the impact of the Local Plan can be mitigated and that there are no major residual impacts that might prevent the delivery of the Local Plan development. Table 10.6 sets out an overall summary of the position of each of the junctions assessed, as part of this Local Plan Transport study.

Junction No.	Junction Location	Conclusion
1	A1023 Chelmsford Rd / A129 Hutton Rd / A1023 Shenfield Rd	Implementation of MOVA (or similar) as a mitigation should provide adequate capacity
2	A129 Rayleigh Road / Hanging Hill Lane	Impact not deemed severe – no mitigation required

Junction No.	Junction Location	Conclusion
3	A128 Ongar Road / Doddinghurst Road	Town Centre junction where sustainable transport mitigation will be required
5	A128 Ongar Road / William Hunter Way	Town Centre junction where sustainable transport mitigation will be required
6	A128 Ongar Road / A1023 Shenfield Road / A128 Ingrave Road / A1023 High Street	Operates below capacity - No mitigation required
7	A128 Ingrave Road / B186 Queens Road	Town Centre junction where sustainable transport mitigation will be required
8	A128 Ingrave Road / Middleton Hall Lane / Seven Arches Road	Operates below capacity - No mitigation required
10	A1023 High Street / B185 Kings Road / A1023 London Road / Weald Road	Implementation of MOVA (or similar) as a mitigation should provide adequate capacity
12	Western Road / William Hunter Way	Town Centre junction where sustainable transport mitigation will be required
13	A127 / A128 Brentwood Road / A128 Tilbury Road	Mitigation Scheme Provided
14	A127 / Childerditch Lane	Operates below capacity - No mitigation required
15	A128 Ingrave Road / The Avenue	Mitigation Scheme Provided
16	A128 Brentwood Road /Running Waters	Mitigation Scheme Provided
17	A1023 Brook Street /Mascalls Lane	Implementation of MOVA (or similar) as a mitigation should provide additional capacity
18	B186 Warley Hill / Eagle Way / B186 Warley Rd / Mascalls Lane	Implementation of MOVA (or similar) as a mitigation should provide additional capacity
19	B186 Warley Street / A127 eastbound	Funded ECC Scheme Provides adequate capacity
20	B186 Warley Street / A127 westbound	Funded ECC Scheme Provides adequate capacity
22	A1023 Chelmsford Road / Alexander Lane	Operates below capacity - No mitigation required
23	A12 Junction 12	Operates below capacity - No mitigation required
24	Roman Road / A12 Slip	Mitigation Scheme Provided
25	M25 Junction 28	Further work required with HE and other authorities
26	M25 Junction 29	Further work required with HE and other authorities
27	A128 Tilbury Road/Station Road	Mitigation Scheme Provided

Table 10-1: Junction Summary

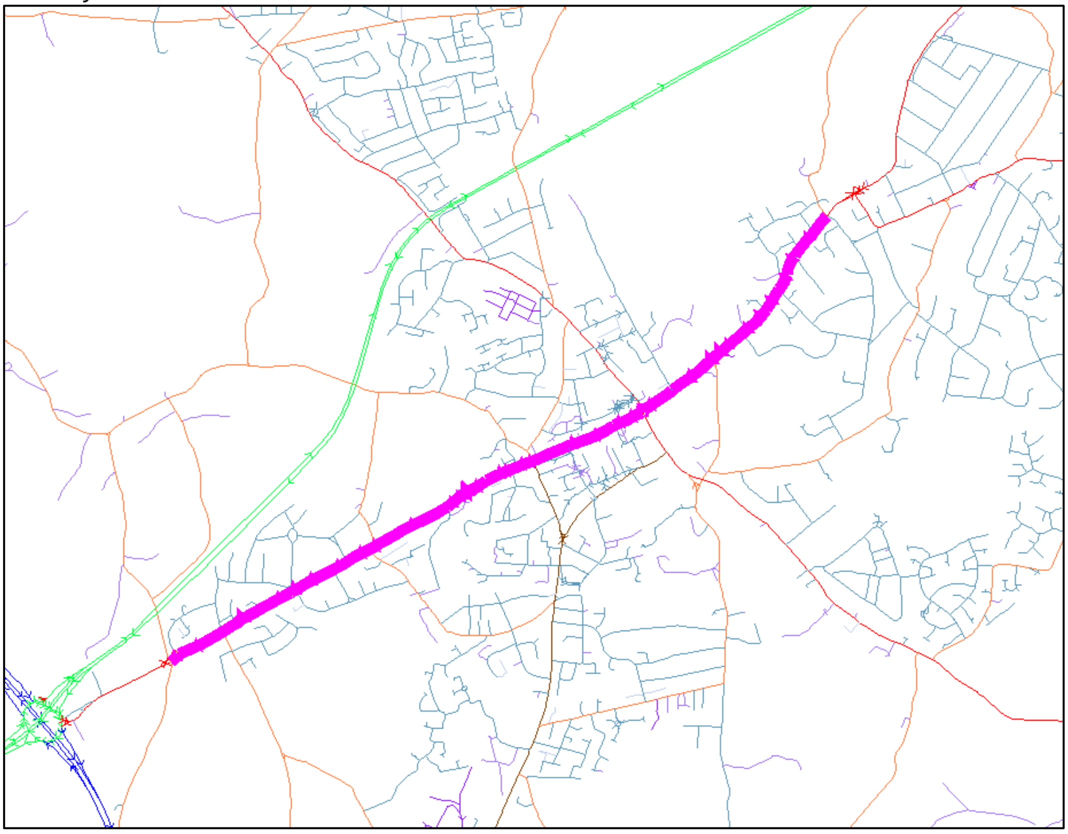
10.6.2 The evidence provided in this report show that the Local Plan can be delivered and any impact can be mitigated, through either sustainable travel interventions or physical highway mitigation. Through concentrating investment on improving sustainable transport, this will benefit all residents within the borough, not just those in the new developments.

10.6.3 There are still some elements related to the Strategic Road Network, where the impact is wider than from Brentwood, where there will be a need to work with Highways England and other authorities to examine these issues further.

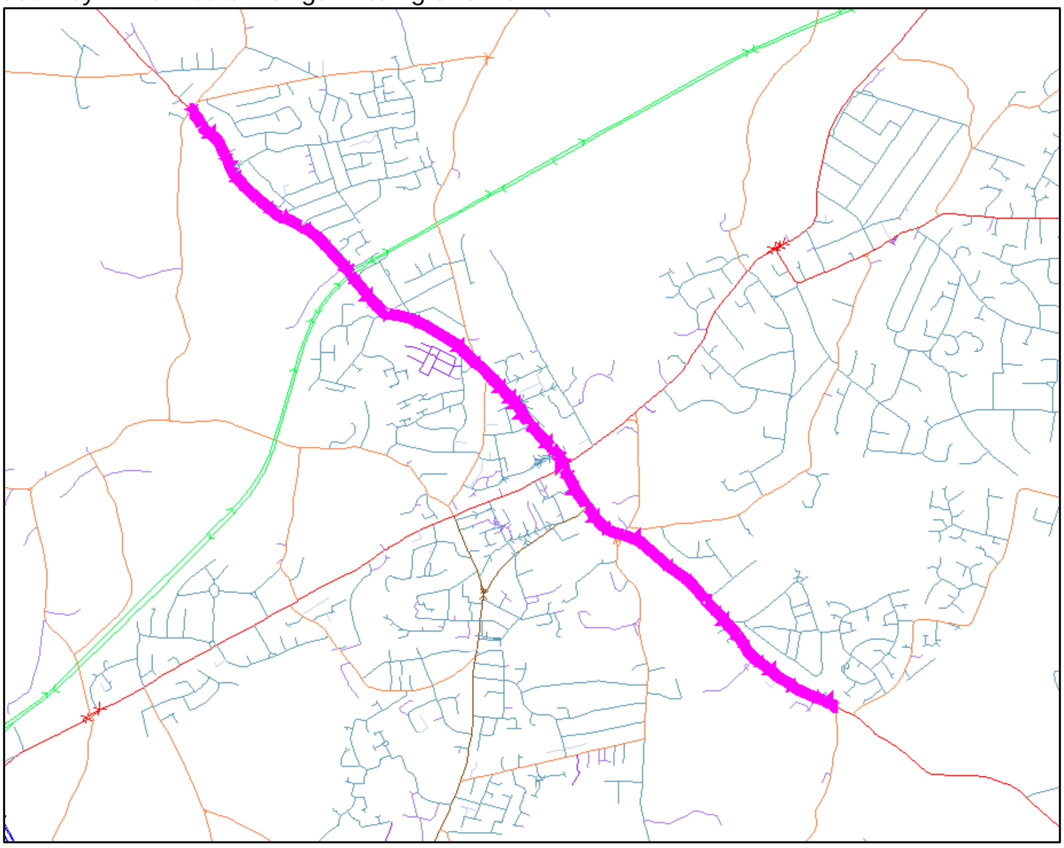
Appendix A Count Data Analysis

Appendix B Journey Time Routes

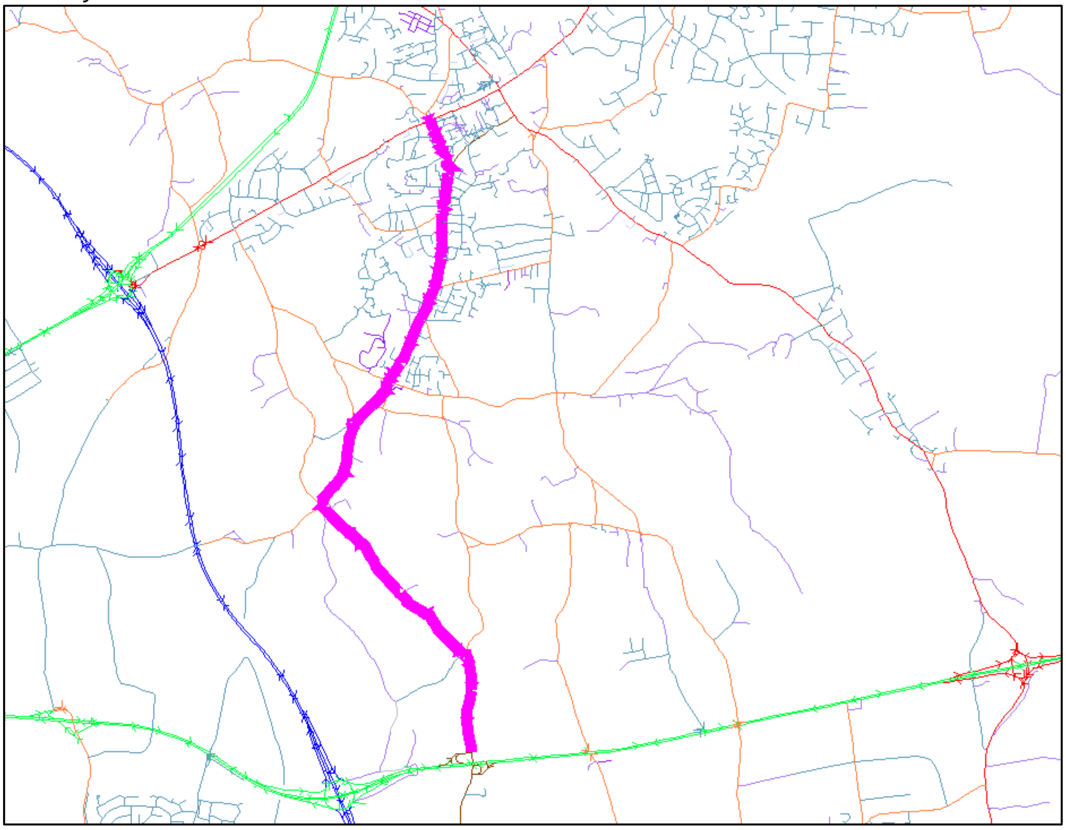
Journey Time Route - A1023



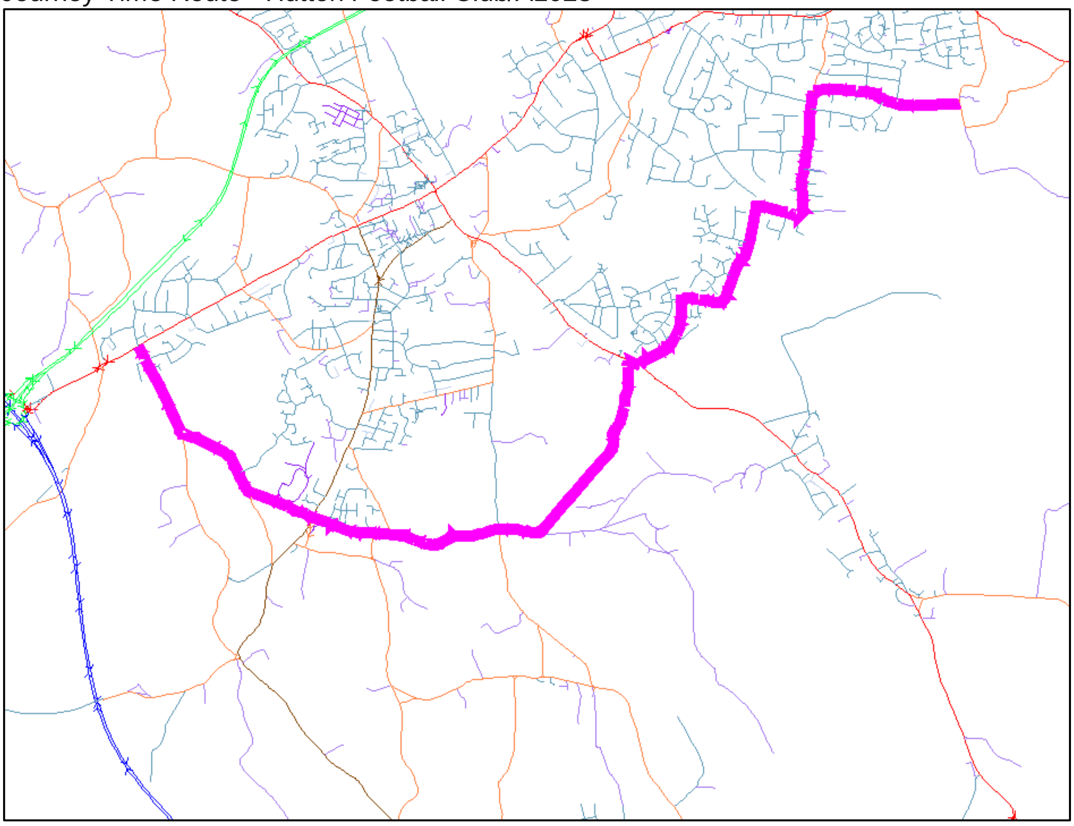
Journey Time Route - Ongar Rd/Ingrave Rd



Journey Time Route - B186/A1023



Journey Time Route - Hutton Football Club/A1023



Appendix C NTS Accessibility

Job Name:	Brentwood Local Plan – Transport Modelling
Job No:	28085
Note No:	28085-BLPTM-TN002
Date:	26/04/2018
Prepared By:	Jamie Pound
Subject:	Use of NTS to inform Trip Rates by Accessibility Level

Introduction

This technical note is one of a series of notes produced to assist in the understanding of the methodology in developing the modelling tools used to assist in the development of the transport evidence base for the Brentwood Local Plan. This note sets out how NTS trip rates have been used to account for differing accessibility levels for zones within the model area.

Use of NTS Data to Inform Accessibility Levels

NTS has been used within the development of the model to date to provide trip rates for different trip purposes and age groups. This approach has previously been agreed with Essex highways and Highways England through dialogue with AECOM, as part of the earlier study. A comparison of these rates, against TRICS was also previously undertaken and it was agreed that an adjustment would be made to NTS rates to reflect some differences. NTS provides a rich source of data, as it can break trip rates down by trip purpose, mode and age group, unlike TRICS, which provides additional flexibility within the modelling tool..

As part of the updated modelling, PBA have been considered the NTS data further to take account of different accessibility levels, depending upon the geographical location of proposed developments, NTS includes categorisation by area definitions for five types, which are:

- Major Conurbation
- Urban City or Town
- Rural Town or Fringe
- Rural Village,
- Rural Hamlet or Isolated Dwelling

The previous model combined the latter three definitions, to provide a single set of trip rates by trip purpose and age group.

To allow different accessibility levels to be taken into account for development zones, a set of trip rates for each of the latter three definitions have been produced. The categories used within NTS, match those assigned to census output areas, with each output area within the UK, falling into one of the four definitions. Within the model, this allows the zones to be categorized in the same way, as they are based on census output areas.

DOCUMENT ISSUE RECORD

Technical Note No	Rev	Date	Prepared	Checked	Reviewed (Discipline Lead)	Approved (Project Director)
28085/5505/TN001	-	27.04.18	DC	PG	PG	RP

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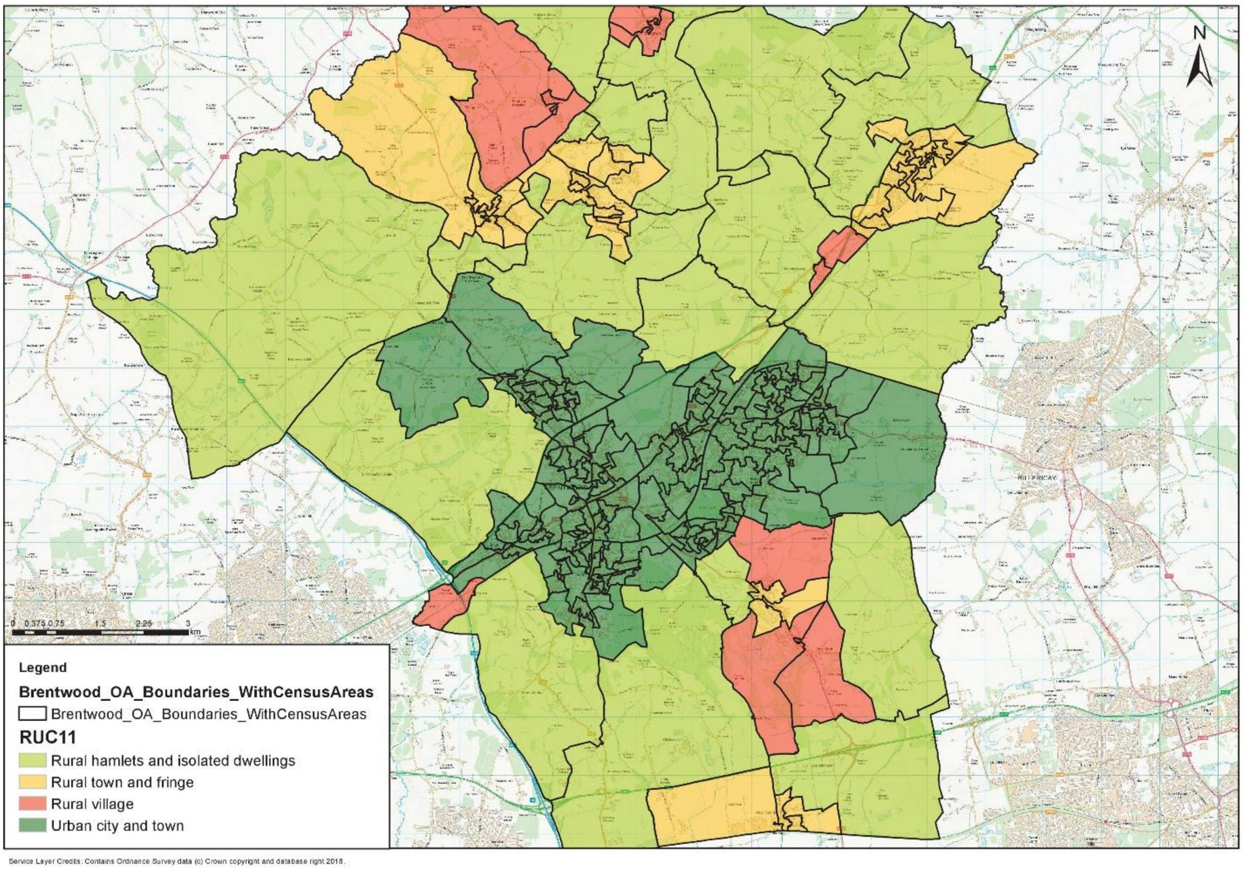
Each of the zones in the model have been allocated one of the area definitions, based on the census output area definition for that zone. By using this data, combined with the location of each of the committed/LP developments it was possible to assign an appropriate NTS trip rate.

Figure 1 shows the census OA classifications.

Figure 1: 2011 Census OA area classifications



Using this methodology means that the number of trips for each of the developments will be more accurate with higher levels of car trips outside of the urban areas and a lower level of walk/cycle trips.

The NTS trip rates will be used within the initial assessment of the local plan developments. As part of the mitigation that will be required to assist in delivering the local plan, sustainable travel measure will be required. These will be taken on board and will require further adjustment to trip rates/trips from both the local plan developments and the other areas which may benefit from the introduction of such measures. The methodology for deriving this further reduction will be detailed in a separate technical note.

NTS Trip Rates Used

An extract of the trip rates used for each of the categories are shown in Tables 1, 2 and 3 for Urban City or Town, rural town or fringe and rural village/rural hamlet and isolated dwellings respectively. The rates shown are for 08:00-09:00, home to purpose, work/employers business and education.

TIME PERIOD :		0800-0900						
NTS Trip Rates								
Home-to-Purpose Trips								
						Trips per Person	Trips per Person	Trips per Person
						Age 0-16	Age 17-64	Age 65+
		Destination Purpose :	Work & EB					
			Mode :	Walk & Cycle		0	0.030752	0.010705
			Mode :	Car/Van Drive		0	0.112582	0.064583
			Mode :	Car/Van Passenger		0.007231	0.014216	0.003335
			Mode :	All Modes		0.012773	0.176157	0.081401
		Destination Purpose :	Education					
			Mode :	Walk & Cycle		0.199752	0.005874	0
			Mode :	Car/Van Drive		0	0.003167	0
			Mode :	Car/Van Passenger		0.102753	0.003203	0
			Mode :	All Modes		0.471097	0.018993	0

Table 1: NTS Rates Urban City or Town

TIME PERIOD :		0800-0900						
NTS Trip Rates								
Home-to-Purpose Trips								
						Trips per Person	Trips per Person	Trips per Person
						Age 0-16	Age 17-64	Age 65+
		Destination Purpose :	Work & EB					
			Mode :	Walk & Cycle		0	0.020023	0.001601
			Mode :	Car/Van Drive		0	0.116461	0.04987
			Mode :	Car/Van Passenger		0	0.010568	0.003146
			Mode :	All Modes		0.020462	0.156727	0.054616
		Destination Purpose :	Education					
			Mode :	Walk & Cycle		0.061139	0.001914	0
			Mode :	Car/Van Drive		0	0.003341	0
			Mode :	Car/Van Passenger		0.085308	0.002227	0
			Mode :	All Modes		0.406418	0.014872	0

Table 2: NTS Rates Rural Town or Fringe

TIME PERIOD :		**0800-0900**							
NTS Trip Rates									
Home-to-Purpose Trips									
							Trips per Person	Trips per Person	Trips per Person
							Age 0-16	Age 17-64	Age 65+
		Destination Purpose :	Work & EB						
			Mode :	Walk & Cycle			0	0.003213	0
			Mode :	Car/Van Drive			0	0.123126	0.074839
			Mode :	Car/Van Passenger			0	0.0105	0.001056
			Mode :	All Modes			0	0.141887	0.075895
		Destination Purpose :	Education						
			Mode :	Walk & Cycle			0.012638	0.000745	0
			Mode :	Car/Van Drive			0	0.00539	0
			Mode :	Car/Van Passenger			0.105079	0.002824	0
			Mode :	All Modes			0.380083	0.013426	0

Table 3: NTS Rates Rural Village/Rural Hamlet and Isolated Dwellings

Summary

The approach used to inform accessibility levels by geographical location, has utilised NTS area definition categories. It is felt that this is a proportionate approach to account for the different accessibility levels within the model and maintains a level of consistency with the use of NTS data to provide trip rates.

NTS is a rich source of data for providing trip rates and can be broken down easily by trip purpose, which is an advantage over TRICS.

Appendix D NTS Trip Rates v. TRICS

Appendix E Sustainable Transport Measures - Central and Northern Brentwood

Appendix F Potential Park Ride and Stride Hub Sites

Appendix G Sustainable Transport Measures - Southern Brentwood

Appendix H Reference Case Flows

Appendix I Local Plan Flows

Appendix J Trip Distribution Plots – Dunton Hills and Brentwood Enterprise Park

Appendix K Junction Modelling – Summary Outputs

Appendix L Full Junction Modelling Files

Appendix M Merge/Diverge Assessments