Cheshunt and Waltham Cross A10 Study

Assessment of Impact of Local Development Framework Proposals on Key Junctions

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Document Control Sheet

Report Title	Cheshunt and Waltham Cross A10 Study
CD Reference	
Status	Final
Revision	7
Control Date	1 August 2011

Record of Issue

Issue	Status	Author	Date	Check	Date	Authorised	Date
	Final Draft	TK	31-5-2011	MC	31-5-2011	MC	31-5-2011
	Final	TK	1-8-2011	MC	1-8-2011	MC	1-8-2011

Distribution

Organisation	Contact	Number of Copies
Hertfordshire Highways	David Burt	4

Contents

Figures

Tables

Executive Summary

1. This study is aimed at determining the impact of the Broxbourne Local Development Framework (LDF) proposals on key junctions on the A10 in the Cheshunt and Waltham Cross area. The study also tests mitigating measures that have previously been proposed within the Waltham Cross and Cheshunt Urban Transport Plan (UTP) to deal with congestion issues and suggest alternative proposals to mitigate the impact of LDF land use changes.

2. Forecast results from a Transport Assessment Model (TAM) developed for Broxbourne by MVA Consultancy and a Transport Assessment for the Brookfield Riverside development were directly used as the source of future traffic flows, after adjustment with recent traffic counts.

3. The impact of traffic flow for three 'Development Packages' were analysed, namely a 2031 Case with no development in Broxbourne (i.e. only background traffic growth occurring), with the LDF short term aspirations taking place (Package 2) and a package with all the developments in the LDF taking place (Package 5).

4. The TAM forecast additional vehicle trip for Package 2 of 1,589 in the AM peak and 2,454 in the PM peak hours. For Package 5 the corresponding numbers are 4,493 for the AM peak and 4,993 for the PM peak hour. The forecast increases in traffic flow on the A10 are approximately +15% for the AM peak and +15% to +20% for the PM peak under Package 2 and +30% in the AM and +50% in the PM peak under Package 5.

5. Analysis of the junctions from the M25 to the A10 / Church Lane junction showed that the junction are already operating close to or at capacity and that no set of low cost measures will accommodate the forecast growth in traffic. Specifically, the junctions of the A10 with College Road and Church Lane are the most severely stressed with increased traffic flows. As a result, a further option for widening the A10 at these two junctions has been modelled and has been shown to accommodate development growth approaching Package 2 but not Package 5. Significant works will also be required to accommodate Package 2 at the other junctions investigated.

6. At all junctions, widening options would affect underground services and require purchase of land outside the existing highway. Widening of the A10 would also affect residents‟ accesses and parking and impact on existing structures. Cost estimates that are provided in this report are based on conceptual designs and broad unit prices and would need to be refined as proposals are developed further. Detail identification and assessment of land requirements and impact were outside the scope of this study and Hertfordshire County Council will not be liable for any damages or loss arising to private landowners as a result of its publication..

7. There have been slight changes in the LDF proposals since development of the TAM. Also, the trip generation used in the TAM is likely to overestimate rather than underestimate vehicle trip generation. It must however be emphasised that, even taking these into account, it is unlikely to alter the general conclusion from this study. The numbers in paragraph 4 above underline the magnitude of forecast growth, while it has been shown that the junctions on the A10 are already operating at or close to capacity.

8. The following table summarises the results in broad terms:

Junction	Improvements tested	Accommodate 2031 Base	Accommodate Package 2	Accommodate Package 5	Land Required	Services Affected	Indicative costs
A10 / M25	Eb-Nb & Nb-Wb slips	Yes	Yes	No	N / A	Yes	£42.28M
A10 / A121 / B198	Full signalisation, 3 circulatory lanes and A10 southbound widening	Yes	Stressed	No	Yes	Yes	£2.64M
A10 / A121 / B198	Signalised 'Hamburger' junction	Yes	Yes	No	No	Yes	£2.02M
A10 / College Road	Separate Signal Stages	No	No	No	No	No	£175k
A10 / College Road	A10 Widening	Yes	Stressed	No	Yes	Yes	£12.33M
A10 / Church Lane[1)]	Additional westbound lane	Yes	No	No	Yes	Yes	£7.47M
A10 / Church Lane[1)]	A10 Widening & westbound lane	Yes	Yes	No	Yes	Yes	£16.66M
A10 / Church Lane[1)]	A10 Widening & westbound lane, southbound right turn ban with pedestrian stage	Stressed	No	No	Yes	Yes	£12.3M
Turnford Interchange[2)]	Dedicated left turn slip roads and new southbound on-slip	Yes	Yes	Not fully tested	Yes	Likely	Dev Proposal
New River Arms Roundabout[2)]	Widening on east bound approach	Yes	Yes	Not fully tested	No	Likely	Dev Proposal

Cost estimates are in 2009 prices – refer to Section 11

[1)] Based on AM only, forecast PM data unreliable

[2)] Based on PM data from Transport Assessment

[3)] 'Stressed' refers to the junction as a whole operating very close to capacity with demand exceeding on some arms.

9. There are options in the areas of Travel Demand Management , 'Smarter Choices' and Intelligent Transport Systems aimed at reducing person and vehicle trip generation and making optimal use of existing infrastructure. These should undoubtedly have to be pursued, but given the magnitude of the forecast increase in trips associated with the LDF, are unlikely to be able to negate the need for highway improvements. As an indication, better use of roadspace, capacity provision and demand reduction will have to combine to accommodate 30 to 50% of total forecast demand to maintain levels of operations.

10. The tests illustrate that highway improvements alone would not fully cater for the collective impacts of the proposed developments in either of the packages tested. In order to accommodate development, strategic masterplanning would be required to include the need for improvements to all modes of transport and to identify highway improvements associated with specific areas of development. It is important that a timetable is agreed that sets out the delivery of developments and the trigger points of required highway improvements and interventions.

11. In addition to the highway measures noted in this report, necessary sustainable transport measures would need to be costed and included. This is a prerequisite for a scheme under which financial contributions to mitigation measures can be collected through planning obligations. Given the number of developments involved, a scheme set up under the Community Infrastructure Levy Regulations may be appropriate.

12. The table below shows the sequence of studies undertaken to date and future work with the lead authorities identified.

Sequence of Studies

Study	*Lead Organisation*	*Consultant*	*Summary of Study Area and Study*
Delivering Strategies Broxbourne Transport Modelling	`	*MVA*	*Study commissioned to further consider highway impacts of LDF traffic in the Borough following mock inspection comments. Study used a spreadsheet based model (TAM) and identified stress on A10 junctions in the Borough.*
Waltham Cross and Cheshunt A10 Study	*HCC in partnership with Broxbourne and the Highways Agency*	*Mouchel*	*Study commissioned to further consider impacts of LDF traffic and consider interventions on the A10 between the M25 and Turnford Interchange following recommendations from the Waltham Cross and Cheshunt UTP (Oct 2010) and the MVA study. Junction models produced to test interventions.*
A10 Route Management Strategy	*Broxbourne in partnership with HCC and Highways Agency*	*TBC*	*The need for an A10 Route Management Strategy is identified by Broxbourne Council in their Core Strategy. A funding mechanism for this study is still to be established.*

1 Introduction

Hertfordshire Highways have commissioned Mouchel to undertake a study to determine the impact of the Broxbourne District Council's Local Development Framework (LDF) proposals on key junctions on the A10 in the Cheshunt and Waltham Cross area, and to test mitigating measures that have previously been proposed within the Waltham Cross and Cheshunt Urban Transport Plan to deal with congestion issues as well suggesting alternative proposals to mitigate the impact of LDF land use changes.

It was agreed that forecast results from a Transport Assessment Model (TAM) developed for Broxbourne by MVA Consultancy and described in a report *Delivering Strategies - Broxbourne Transport Modelling* for Broxbourne Borough Council, July 2010, will directly be used as the source of future traffic flows. Henceforth, this report will be referred to as the MVA Report.

The proposal for the study includes the testing of three scenarios: The 2011 base case, 2031 Package 2 (Developments in the LDF Core Strategy foreseen to progress in the shorter term) and Package 5 (Maximum Development, including all LDF areas of search). The scenarios and packages included in the study are described in more detail in Sections 1.3 and 5. The study area was the junction on the A10 between and including the Turnford Interchange and M25 Junction 25 as shown on Figure 5 on page 7. The six junctions listed in Section 2.1 were assessed in detail, but traffic using other access points were included in the junction models.

1.1 The role of the A10

The A10 was historically the main road between Central London and Cambridge, passing through Hertfordshire. In Hertfordshire, the route passes through or close to the major towns of Cheshunt, Hoddesdon, Hertford, Ware and Royston thus providing regional access to these towns. The M11 has taken over some of the regional function of the A10 as connector from the M25 to Cambridge. Cambridge is signed at the M11 / M25 Junction 27 and not from A10 / M25 Junction 25. Cambridge is signed at other junctions on the A10 e.g. the A121 and A414.

Given the regional function of the A10 through the study area, it can be expected to carry relative high volumes of through traffic, although that aspect has not been quantified as part of this study.

The A10 is the only major road that provides regional vehicle access to the study area, connecting to the M25 to the south and the A10 extending northwards. The A10 is a 4-lane dual carriageway through the study area, recently widened to three lanes in short sections at the Park Plaza junction between the A10 junctions with the A121 and the M25. Access is limited to major junctions but there are some frontage accesses in the Cheshunt area.

As will be discussed in more detail, when analyses of specific junctions are presented in Section 10 of this report, the A10 suffers traffic congestion during peak periods. Due to its traffic carrying function and geometry, the A10 has a segregating effect on the local community and act as a barrier to local movement. Internal journeys have limited opportunities to cross the A10. This also makes for poor accommodation of east-west movement for pedestrians and cyclists.

1.2 Local Development Framework

The Broxbourne Local Development Framework (LDF) Core Strategy sets out the spatial vision for the future of Broxbourne and addresses the key planning issues facing the borough. The following introduction is primarily extracted from the Submission Document December 2010, to serve a background.. The LDF Core Strategy explores the unique features of the borough and identifies the main challenges and key drivers of change over the next 15 years. It sets out plans to guide new development, regenerate neighbourhoods, improve services and facilities and protect the environment.

The key policies of the Core Strategy are:

- To regenerate neighbourhoods by building high quality and sustainable homes in urban areas, small edge-of-urban sites and/or large green belt sites where they are well connected to services and facilities by public transport, walking and cycling.
- To build 240 dwellings per year with a flexible 40% affordable housing policy for on-site provision or commuted payments for off-site provision, in a mix of house types and sizes with developments in urban areas basing their design and density on local surroundings and developments in other locations favouring family homes.
- Greater Brookfield will be developed for in the order of 50,000m^2 of new retail floorspace, 15,000m^2. of new leisure floorspace and about 300 dwellings as well as major transport improvements. Hoddesdon and Waltham Cross town centres are foreseen to remain popular destinations for food shopping, non-food shopping, eating/drinking and community events.
- Existing employment areas will continue to be a focus for job creation and will be complemented by new retail and leisure jobs at Greater Brookfield and high-value jobs at Park Plaza.
- All development will be designed to enhance its surroundings and to reduce its impact on climate change. The green belt, Lee Valley Regional Park and other important open spaces, landscapes and historic areas will continue to be protected and enhanced.
- Appropriate infrastructure such as rail services, buses, utilities, schools and healthcare centres will be brought forward to support regeneration and growth and an A10 Route Management Strategy will be prepared to minimise road congestion.
- Sense of community and sense of place will be enhanced by promoting unique assets such as the Olympic Lee Valley White Water Centre and Lee Valley Regional Park.

Figure 1 shows Map 3: Key Diagram from the Broxbourne Local Development Framework (LDF) Submission Core Strategy December 2010. Indicated on the map are the locations of the A10, Greater Brookfield, the areas of search of the LDF as well as other key features of the area.

Figure 2 shows Map 4 Housing Areas of Search from the LDF.

Figure 3 shows Map 5: Employment Areas of Search from the LDF, with the locations of Park Plaza West and Maxwell's Farm West

The outputs of this study will guide the A10 Route Management Study that has been recommended by Broxbourne in the Core Strategy to consider the wider impacts on the

A10 and identify a strategy for delivery. HCC will also consider the findings in the Inter Urban Route Strategy for Hertfordshire that is being developed over the coming financial year in partnership with local partners.

Table 1 shows the sequence of studies undertaken and future work.

Table 1: Sequence of Studies

Study	Lead Organisation	Consultant	Summary of Study Area and Study
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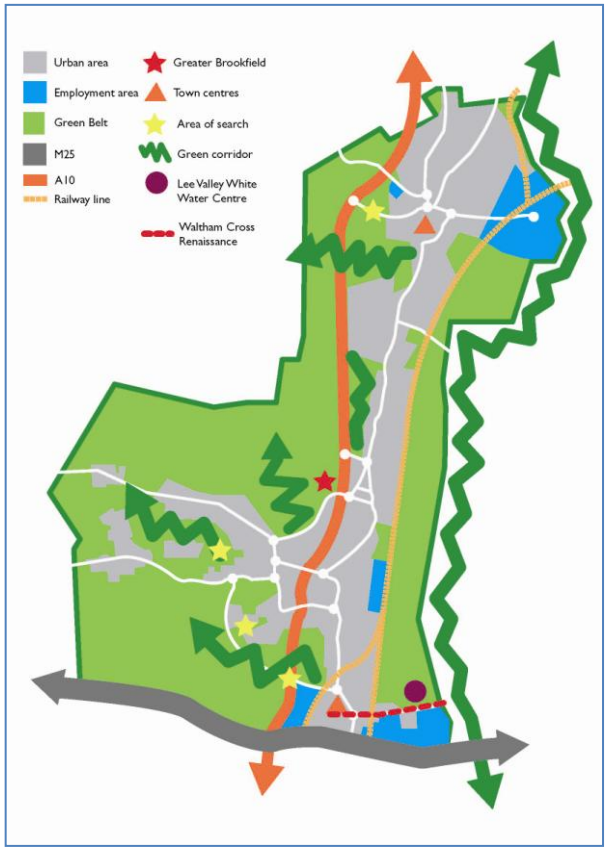


Figure 1: LDF Map 3 Key Diagram

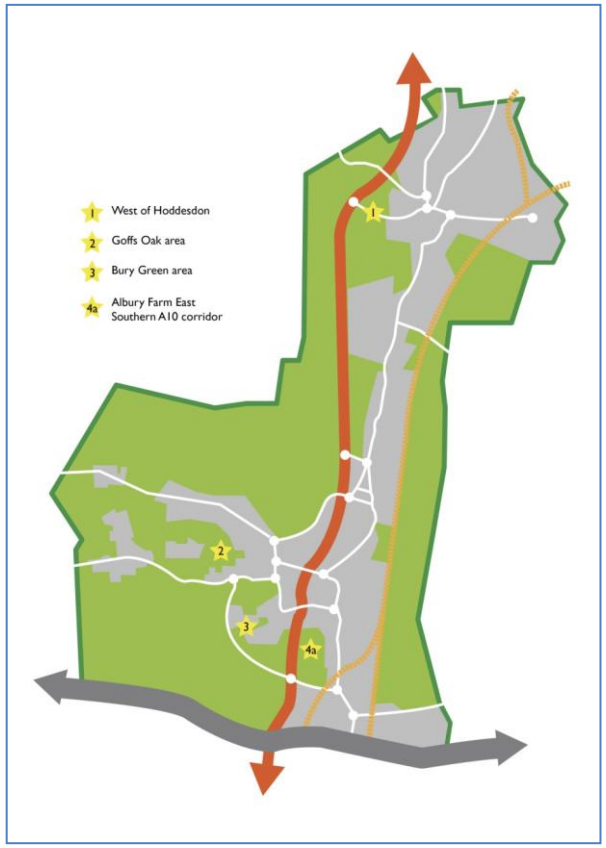


Figure 2: LDF Map 4 Housing Areas of Search

Figure 3: LDF Map 5 Employment Areas of Search

1.3 Scenarios and Development Packages

A set of eight Development Scenarios is listed in the MVA Report as summarised in Table 2 below. Development Packages comprising of combinations of the Development Scenarios were identified in the MVA Report and vehicle trips assessed using TAM. For this study, it was agreed that and Package 5, for the horizon year 2031 will be investigated. *Package 2 corresponds to Development Scenario S2* in Table 2 and *Package 5 contains all the developments* (with no A10 access for the West of Hoddesdon Development). Figure 4 shows the location of the developments copied from Figure 3.1 of the MVA Report.

Table 2: Development Scenarios

		Development description		Development quantum
Package 5	Package 2	S1 Baseline		No BBC growth, external growth included
		S2 Shorter Term Core Strategy – including: Commitments + SHLAA (Strategic Housing Land Availability Assessment): Park Plaza North Greater Brookfield		2,700 residential units 33,000m^2 mixed use employment 50,000m^2 retail, 10,000m^2 leisure,110 room hotel, 500 residential units
		S3 Edge of Urban Sites Albury Farm (accessed from Albury Ride) Bury Green Road St. Mary's School Playing Field West		300 residential units
		S4 West of Hoddesdon (urban access)		1,000 residential units
		S5 West of Hoddesdon (A10 access)		1,000 residential units
		S6 Goff's Oak		1,000 residential units
		S7 Maxwell's Farm West		100,000m^2 general industry
		S8 Park Plaza West		100,000m^2 office

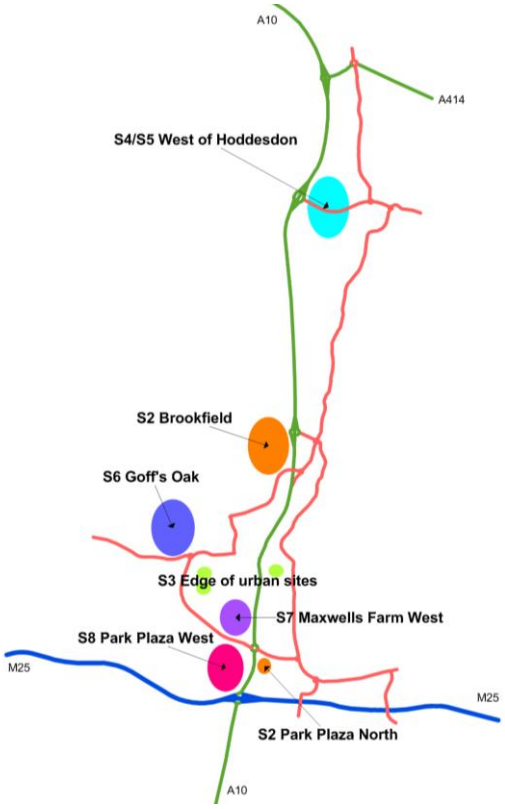


Figure 4: Location of Developments

2 Scope of the Study

2.1 Junctions Analysed

The following junctions were agreed as the extent of the study:

- 10 Great Cambridge Road roundabout j/w B198 Lt Ellis Way & A121 Winston Churchill Way
- A10 Great Cambridge Road signalised junction with B198 College Road
- A10 Great Cambridge Road signalised junction with Church Lane
- Turnford Interchange - A10 Great Cambridge Road j/w A1170
- A1170 Great Cambridge Road/ B176 High Road New River Arms Roundabout
- M25 junction 25 Interchange.

The location of the study area and junctions are shown on Figure 5.

Figure 5: Study Area

3 Background information

To inform the various aspects of the study additional information was gathered. This included accident data over the previous three years, a level C2 enquiry has been lodged to statutory undertakers equipment in the areas where road works could potentially be proposed, highway boundaries in the study area were obtained, existing speed limits and pedestrian crossings were surveyed, bus routes and frequencies were summarised from current time tables and plots of existing Public Right-of-Ways and cycle paths were obtained from the Hertfordshire County Council database.

3.1 Accidents

Accident data for the period from 1st September 2007 until 31st August 2010 was obtained from the Hertfordshire County Council Highways database. The accident data was only available at five of the six junctions within the A10 study (this excluded the A10 / M25 Interchange, as the data was held by another authority).

In total, there were 105 accidents during the 3-year period, about 90% classified as causing slight injuries and 10 accidents classified as serious. There were no fatal accidents in the study in the period analysed. All the junctions in the study area are on Hertfordshire County Council's list of hazardous junctions where 6 or more serious accidents occurred in a 3-year period.

A junction-by-junction summary of accidents is given in Table 3. Below is a brief synopsis for each junction.

Winston Churchill Way / Lieutenant Ellis Way / A10 roundabout
There are a total of 62 accidents (60 accidents were slight and 2 accidents were serious) at this roundabout. 41 of the accidents were due to rear end shunts which could indicate a lack of awareness of the approaching roundabout along with driver hesitancy. Of the rear-end collisions 23 were on the A10 southbound and 11 on A10 northbound. 7 accidents were due to drivers pulling out in front of road users already on the circulatory of the roundabout. This junction is currently ranked the worst on the county's list of hazardous sites.

College Road / A10

There were 20 accidents (18 accidents were slight and 2 were serious) at a 4 way approach arm signalised junction. The majority of accidents (12) were caused by rear end shunts, 8 on the A10 southbound. 4 accidents were caused by a failing to adhere to the red signal and 3 accidents were due to pulling in front of other road users.

Church Lane / A10
There were a total of 10 accidents (9 slight and 1 serious) at the 4 way approach arm signalised junction. Rear end shunts again accounted for 4 accidents of which 3 were on the A10 southbound and 2 accidents were again failing to adhere to the red traffic signal.

Turnford Interchange
A total of 7 accidents occurred at Turnford Interchange (all were slight). 4 accidents were due to rear end shunts and 2 were due to poor lane control.

B176 High Road Turnford / A1170

A total of 9 accidents occurred at the B176 High Road / A1170 (8 slight and 1 serious) a 4 approach arm roundabout. 3 accidents were caused by rear end shunts and 2 by users pulling in front of other road users.

No comparative data was available for M25 Junction 25, which is managed by the Highways Agency and not Hertfordshire County Council.

Table 3: Summary of Accidents at Junctions: 1 September 2007 to 31 August 2010

Junction	Number of Accidents	Severity	Type of Accidents	Motor vehicles	Pedestrians	Cyclists	Time of Accident *
A121 / B198 / A10	62	2 Serious 60 Slight	50 due to read end shunts, 7 drivers pulling in front of other road users	62	0	0	Peak 19 Day 24 Night 19
College Road / A10	20	2 Serious 18 slight	12 due to rear end shunts, 4 failure to adhere to traffic signal, 3 drivers pulling in front of other road users	20	0	0	Peak 3 Day 8 Night 9
Church Lane / A10	10	1 Serious 9 Slight	6 due to rear end shunts, 2 failure to adhere to traffic signal	9	0	1	Peak 3 Day 4 Night 3
A1170 Turnford Interchange	7	7 Slight	2 due to rear end shunts, 2 due to poor lane control	4	0	0	Peak 2 Day 1 Night 1
New River Arms	9	1 Serious 8 Slight	3 due to rear end shunts, 2 drivers pulling in front of other road users	9	0	0	Peak 2 Day 6 Night 1

* Peak (6:00-9:00 & 16:00-19:00); Day (9:00-16:00); Night (19:00-06:00)

A plot of accidents is shown in Figure 6.

The majority of accidents that occur at the various junctions within the A10 study area are rear end shunts which could be associated with a road of relative high design standards, where higher speeds prevail and congestion occurs. Increased traffic flows and congestion can be expected to affect road safety negatively. A review of speed limits and their enforcement could address some of the road safety issues, while signalisation and appropriate speed limit to suit that may largely address the accident problem at the A10 / A121 / B198 roundabout.

A detailed study of road safety was viewed as outside the scope of this study. Proposal investigated have been discussed with safety auditors (See Section 11.2). Further development of proposals should be subject to the appropriate levels and stages of road safety audits and non-motorised road user audits.

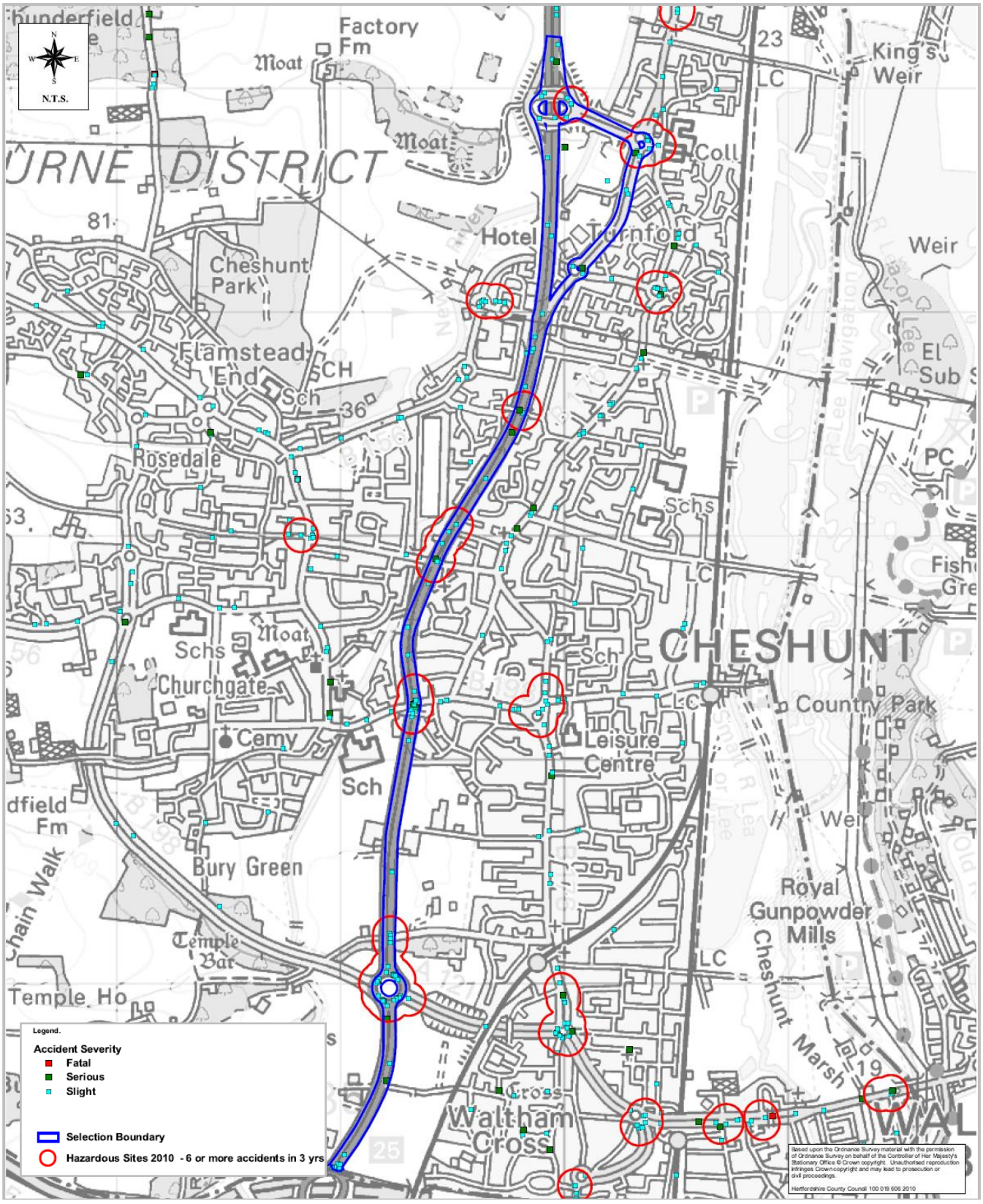


Figure 6: Plot of accidents Sept 2007 - August 2010

3.2 Statutory undertakers equipment

A C2 level search for statutory undertakers' equipment was done and the results are shown in Appendix B. The presence or not of these services was used to inform the conceptual design and cost estimates of proposals as described in Section 11.

3.3 Highway Boundaries

Highway boundaries were obtained from Hertfordshire County Council and these are shown in Appendix C. The highway boundaries were also used to support the conceptual design of improvements and cost estimates as described in Section 11.

3.4 Speed Limits

The existing speed limits in place on the A10 in the study area are shown on Figure 7. There are some inconsistencies and it will be necessary to review speed limits using surveys and applying DfT Circular 01/2006 Setting Local Speed Limits. This needs to consider e.g. the proposal to signalise the A10 / A121 / B198 roundabout.

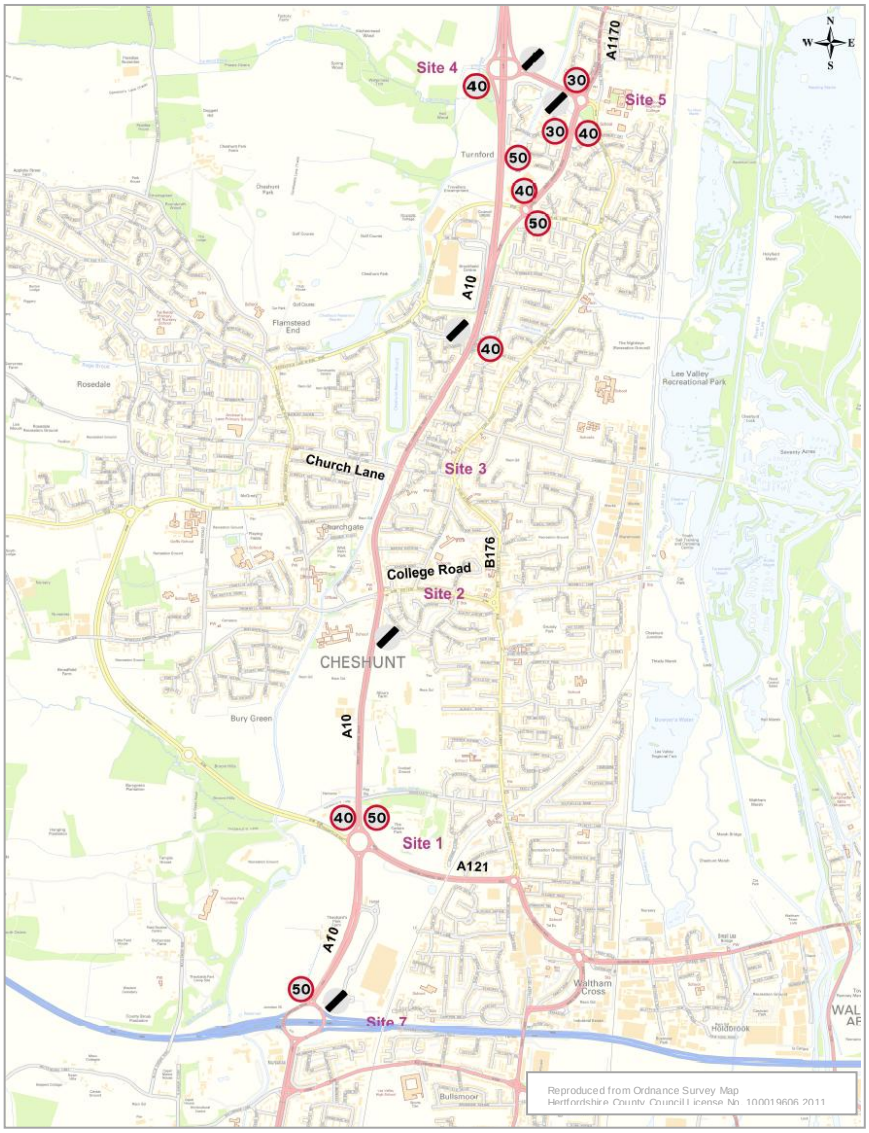


Figure 7: Current Speed Limits

3.5 Pedestrian and Cycle Facilities

The location and type of existing pedestrian crossings of the A10 in the study area were recorded and the result is shown on Figure 8. Footways along the A10 are also shown. Also shown are Public Right of Way footpaths, Roads used as public paths (RUPP) and cycleways contained in the County Council's database. Pedestrian overpasses have been provided at Brookfield Lane, College Road and just north of Theobald's Lane. There are signal-controlled crossings across the A1170 near Vancouver Road and across the A10 at Killsmore Lane, on one side at the Church Lane junction and at the new Park Plaza access (Great Eastern Road). The uncontrolled crossing places in the urban area between the over bridges at Brookfield Lane and the one at College Road are of low standard and not inviting. The new overbridge at Theobald's Lane and the paths leading to it are signed as for shared cycle / pedestrian, while the signalised crossings east of the A121 roundabout and at the Park Plaza junction are toucan crossings, but shown in the HCC database yet. Although there is footway on at least one side of the A10 through the study area and on both sides in the urbanised area, there are long sections with no formal crossing places.

Is indicated in the introduction in this report, due to its traffic carrying function and geometry, the A10 has a segregating effect on the local community and act as a barrier to local movement. Internal journeys to work, school, leisure and shopping, irrespective of mode of travel, have limited opportunities to cross the A10. This makes for poor accommodation of east-west movement for pedestrians and cyclists including separating part of the town from the Waltham Cross, Theobald's Grove and Cheshunt rail stations and the Waltham Cross bus station.

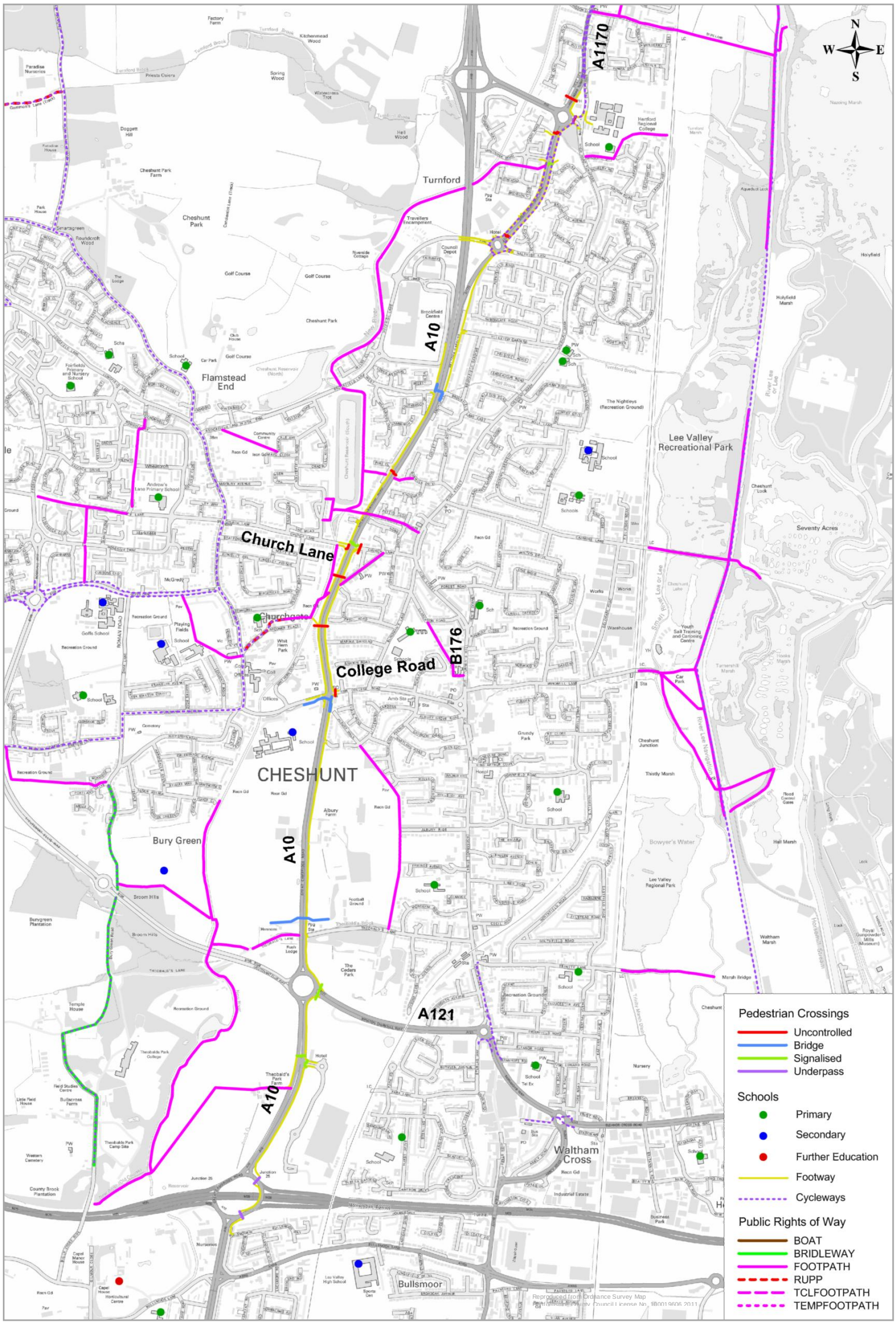


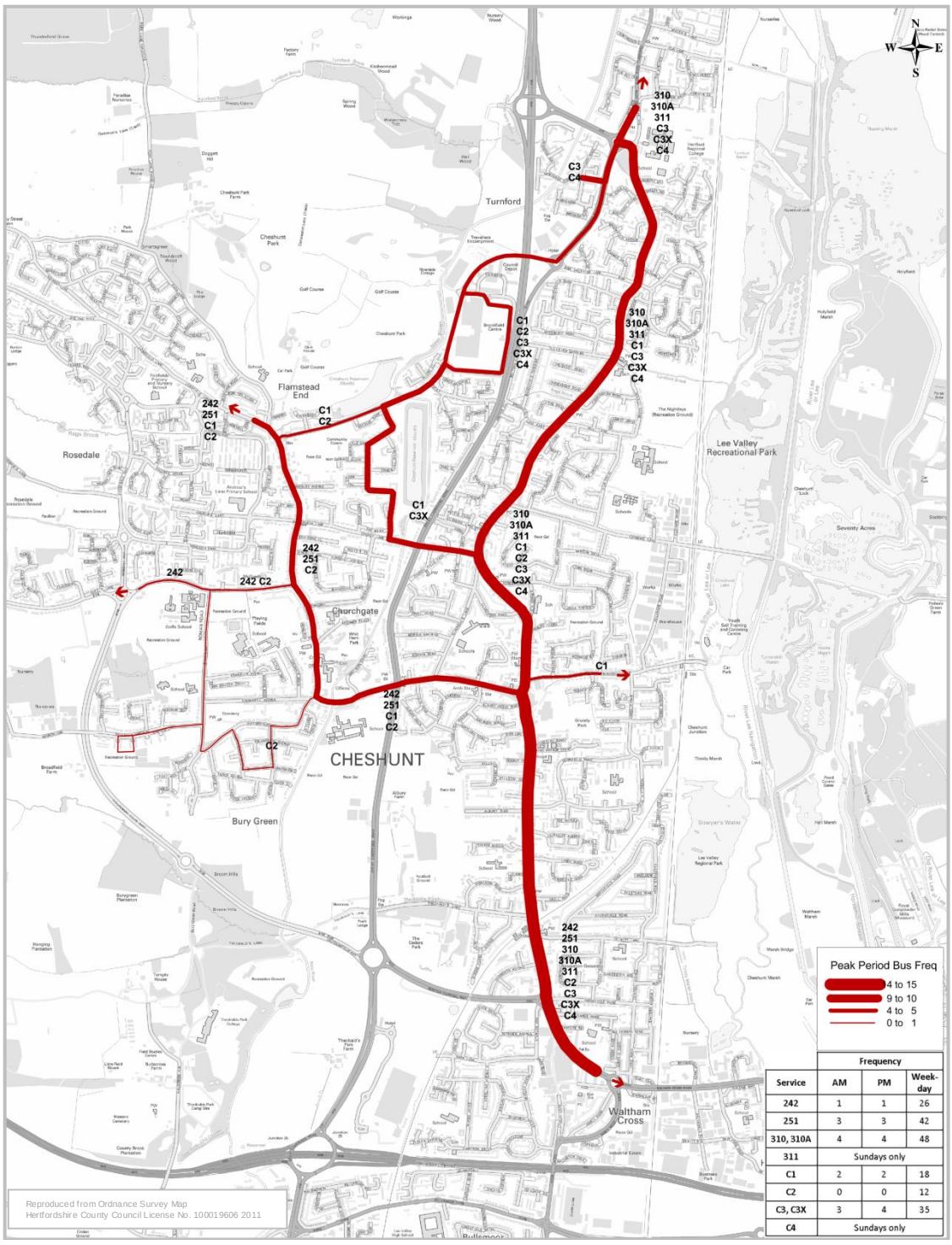
Figure 8: Pedestrian Facilities, Footpaths and Cycleways in the Study Area

Note: Public Right of Way and cycleways shown are those in the current HCC database

3.6 Bus Routes

Bus routes and frequencies serving the area adjacent to the A10 are shown on Figure 9. The information was obtained from the Intalink website on 31 March 2011. There are no local bus services on the A10 in the study area. Most routes use B176 Crossbrook Street and call at the Waltham Cross bus station. While the services provide reasonable coverage and frequencies, it cannot be regarded as a high standard service. To address vehicle trip generation public transport needs to serve new and proposed residential and employment areas.

The relative share of public transport in the area is relatively low. This is reflected in existing travel patterns as highlighted in the Cheshunt and Waltham Cross Urban Plan and in Section 13 of this report. The trip generation figures used in the modelling that fed into this study also reflect this (See Table 8 on page 21). General opportunities to enhance public transport are highlighted in Section 13.



Service	Frequency AM	PM	Week-day
242	1	1	26
251	3	3	42
310, 310A	4	4	48
311	Sundays only		
C1	2	2	18
C2	0	0	12
C3, C3X	3	4	35
C4	Sundays only		

Figure 9: Local Bus Routes and Frequencies

4 Traffic Surveys

Traffic at the subject junctions were surveyed on the following days:

- A10 Great Cambridge Road roundabout j/w B198 Lt Ellis Way & A121 Winston Churchill Way: Tuesday 16 November, 2010 (Junction 1)
- A10 Great Cambridge Road signalised junction with B198 College Road: Tuesday 16 November, 2010 (Junction 2)
- A10 Great Cambridge Road signalised junction with Church Lane: Wednesday 17 November, 2010 (Junction 3)
- A10 Great Cambridge Road j/w A1170 roundabout: Wednesday 17 November, 2010 (Junction 4)
- M25 Junction 25, A10 interchange : Wednesday 1 December, 2010 (Junction 7)

The above junction numbers were used as reference number for the traffic survey data shown in Appendix A

The junction of the A1170 Great Cambridge Road/B156 Halfhide Lane Roundabout numbered as 6, was originally foreseen as part of the study but left out of the final agreed study proposal.

Classified vehicle turning counts were undertaken for each arm in 15-minute intervals, classified to the nine classes between 07:00 and 19:00. The traffic counts are shown in Appendix A; with the first page of Appendix A showing the vehicle classification used. Nine classes were used, corresponding to classification used by the Hertfordshire Highways data team. These classes can easily be aggregated to e.g. the 5 classes in COBA if required for further analysis. Queue lengths were recorded at sixty-second intervals, from each junction's stop-line up to an agreed maximum length per site.

Cycles using the junctions were also recorded. Videos which would show pedestrians are also available. Given the dates when the surveys were undertaken and the very cold weather conditions at the time, pedestrian and cycle counts are unlikely to be representative.

Preceding the surveys, it was checked that no proposed or current works conflict with the scheduled survey dates and for compliance with health and safety policies, legal requirements, and relevant codes of practice ensuring appropriate levels of risk and quality management. Liaison with Halcrow, Connect Plus and the Highways Agency was also required in order to obtain permissions and roadspace bookings for surveying site 7, M25 junction 25. During the course of the survey, equipment integrity checks were undertaken.

No scheduled or unscheduled roadworks were present near any of the surveys.

The surveys undertaken at sites 1 and 2 on Tuesday 16 November were affected by heavy fog which persisted all day. However, due care was taken during the off-site count and the supplied data is considered to be accurate.

A traffic incident on the A10 near site 4 obstructed southbound traffic between 09:43 and 10:55 on Wednesday 17 November.

The survey at site 7 was delayed until Wednesday 1 December whilst permissions and roadspace bookings were obtained. The area was affected by very cold weather and actual or predictions of snow in the early part of December. The potential impact of, and adjustments for this will be described in more detail in Section 6.1.

During the course of the study, it was agreed to undertake peak hour only (08:00 to 09:00 and 17:00 to 18:00) counts at the following junctions:

- Junction 5 – A170 / B176 Great Cambridge Road / High Road (New River Arms Roundabout: Wednesday 9 February, 2011
- Park Plaza Access T-junction: Wednesday 9 February, 2011.

On 9 February 2011, the weather was clear and there were no incidents at the time of the surveys.

5 Transport Assessment Model (TAM)

Future traffic forecasts for the study were made available by MVA Consultancy through Hertfordshire County Council from a model referred to as MVA's Transport Assessment Model (TAM). Although a broad verification of the data was undertaken, clarification and changes requested and received from MVA and adjustments made to the data as described in Section 6.3, detail review, checking and critique of the results were considered outside the scope of this study.

The following are summarised from the report by MVA Consultancy *Delivering Strategies - Broxbourne Transport Modelling* for Broxbourne Borough Council, July 2010, to briefly provide background on the Transport Assessment Model. More details are to be found in the full document.

In order to assess the scale of the potential impacts of proposed development and any requirements for mitigating measures, Broxbourne Borough Council (BBC) appointed MVA Consultancy to undertake a strategic transport modelling exercise for the Borough. A spreadsheet-based approach was used to provide high-level information on development impacts to enable assessment of Core Strategy options. The TAM is based on the conventional four-stage modelling, which considers all the variables leading from changes in land use, through the generation of new or additional trips, to where on the network journeys are made. The four stages are Trip Generation, Trip Distribution, Trip Mode Share and Trip Assignment. The model considers both 'generated' trips (i.e. residential development) and also 'attracted' trips (i.e. office, commercial and leisure developments).

Key inputs into the model are:

- development quantum (residential units, B1/B8/etc land uses);
- trip rates (TRICS, National Travel Survey and 'Focus on Personal Travel');
- distribution profiles (Gravity modelling, Census Journey to Work data);
- mode share assumptions (Census Journey to Work data, schools data); and
- highway assignment assumptions (including congestion / rat running).

Two time periods have been modelled in TAM – an AM peak period represented by 8-9am and a PM peak period represented by 5-6pm.

Development phasing has not been explicitly modelled in TAM. Each Core Strategy development scenario has been tested at 100% build-out.

It should be noted that the approach used inherently incorporates some double counting:

- The TAM modelling work has adopted a conservative approach to trip generation. All development proposed in each of the Core Strategy scenarios is assumed to be entirely new (greenfield sites). In some instances, it is likely that there are existing development sites (brownfield) which currently generate trips that should be 'netted off'. No netting off has been undertaken and all sites are assumed to be greenfield.
- In the case of residential development, it is assumed that the new dwellings constructed are filled with new residents to the Borough (at existing occupancy rates). The decreasing trend in household occupancy is predicted to continue and so, in reality, it might be expected that the new dwellings being constructed may

include residents who are already living in the Borough – and thus already making journeys on the highway network.

- These assumptions imply that the modelling work is robust and presents a 'worst case' in terms of trip generation, highway network flows, and ultimately impact.

In the trip generation stage, the model calculates peak-period person trip rates for each land use, by journey purpose and therefore the total number of person trips generated and attracted to/from the study area during peak periods. Generic trip generation figures were used and applied based on the quantum of development, rather than taking the possible specific characteristics of developments into consideration as many of these are yet to be defined.

Specifically paragraph 2.7.6 from the report by MVA should be noted: *Considerations such as a modal shift from car to bus as a result of improved public transport, a modal shift from car to walk/cycle as a result of an improved street environment and better integration of land uses, and a modal shift from car to public transport (bus and rail) from travel demand management measures (including but not exclusively car parking policies) have not been considered. This ensures a conservative approach is taken whereby the impacts and interventions in latter Chapters are presented as 'worst case' scenarios which could be improved by consideration of the factors above using amended mode shares*.

Resulting person trips for Packages 2 and 5 are shown in Table 4 below.

Table 4: Person Trips for Packages 2 and 5

Land Use	AM Inbound	AM Outbound	AM TOTAL	PM Inbound	PM Outbound	PM TOTAL
P2 Core Strategy	1,300	1,700	3,000	1,700	1,900	3,600
P5 Maximum	4,200	3,600	6,800	2,600	4,600	7,200

Vehicle trip generation for Packages 2 and 5 are shown in Table 5 below.

Table 5: Vehicle trip Generation for Packages 2 and Package 5

Land Use	AM Inbound	AM Outbound	AM TOTAL	PM Inbound	PM Outbound	PM TOTAL
P2 Core Strategy	767	822	1,589	1,117	1.337	2,454
P5 Maximum	2,778	1,715	4,493	1,770	3,223	4,993

For trip distribution, the following data sources have been used to provide inputs into the model: Hertfordshire County Travel Survey; population and employment data from the 2001 census at ward level, using the 'Journey to Work' dataset as a proxy for this.

Trip distribution profiles are provided in Appendix 2 of the MVA report, with the resultant total trip distribution shown in Table 6 and the trip distribution for Package 2 and Package 5 shown in Table 7.

Table 6: Total Distribution applied in TAM

Model Zone	To/from North Broxbourne	To/from South Broxbourne	To/from West Broxbourne
North Broxbourne	36%	4%	5%
South Broxbourne	6%	34%	13%
West Broxbourne	2%	3%	23%
TOTAL 'Local'	44%	41%	41%
Enfield	6%	16%	14%
Welwyn Hatfield	3%	3%	4%
East Hertfordshire	16%	5%	7%
Harlow	3%	1%	1%
Epping Forest	3%	3%	2%
TOTAL 'Neighbouring'	31%	28%	28%
Strategic South	8%	11%	11%
Strategic West	6%	8%	8%
Strategic North	5%	6%	6%
Strategic East	4%	5%	5%
TOTAL 'Strategic'	23%	30%	30%

Table 7: Trip Distribution for Package 2 and Package 5 Developments

Model Zone	Package 2	Package 5
North Broxbourne	8%	11%
South Broxbourne	17%	21%
West Broxbourne	43%	29%
TOTAL 'Local'	68%	62%
Enfield	6%	8%
Welwyn Hatfield	2%	2%
East Hertfordshire	5%	6%
Harlow	1%	2%
Epping Forest	3%	5%
TOTAL 'Neighbouring'	18%	22%
Strategic South	5%	6%
Strategic West	4%	4%
Strategic North	3%	3%
Strategic East	2%	3%
TOTAL 'Strategic'	14%	16%

Assumptions on trip distribution and other aspects are covered in the report by MVA, specifically Section 2 and Appendix 2. It was assumed that the mode of travel used will differ by distance and also by land use. Data sources used to create mode share profiles included: Census 2001 data (including the 'Journey to Work' dataset); previous technical reports (e.g. Transport Assessments); qualitative information on current and proposed highway and public transport conditions, schemes and interventions. Current 'base' year mode shares were calculated using the Census Journey to Work dataset.

It should be noted that the base-year mode shares have been left unchanged in the future year modelling work. This is therefore assuming that there is no future change in transport infrastructure provision, travel behaviour, or other factors that could influence mode share. Considerations such as a modal shift from car to bus as a result of improved public transport, a modal shift from car to walk/cycle as a result of an improved street environment and better integration of land uses, and a modal shift from car to public transport (bus and rail) from travel demand management measures (including but not exclusively car parking policies) have not been considered. This is also a conservative approach whereby a 'worst case' scenario was created.

Resulting trip-mode share profiles for Packages 2 and 5 are shown in Table 8 below.

Table 8: Mode Share Applied in the TAM

Time / Land Use	Trip Mode Shares				
AM peak	Car	Bus	Rail	Walk	Cycle
Package 2	71%	9%	3%	14%	2%
Package 5	75%	8%	3%	12%	2%
PM peak	Car	Bus	Rail	Walk	Cycle
Package 2	82%	6%	4%	6%	2%
Package 5	83%	5%	4%	5%	2%

For the assignment of trips, access for each of the Core Strategy developments was specified by Broxbourne Borough Council, including indicative junction arrangements with details included in the MVA Report.

In parallel with the development of the bespoke spreadsheet model (TAM), additional data has been sourced from the Hertfordshire Infrastructure Investment Study (HIIS), including future year flows for 2011, 2021 and 2031 at all major links/junctions.

Relevant data from the HIIS study was combined with the spreadsheet model to provide a view of how the Borough's highway network could perform with/without Core Strategy development.

HIIS was undertaken using inputs from the East of England Regional Model (EERM). The highway model component of EERM has a strategic focus with a representation of the network and flows across the East of England. Future transport improvements are represented in the mode. 'Background' traffic growth is also included and takes into account factors such as increased car ownership and use over time.

Future year land use developments, consistent with those in the East of England Plan, are also represented in EERM. Alternative scenarios were made available for a 2021 forecast year which considered 'with East of England Plan development' and 'without East of England Plan development'. The difference in network flow in the Borough between these two different 2021 scenarios is generally relatively minor which would suggest that the impact of East of England Plan development may not, in itself, have a significant impact on highway performance.

Combining TAM model outputs that specifically consider BBC development and 2031 forecast year EERM data (which includes East of England Plan development, also including BBC) is, whilst still being robust and conservative, a reasonable approach given the limited assessed impact of any implied double counting.

The MVA Report Delivering Strategies – Broxbourne Transport Modelling Section 2.9 describes the process used to estimate a PM peak hour from the available AM data by transposing flows, as no PM peak data was directly available from the HIISS EERM run.

Although estimating PM flows by transposing AM flows appears reasonable in most cases it did show some anomalies. This became very noticeable in the background growth from 2011 to 2031 at the Church Lane junction, where east-west flows are unbalanced. See Section 10. All PM results should thus be treated with circumspection.

The report also describes in Section 2.10 the creation of of a composite model which took theoretical junction capacity and predicted background link and turning flows from the HIIS EERM model output and then added the predicted development flows calculated from the TAM spreadsheet. This process created future year highway flows for each development package and a calculation of volume to capacity ratios for links and junctions

During review of the TAM, In January 2011 Hertfordshire County Council Transport Planning identified specific issues to be considered in using the results and the model. Briefly, those that are not directly covered above are:

- TAM is a spreadsheet based model and although trip distribution is based on a gravity modelling approach and trips have been assigned to the most logical routes between particular origins and destinations, it is based on a number of assumptions and is not capable of reassigning traffic due to congestion and increased journey times in the network.
- TAM did not consider the reassignment of traffic to the wider network as a result of the proposed introduction of a southbound on-slip at the Turnford Interchange (See Section 6.4).
- The HIIS EERM model run used for 2031 included Regional Spatial Strategy (RSS) levels of growth throughout the county (including in Broxbourne). This does mean that an allowance of development in the borough is included in the base model run (package 1) and adding specific development trips on top of this implies an element of double counting. MVA did however undertake a comparison of the 2021 EERM with and without RSS model runs and found relatively little difference in the flows within the borough.
- A number of neighbouring authorities are looking at reduced levels of development (compared to the RSS). Using the HIIS EERM model output is thus likely to overestimate the number of external trips coming into the area.
- The core strategy is based on the information available at the time when the MVA modelling work started (March 2010). Since then some of the SHLAA sites may have been removed and others may have been added.

6 Adjustment to surveyed and forecast traffic flows

6.1 Adjustments to survey data

As the counts were undertaken in November and December, usually not considered as "neutral months" (April, May, June, September and October), it was necessary to check whether it is required to adjust survey results to represent average conditions. HCC operates a continuous traffic counter (Site 135) on the A10 between Lieutenant Ellis Way (Junction 1) and College Road (Junction 2). HCC checked some of the data from this counter before agreeing to the surveys going ahead in November and on 1st December. Further analysis was possible retrospective of the actual counts to find whether adjustments to the counts are required.

From data for 2007, 2008, 2009 and 2010, the daily flows for the neutral months were extracted from data from Site 135. Bank holidays were not included in the data and days where there were clear failure of the counting equipment or extraordinary low counts, for reasons not explored here, were deleted. This resulted in average counts for weekdays in neutral months, based on data from 91 days in 2007, 83 in 2008, 89 in 2009 and 80 in 2010, out of a possible 102 days in a typical year.

The data from Site 135 was also used to determine the trend of traffic flow along the A10 over the past number of years.

As shown on Figure 10 and in Table 9, there is no clear growth in average weekday flow in neutral months. This would support an assumption that counts late in 2010 would closely represent data for a 2011 Base Case and that even 2008 data is very comparable with what can be expected in 2011.

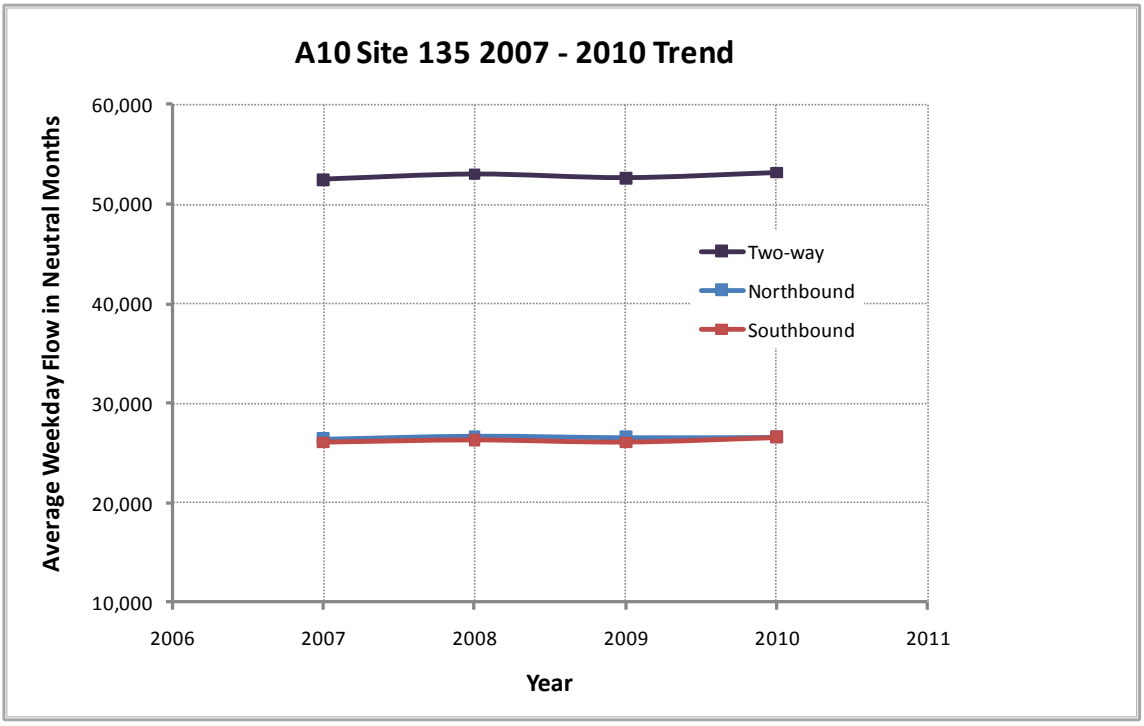


Figure 10: Average Two-way Weekday Flow in Neutral Months - Annual Trend

Table 9: Percentage Change in 5-day Average Flow 2007 – 2010

Period	5 Day Average	% change
2007 – 2008	52,470	+1.06%
2008 - 2009	53,026	-0.75%
2009 - 2010	52,626	+1.06%
2007 - 2010	53,185	+1.36% (+0.45%p.a.)

Figure 11 shows the 5-day average plotted by week as well as the daily traffic counted on the days where junctions were surveyed namely 16 and 17 November 2010 and 1 December 2010.

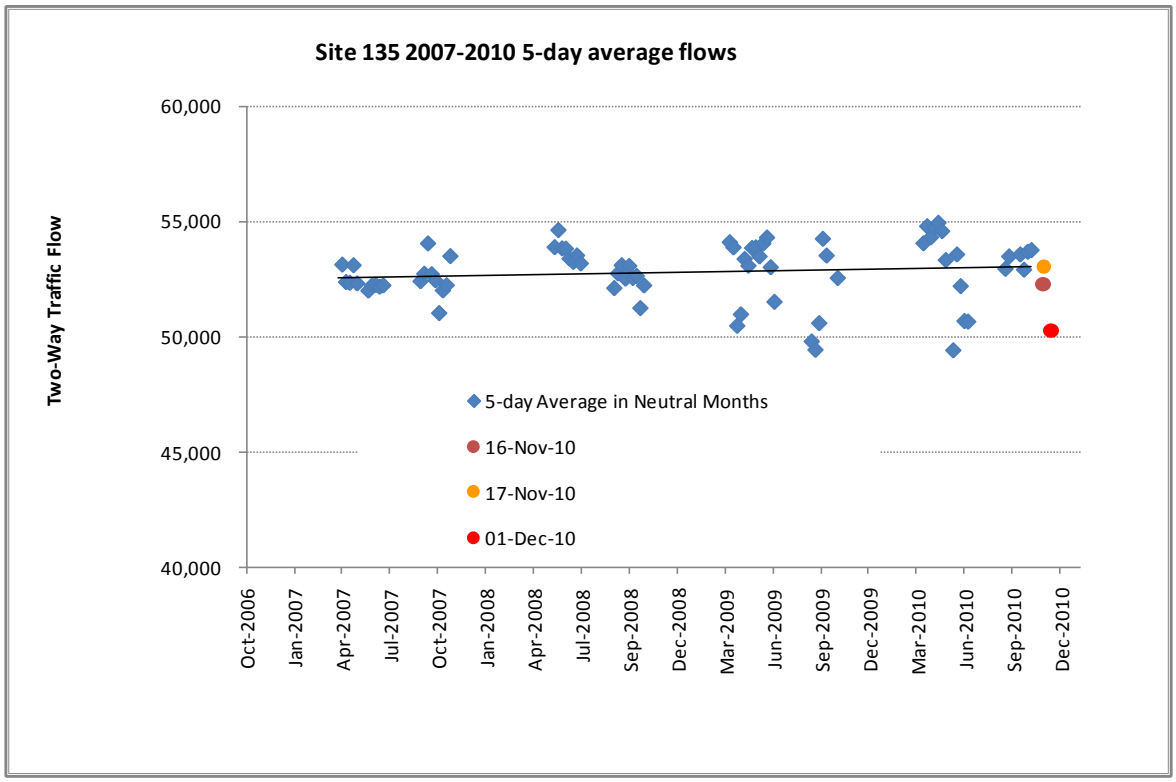


Figure 11: Two-way Weekday Flow in Neutral Months – by week 2007-2010

As shown, the counts in November were very close to the overall average, the daily count for 16th November being 1.03% lower and for 17th November 0.43%higher that the 2007 to 2010 average. It was therefore considered that the survey results from November adequately represent an average weekday in the year and that no further investigation or adjustments were required.

The daily flow on the 1st December 2010 was however about 5% lower compared to the 5–day average in neutral months from 2007 to 2010 and approximately 3.5% lower than the average weekday flow in neutral months during 2010. Traffic on 1 December was

most likely affected by forecasts of inclement weather and actual snow showers during the day. The traffic pattern during the day was thus explored further. Figure 12 shows the average flow by hour during weekdays in November 2010 and for 1 December 2010.

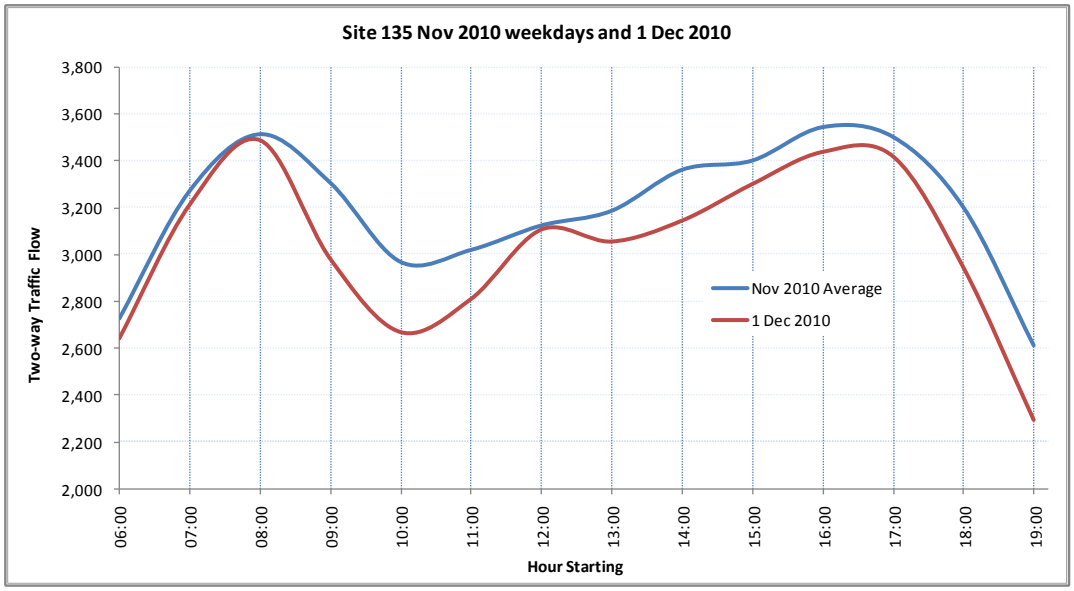


Figure 12: Two-way Flow during November 2010 and on 1 December 2010

It appears that traffic flow was disrupted during 1st December 2010. During the morning peak hour, 08:00 to 09:00 as applied in this study, the hourly flow was however only 0.7% less than the November average. It is clear that the drop in flow for the day compared to that in neutral months in 2010 (approximately 3.5% as indicated above) can be attributed to a decrease in traffic after the morning peak hour while a peak in traffic was still experience during the afternoon. For the hour from 17:00 to 18:00, flow was 2.4% less than the average for the same hour in November.

For the count undertaken on 1st December 2010 at the junction of the A10 and the M25 (M25 Junction 25), it was decided not to adjust the morning peak hour, but to adjust the afternoon peak hour upwards by 2.4%.

6.2 PCU Adjustments

Traffic counts were converted to passenger car units (pcus) by application of vehicle equivalencies offered in DFT Traffic Advisory Leaflet 1/06 - General Principles of Traffic Control by Light Signals. The vehicle classifications used in the surveys and the pcu equivalence for each class are shown in Table 10

Table 10: PCU Conversion Factors

Vehicle Type	Passenger car equivalency factor
Pedal Cycles	0.2
Two wheeled motor vehicles	0.4
Cars and Taxis	1
Buses and Coaches	2
Light Goods Vehicles	1
Medium Goods Vehicles	1.5
Heavy Goods Vehicles	2.3

Other flows used in the study from TAM and Transport Assessments were taken as already expressed in passenger car units.

6.3 Comparison TAM Base and Counts

The TAM results included a 2011 base with turning movements at each junction. These were compared to the counts at the junctions taken in late 2010 and early 2011, first by simple differences and percentages but also using a GEH factor. The GEH factor was also used further in the analysis to compare forecast flows at junctions to flows to those after the balancing described in Section 6.5 and within the LINSIG network.

Using the GEH Statistic avoids some pitfalls that occur when using simple percentages to compare two sets of flows. Although the statistic is normally used to compare flows on links, it is useful here to compare modelled and observed flows rather than to consider only absolute or percentage differences.

For traffic modelling work, a GEH of less than 5.0 is considered a good match between the modelled and observed hourly volumes, while GEHs in the range of 5.0 to 10.0 may warrant investigation. If the GEH is greater than 10.0, there is a high probability that there is a problem. The DMRB required the application of the GEH statistic to a much larger number of links in a network for the purposes of calibration and validation, but that was not the intended application of the statistic here.

Comparing the survey result (expressed in pcus as described in Section 6.2) with the TAM 2011 forecast showed that, although the total traffic through junctions matched reasonably well, turning flows did not. It was therefore decided to discard the TAM 2011 base flows and superimpose the changes forecast by TAM between 2011 and 2031 onto the recent counts. This was simply done by subtracting TAM 2011 base flows from the TAM 2031 forecast flows and adding the result to the actual counts for each movement at each junction.

6.4 Other adjustments

Further adjustments and assumptions were required as progress with some developments overtook the TAM model, which was completed in July 2010.

The TAM model had lower traffic flow from the new road link serving the proposed Brookfield Riverside development onto the Turnford Interchange than that shown in the report *Brookfield Riverside Preliminary Transport Assessment Supplementary Information*.

This was primarily due to the assumption in TAM of a higher proportion of trips heading south and west from the development and an erroneous assumption that added trip rates in the Transport Assessment were person trips rather than vehicle trips. The TAM also did not account for reassignment of traffic as a result of the proposed southbound on-slip from the Turnford Interchange to the A10.

For this study, it was assumed that assignment of traffic in the Turnford Area would not affect the forecasts by TAM for the network further south in the study area.

The TAM forecasts were therefore not used in the analysis of the New River Arms Roundabout and the Turnford Interchange. Instead, 2008 flows from the above mentioned transport assessment was compared to the 2010 and 2011 traffic counts and 2022 forecasts from the transport assessment were used. To be consistent with the

analysis of other junctions in the network these were growthed to 2031. This was by using the procedure in WebTAG 3.15.2 Paragraph 5.5.2 combining NTEM and TEMRO growth. This resulted in background growth factors from 2022 to 2031 of 1.033 and 1.035 for the AM and PM peaks respectively.

For the junctions between and including M25 Junction 25 and Church Lane a network was built in LINSIG Version 3. The TAM includes, as based on the EERM, a zone connector between College Road and Church Lane and does not feature Theobald's Lane. For the access to the Maxwell's West development, TAM assumed a left-in-left-out arrangement while it was requested for this study to include a four-armed junction on the A10 serving both Maxwell's West and the Albury Farm Development. Flows had to be adjusted for these, but required further balancing of the network for input to LINSIG, which is described in Section 8. As it was not possible to undertake surveys simultaneously at all adjacent junctions there were also variations between counts at junctions. Some manual balancing of networks was therefore required.

For the Maxwell's West junction in Package 5, TAM assumed a left-in-left-out arrangement and assigned inbound traffic from the north to make U-turns at the A121 roundabout and outbound traffic to the south to make U-turns at Church Lane. For this study, it was requested that flows should represent the case for a four-armed junction in place. Assigned traffic therefore had to be adjusted manually. For traffic to and from the Maxwell's West and Albury Farm developments, the generated flow as shown in *Summary Design Report - Maxwell's West*, November 2010 by Bidwells Transport Planning, were entered to the network.

6.5 Network Balancing

There was a clear discrepancy between counts, done on different days, at M25 Junction 25 and the A10/ A121 / B198 Roundabout in the AM peak. This was corrected by adjusting the flow at Junction 25 by a factor 1.09 and at the A10 / A121 / B198 junction by 0.95.

The data from TAM provided only included link flows rather than turning flows at M25 Junction 25. Turning flows for all the tests were based on inflows at each arm distributing to turning ratios of the count undertaken in 2010.

Balancing between junctions was achieved by setting inflow at an A10 arm at each junction to the outflow of the previous junction and distributing turning flows according to the original ratios of inflow at each junction. . For Package 5, flows it was found that it provides a slightly better fit to proportion turning flows at M25 Junction 25 to outbound rather than inbound flows.

The Turnford Interchange and New River Arms roundabouts were viewed as isolated junctions with flows as provided in:

- Brookfield Riverside Preliminary Transport Assessment (Draft), October 2009 and
- Brookfield Riverside Preliminary Transport Assessment Supplementary Information, May 2010

7 Forecast Traffic Flows

The forecast turning movements expressed in passenger car units at the subject junctions after the adjustments described in the preceding section are shown in Appendix D, for the peak hours and for the following cases:

- 2011 adjusted flows from the 2010 counts
- 2031 base
- 2031 with Package 2 Core Strategy shorter term developments
- 2031 with Package 5 - Maximum development

For the two roundabouts in the Turnford area 2010/11, counts are shown as well as flows from the Transport Assessment documents of October 2009 and May 2010, for 2008, and 2022. To make these consistent with the other junction analysis these were also adjusted to 2031 as described in Section 6.4 above. These are also shown in Appendix D.

In all cases, the turning flows are presented in matrix form with the convention that arms are numbered A to D clockwise, starting with the northern arm as A. A diagram to shown this is also included in Appendix D. To place the traffic forecast for the LDF developments into perspective, two-way flow at three locations on the A10 are shown on Figure 13.

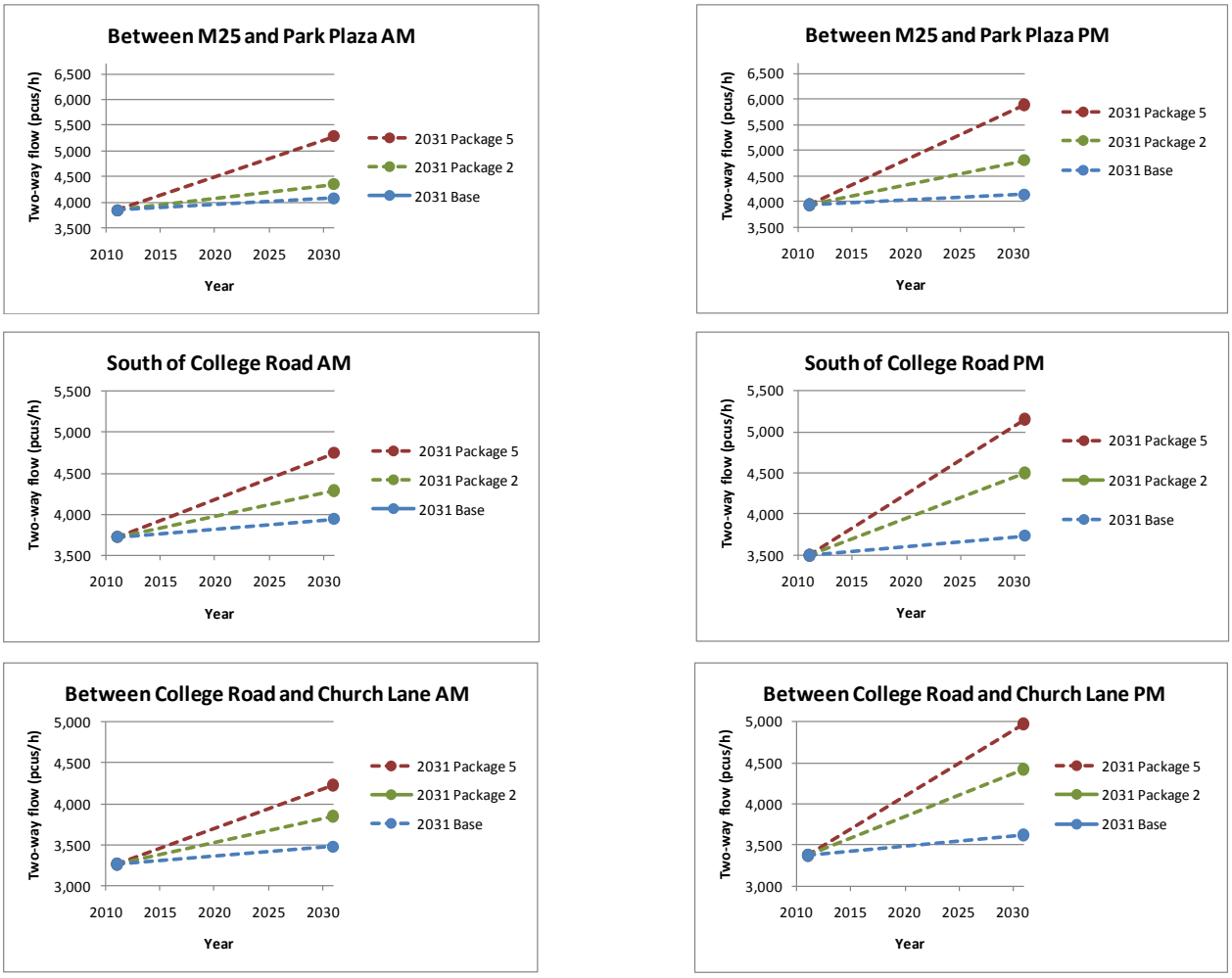


Figure 13: Two-way flow for 2031 Base and with LDF developments

Table 11 below shows the percentage increase in two way flow at the selected location from the 2011 base case to the 2031 base case and with Package 2 and Package 5 development added.

Table 11: Forecast Growth in Two-way Flow

Position	2011 flow	Percentage change from 2011 base to -		
		2031 no Broxbourne growth	2031 Package 2	2031 Package 5
Between M25 and Park Plaza AM	3,839	6.2%	13.2%	37.7%
Between M25 and Park Plaza PM	3,943	5.1%	21.8%	49.4%
South of College Road AM	3,722	5.9%	15.3%	27.5%
South of College Road PM	3,501	6.7%	28.6%	47.1%
Between College Road and Church Lane AM	3,261	6.7%	18.0%	29.7%
Between College Road and Church Lane PM	3,376	7.3%	31.0%	47.3%

8 LINSIG and ARCADY models

For the junction between and including M25 Junction 25 and Church Lane a network was built in LINSIG 3. The Turnford and New River Arms roundabouts were modelled as isolated roundabouts in ARCADY Version 6.

8.1 LINSIG

Although LINSIG has some capability of balancing flows between adjacent junctions, in this case it yielded unacceptable differences between demand flows originally entered and modelled flows, mainly due to the number of route choices available. It proved to be better to manually balance flows before entering into LINSIG 'stand alone' models, as described in Section 6.5 above.

Originally, it was proposed to use a network model to include all intersections from the A10 Church Lane junction in the north to the M25 Junction 25 in the south. During the optimisation process, it became clear that due to the size of the model, the number of route choices available and the fact that at most of the junction demand flows are close to or exceeding capacity, the model struggled to produce a suitable set of signal timings. It was therefore decided to model the junctions as 'stand alone' junctions using a consistent cycle time to simulate operations in a network, deemed to provide more accuracy and reliability of results The operations reported in Section 10 are thus for 'lone standing' junctions but using demand flows from the balanced network described in Section 6.5.

Initially base models were created, these were calibrated using existing geometry, signal staging, and existing stage times. The existing timings were extracted from the UTC system for the College Road junction and Church Lane junctions and the fixed time plans for M25 Junction 25. The queue length results of these models were then validated against the queue length surveys.

As this modelling was to be based on a 'linked network' a common cycle time had to be used for all proposed scenario models. It was deemed suitable that a network cycle time of 120s would be used. In order to have directly comparable results between models, it was necessary to 'optimise' all signal timings. Therefore, to fit this cycle time effectively the roundabout junctions were run using a 60-second cycle time and 'double cycled'.

It must be noted that the results produced from the models would not always be expected to be witnessed 'on-street'; they can only used for comparison. In reality, currently two of the junctions (and possibly more in the future) run under SCOOT (Split Cycle Offset Optimisation Technique). SCOOT, a method for managing and controlling traffic signals in urban areas, is an adaptive system that responds automatically to fluctuations in traffic flow through the use of on-street detectors. The stage and cycle times will thus alter on a cycle-to-cycle basis as the systems tries to optimise operations. The junction models used here are not capable of capturing variations brought about by SCOOT.

The following terms are used in reporting the operations at junctions:

Mean Max Queue- Represents the maximum queue within a typical cycle averaged over all the cycles within the modelled period. It takes into account traffic dispersal and arrival rates.

Degree of Saturation – (DoS) The degree of saturation at an approach is the ratio of the design flow to the actual capacity.

Practical reserve capacity (PRC) is a measure of how much additional traffic could pass through a junction whilst maintaining a maximum degree of saturation of 90% on all lanes.

Experience shows that often a negative PRC is recorded at a junction where one or two arms are operating at a DoS slightly over 100% and the junction is still coping with the flow albeit under stress. The limit is approximately an overall PRC for the junction of -10% before the junction can be considered as not coping with demand flows.

8.2 ARCADY

For the ARCADY models, the input geometry was extracted from Ordnance Survey Maps and recent aerial photos and also compared to values used in the Brookfield Riverside Transport assessment, where a good correlation was found. All other ARCADY parameters were taken as standard except to force it to accept an even demand through the peak hour by using the OD TAB option, so as to be consistent with the approach used at the other junction in LINSIG. As for the LINSIG models predicted queue lengths were compared to observed queue lengths to validate the models.

9 Proposals

9.1 Previously recommended improvements

From observations, reports and the junction analysis described in Section 10, it is clear that significant improvements will be required to address existing congestion and attempt to accommodate forecast traffic demand.

There are various proposals made for the A10 in recent documents, including the Cheshunt and Waltham Cross Urban Transport Plan and the MVA Report mentioned before. A summary of these proposal with references are shown in Appendix E. At the stage of commissioning of this study, it was agreed that grade separation options or restrictions of turning movements at any of the junctions will not be considered part of the study. To address such options adequately, a traffic model with capability of testing reassignment of traffic should ideally be available.

9.2 Selection of options for testing

A workshop was held on 4 February 2011, attended by representatives of Hertfordshire County Council, Broxbourne Borough Council and the Highways Agency, to consider previous proposals and other schemes to improve the junctions under discussion. At this meeting, additional options were put forward. This included a 'hamburger' junction* for the A10 / A121/ B198 junction and an additional northbound to westbound slip lane at M25 Junction 25. It was also agreed that some previous proposals, such as options for grade-separated junctions, should not be pursued at this stage. Options for widening the A10 were raised before but it was only through testing of various options that it became clear that it could be the only solution to, at least partly, accommodate the forecast traffic demand.

Table 12 below lists the options and indicate which have been tested further and the reasons for not exploring some options further.

* Note: A "hamburger" junction refers to a signalised roundabout where carriageway is provided straight through the roundabout for the main road ahead movements with signals where the roundabout sections are crossed. All movements from the minor road and turning movements from the main road use the roundabout and are subject to signal control. A sketch plan of the proposal for the A10 / A121 / B198 junction is shown on Drawing 1034090-001-102 in Appendix G

More details of the options tested and resulting traffic operations are given in Section 10 and 11.

Table 12: Options Considered

Proposal	Comment
A10 / M25 Junction 25	
Dedicated eastbound to northbound slip lane	Tested in conjunction with a northbound to westbound slip lane
Widening the roundabout	Agreed as not a viable option at this stage
Grade separation of the A10	Agreed as not a viable option at this stage
A10 / A121 / B198 Roundabout	
Localised widening and full signalisation	Tested in conjunction with a westbound to southbound slip lane
Signalised cross roads	Tested
Signalised 'hamburger' junction	Tested
Grade separation	Agreed as not a viable option at this stage
A10 / College Road	
Realignment of minor arms	Models used would not be sensitive to such changes. Realignment alone would not significant increase capacity
Running College Road on separate signal stages	Tested
Banning right turns from College Road	Testing would require a model capable of predicting reassignment of traffic.
Grade separation	Agreed as not a viable option at this stage. Testing would require a model capable of predicting reassignment of traffic
Linking junctions in SCOOT	Church Lane and College Road junctions are already in a UTC system
A10 / Church Lane	
Additional westbound lane	Tested
Widening of A10	Tested with further variations
Banning right turns	Testing would require a model capable of predicting reassignment of traffic. A simple test was undertaken to show impact on junction operation when combined with a pedestrian stage.
Grade separation	Agreed as not a viable option at this stage. Testing would require a model capable of predicting reassignment of traffic
Turnford Interchange	
Segregated left turn lanes	Tested
New southbound slip	Tested with traffic assignment from Transport Assessments
New River Arms Roundabout	
Widening eastbound approach	Tested

10 Junction Operations

It became clear that although the lower cost measures for College Road and Church Lane would only bring marginal improvements in operations, it is not adequate to accommodate the flows forecast by TAM for the LDF development packages that were tested. An alternative higher cost option was therefore also tested, namely widening of the A10 at its junctions with College Road and Church Lane.

Proposals at the A10/ A121 / B198 junction, the A10 / College Road Junction and A10 / Church Lane junction were designed in concept and construction costs were estimated. More details are provided in Section 11. Sketch plans of the proposals, including proposals for the A10 / M25 Junction 25 from the Cheshunt and Waltham Cross Urban Transport Plan and proposals from the available transport assessments for the Turnford Interchange and the New River Arms Roundabout are shown in Appendix G. Drawing numbers refer to the sketch plans in Appendix G.

Option tests included:

A10 / M25 Junction

Eastbound to northbound and northbound to westbound slip lanes

A10 / A121 / B198 Roundabout

Option 1: Signalisation of existing roundabout with three circulatory lanes, widening of the A10 southbound approach to three lanes and a westbound to southbound slip lane
Option 2: 'Hamburger' junction
Option 3: Four-arm signal controlled crossing

A10 / College Road

Option 1: Separate staging of signals
Option 2: Widening A10 to three through lanes per direction

A10 / Church Lane

Option 1: Widening of Church Lane westbound to allow an exclusive right turn lane
Option 2: Widening of Church Lane as for Option 1 and widening of the A10 to three through lanes per direction.
Option 3: As Option 2 but no right turn lane from the north, assuming right turns will be banned and with pedestrian crossings on all arms

- Separated staging of the signals controlling the Church Lane approaches was also tested.

Turnford Interchange

As suggested tin the Transport Assessment for the Brookfield Riverside development:

- Segregated left turn lanes added to the A10 slip roads and the proposed link road from Brookfield
- A new southbound on-slip to the A10

New River Arms Roundabout

As suggested tin the Transport Assessment for the Brookfield Riverside development:

- An additional approach lane on the eastbound approach on the A10 link road.

The following paragraphs summarise the operations of the junctions in the LINSIG network and the implications of the proposals. More details of the junction analysis are shown in Appendix F. The Percentage Practical Reserve Capacity (PRC) of the junction as a whole is shown, as well as the number of approaches with one or more lanes with a Degree of Saturation (DoS) between 80% and 100% and the number with Degree of Saturation over 100% are shown in the tables to follow. Definitions of PRC and DoS have been given in Section 8.1. In Appendix F lanes or lane groups where the DoS is over 90% is marked 'amber' and 'red' if it goes over 100%. Estimated queue lengths are also shown in Appendix F. In general, queue lengths also reflect what the DoS shows, namely that when DoS goes well of 100%, queues will be long, so much that it will affect adjacent junctions.

For all tests with proposals, it was assumed that there will be no reassignment of traffic from or to other parts of the network when changes to the junction improve or worsen operations, i.e. the demand flow at the junctions will remain constant.

Sketch plans and cost estimates for options for widening the A10 to three lanes at the College Road and Church Lane junctions were restricted to 200m on either side of the junctions.

If an option for widening is pursued, it would be preferable to widen the whole length of the A10 through the A121, College Road and Church Lane junctions. Diverging and merging traffic on either side of junctions are likely to bring about a reduction of link capacity and cause a potential road safety hazard. Widening throughout would require significant additional construction, land acquisition, relocation of services and subsequent cost. Although no benefit:cost or benefit:risk analysis has been undertake, it is felt that a local widening option will likely have a better benefit to cost ratio compared to continuous widening. Continues widening between College Road and Church Lane could be an option.

Detail identification and assessment of land requirements and impact were outside the scope of this study. Hertfordshire County Council will not be liable for any damages or loss arising to private landowners as a result of the publication of a report setting out proposed highway schemes in the County. The potential for public or private works to be carried out so as to diminish the value of a property is an ordinary risk associated with any purchase and the valuation of the land in question. The right to compensation will only arise in the event such highway schemes are implemented, and an assessment of the risk of such claims should be undertaken as part of the costings before implementing the highway schemes.

Indicative cost estimates of construction are given below with more information on the cost estimates provided in Section 11.

A10 / M25 Junction 25

For the A10 / M25 Junction 25 improvements tested were the addition of dedicated slip lanes from M25 west to A10 northbound and from the A10 south to M25 westbound. The location of theses proposals are shown in Appendix G.

Table 13: A10 / M25 Junction Summary Operations

A10 / M25	Improvement	AM			PM		
		PRC %	No DoS 80 - 100	No DoS>100	PRC %	No DoS 80 - 100	No DoS>100
2011 Base	-	9%	-	-	-9%	4	-
2031 Base	-	-14%	2	2	-16%	-	4
2031 Base	Eb-Nb & Nb-Wb slips	2%	-	-	0.5%	-	-
2031 Package 2	Eb-Nb & Nb-Wb slips	-1%	1	-	-10%	4	-
2031 Package 5	Eb-Nb & Nb-Wb slips	-42%	-	4	-25%	-	4

As shown, improvements will be required even without the LDF growth. The improvements will accommodate background growth to 2031 and Package 2 growth but not the 2031 Package 5 growth.

An estimate of the cost of the westbound to northbound slip lane and widening of the A10 was obtained and adjusted as set out in Section 11.5. It was assumed that the cost of a northbound to westbound slip lane will also require A10 widening with similar cost, making the total £40.88 million.

Water, electricity and telecommunication services could be affected by the proposed road works. The previous estimate did not include land costs.

A10 junction with A121 Winston Churchill Way / B198 Lieutenant Ellis Way

For the A10 / A121 / B198 junction, the improvements tested were full signalisation with an east to south slip lane, three circulatory lanes on the roundabout and widening of the A10 southbound approach. A signalised four-arm junction (cross-roads) was also tested. The signalisation option and the 'hamburger' option are shown on Drawings 1034090-100-101 and 1034090-100-102, respectively, in Appendix G. The option for signalised cross roads was not explored further as it was found not to produce any improvement, as discussed below.

Table 14: A10 / A121 / B198 Junction Summary Operations

A10 / A121 B198	Improvement	AM			PM		
		PRC %	No DoS 80 - 100	No DoS>100	PRC %	No DoS 80 - 100	No DoS>100
2011 Base	-	N/A	2	2	N/A	1	1
2031 Base	-	N/A	-	2	N/A		2
2031 Base	Crossroads	-103%	-	3	-65%	1	3
2031 Base	Signalised Rndbt	3%	-	-	15%	-	-
2031 Base	'Hamburger'	2%	-		15%	-	-
2031 Package 2	Crossroads	-122%	-	4	-107%		4
2031 Package 2	Signalised Rndbt	-3%	3	-	-16%	1	2
2031 Package 2	'Hamburger'	-13%	2	1	-5%	1	-
2031 Package 5	Crossroads	-124%	-	4	-180%	-	4
2031 Package 5	Signalised Rndbt	-71%	-	4	-44%	-	4
2031 Package 5	'Hamburger'	-48%	-	4	-54%	1	2

As shown, improvements will be required even without the LDF growth. The option of signalised crossroads brings no capacity benefit over signalisation of the roundabout and it was not explored further. Signalising the roundabout will accommodate background growth to 2031 and Package 2 growth for the AM, but not for the PM nor for the 2031 Package 5 growth. The 'hamburger' option provides similar, or possibly marginally better, benefits than the roundabout signal option. The 'hamburger' option shows better results for the PM but not the AM.

Telecommunication services will be affected by the proposed road works and a small portion of land will be required for the proposed slip lane. The estimated cost of signalisation and widening at the roundabout is £2.5 million and for the 'hamburger option £1.9 million.

A10 / College Road

For the A10 / College Road the improvements tested were separated signal stages on College Road and widening of the A10 for 200m on either side of the junction to allow three ahead lanes on both the A10 approaches. A possible layout is shown on Drawing No 1034090-100-103 in Appendix G.

Table 15: A10 / College Road Junction Summary Operations

A10 / College Road	Improvement	AM			PM		
		PRC %	No DoS 80 - 100	No DoS>100	PRC %	No DoS 80 - 100	No DoS>100
2011 Base	-	-8%	3	-	-7%	2	-
2031 Base	-	-22%	-	3	-26%	1	3
2031 Base	Separate Stages	-47%	-	4	-58%	-	4
2031 Base	A10 Widening	1%	-	-	-2%	2	-
2031 Package 2	Separate Stages	-56%	-	4	-72%	-	4
2031 Package 2	A10 Widening	-7%	3	-	-12%	2	2
2031 Package 5	A10 Widening	-32%	1	2	-20%	1	3

As indicated, improvements are required if the forecast background growth to 2031 needs to be accommodated. Separate staging of signals on College Road fails to add capacity. Widening of the A10 to three lanes would barely provide for Package 2 growth and not for Package 5 growth.

Widening of the A10 will require land take and impact on residents' parking and accesses. The existing pedestrian bridge will have to be replaced or reconfigured as some of its supports are within the areas to be widened. Signal settings would allow controlled at-grade crossings over the northern and southern arms of the junction.

Water, electricity and telecommunication services will be affected by the A10 widening.

The estimated cost of introducing separate stages at the signals is £150,000 while the cost for widening the A10 at the junction is estimated at £11.8 million.

A10 / Church Lane

For the A10 / Church Lane junction the improvements tested were widening Church Lane westbound to two lanes and widening of the A10 to three ahead lanes and variations thereof.

- Separate staging of signals Church Lane
- Widening of Church Lane westbound to allow a separate right turn lane as shown on Drawing No 1034090-100-104 in Appendix G
- Widening of the A10 for 200m either side to allow three northbound ahead lanes and three ahead lanes and a right turn lane southbound as shown on Drawing 1034090-100-105 in Appendix G.
- Widening of the A10 for 200m either side to allow three northbound and southbound ahead lanes. This option would require a ban of southbound right turns and the introduction of a pedestrian stage and a possible layout is shown on Drawing No. 1034090-100-106. The analysis here did not include reassignment of the right turn traffic (counted as 123 in the AM peak and 245 in the PM peak) and it was assumed that these movements will be totally displaced.

The option where the right turn lane is retained would require pedestrians to cross 4 lanes across the southbound carriageway, say 3.25mx4 = 13m. Local Transport Note 2/95 paragraph 5.2.3 states: *Where the road is more than 15 metres wide a staggered layout should be provided. If the road width is greater than 11 metres, a staggered layout should be considered*. It would be possible to provide a pedestrian refuge similar to the existing layout at College Road, but that would require significant additional land acquisition and such an option was not explored further at this stage.

Table 16: A10 / Church Lane Junction Summary Operations

A10 / Church Lane	Improvement	AM			PM		
		PRC %	No DoS 80 - 100	No DoS>100	PRC %	No DoS 80 - 100	No DoS>100
2011 Base	-	-10%	2	-	-16%	1	2
2031 Base		-6%	2	-	-49%	-	3
2031 Base	Separate Stages	-34%	-	4	-59%	-	4
2031 Base	Add. Church Lane WB Lane	-4%	2	-	-57%	-	3
2031 Base	A10 widening	6%	-	-	-40%	-	3
2031 Package 2	Separate Stages	-42%	-	4	-72%	-	4
2031 Package 2	Add. Church Lane WB Lane	-9%			-59%	-	3
2031 Package 2	A10 widening	1%	-	-	-39%	-	3
2031 Package 2	A10 widening Peds & no right turn	-22%	-	3	-46%	-	3
2031 Package 5	Separate Stages	-46%	-	4	-94%	-	4
2031 Package 5	Add. Church Lane WB Lane	-26%	2	2	-86%	-	3
2031 Package 5	A10 widening	-14%	1	1	-58%	1	3
2031 Package 5	A10 widening Peds & no right turn	-39%	-	3	-62%	-	3

PM Unreliable forecast data

The high demand flows for the PM peak are due to the way the PM peak flows were created in the MVA model, i.e. by transposing AM background flows (see Section 5), which failed to give a reasonable result in this case, as particularly the westbound PM flow is forecast to grow disproportionally from 2011 to 2031 . It is recommended that the PM result be ignored here.

Looking at the AM results only, the widening of Church Lane westbound would add capacity and handle forecast demand flows almost to levels forecast for Package 2 but not to Package 5. Widening of the A10 to three through lanes would come accommodate Package 5 growth, bit with some arms stressed.

The additional westbound lane would require residential land take and affect water and telecommunication services.

Widening of the A10 will require land take and impact on residents' parking and accesses.

The option where right turns from north are banned and a pedestrian stage introduced would reduce the land required for widening. As shown, this would significantly reduce vehicle capacity. This study did not extend to assessing the impact of diverted traffic.

Water, electricity and telecommunication services will be affected by the A10 widening.

The cost of providing an additional lane on the westbound approach is estimated at £7.2 million and for widening the A10 at the junction, including the westbound lane, £16.2 million.

Turnford Interchange and New River Arms Roundabout

2008 flows from the above mentioned transport assessment were compared to the 2010 and 2011 traffic counts and 2022 forecasts from the transport assessment were used. To be consistent with the analysis of other junctions in the network these were grown to 2031. This was by using the procedure in WebTAG 3.15.2 combining NTEM and TEMRO growth. This result in background growth factors from 2022 to 2031 of 1.033 and 1.035 for the AM and PM peaks respectively.

The Turnford Interchange and New River Arms Roundabout were modelled as isolated junctions using ARCADY.

For the two roundabouts in the Turnford area, current operations and predicted PM operations with forecast flows and the effect of improvements recommended by the Transport Planning Practice (Brookfield Riverside Preliminary Transport Assessment (Draft), October 2009 and Brookfield Riverside Preliminary Transport Assessment Supplementary Information, May 2010), are shown in

Table 17 and

Table 18.

Table 17: A1170 Roundabouts Current AM Operations

		Existing		
Junction	**Approach / Lane**	**Demand Flow (veh/h)**	**Ratio Flow to Capacity**	**Queue (veh)**
A1170 / A10 Turnford Interchange	A10 Southbound off-slip	934	0.48	1
	A10 Link Road Westbound	803	0.33	1
	A10 Northbound off-slip	208	0.13	1
A1170 / B176 New River Arms Roundabout	A1170 Southbound	800	0.46	1
	B176 Westbound	618	0.39	1
	A1170 Northbound	762	0.37	1
	A10 Link Eastbound	1128	0.57	1

Table 18: A1170 Roundabouts Current and Forecast PM operations

		Existing			2008 Based on Transport Assessment without improvements			2031 Based on TA with Improvements		
Junction	Approach / Lane	Demand Flow (veh/h)	Ratio Flow to Capacity	Queue (veh)	Demand Flow (veh/h)	Ratio Flow to Capacity	Queue (veh)	Demand Flow (veh/h)	Ratio Flow to Capacity	Queue (veh)
A1170 / A10 Turnford Interchange	A10 Southbound off-slip	688	0.36	1	690	0.36	1	541 (558 Left)	0.41	1
	A1170 Westbound	921	0.37	1	742	0.30	1	1628	0.82	5
	A10 Northbound off-slip	274	0.17	1	256	0.152	1	322 (290 Left)	0.26	1
	Brookfield Access Road	-	-	-	-	-	-	1532 (799 Left)	0.74	3
A170 / B176 New River Arms Roundabout	A1170 Southbound	803	0.44	1	816	0.46	1	1183	0.80	4
	B176 Westbound	762	0.43	1	706	0.42	1	986	0.80	4
	A1170 Northbound	908	0.47	1	948	0.46	1	868	0.61	2
	A10 Link Eastbound	1001	0.53	1	945	0.51	1	2093	0.80	4

As indicated the junctions are shown to be operating well under the flows forecast in the Transport Assessment and with the recommended improvements. This study therefore did not attempt to search for further improvement measures. As the proposals will be the subject of further assessments and applications, this study did not attempt to advance the conceptual designs or prepare estimates of the costs of implementation of the proposals.

11 Conceptual Designs and Cost Estimates

11.1 Conceptual Design

Sketch plans of the proposals involving highway works are shown in Appendix G. The proposals are only conceptual and sketched out on OS base drawings as options. Note has been taken of highway boundaries and utilities but these and other impacts such as environmental consideration and construction methods are yet to be considered. No topographical or inventory surveys have been undertaken as part of this study.

Safety advice on the conceptual designs has been obtained, but further development of designs should be subject to the appropriate level and stages of road safety audits. Designs also need to undergo Environmental Assessments and Non-motorised User Audits.

The Conceptual design supplied must therefore not be used or portrayed as a completed design for consultation/detailed design or construction purposes.

As the M25 Junction 25 is managed by the Highways Agency and proposals for the junction have already been advanced by others, this study did not include conceptual designs or cost estimates for this junction. A cost estimate from 2005 for the proposed eastbound to northbound slip lane has been found. Diagrams of portion of the proposed slip lane and the location of the proposed improvements are shown in Appendix G. No designs or cost estimates were undertaken for the proposed northbound to westbound dedicated slip lane but it was assumed to be similar to the eastbound to northbound slip lane and will also require widening of the A10.

11.2 Road Safety

The concept proposals were discuss on 4 April 2011. Notes of this meeting are shown in Appendix H. For most, there was agreement that safety issues could be addressed in more detail at following stages of design.

11.3 Construction (Design and Management) Regulations 2007 [CDM]

This report describes a number of options that may include construction work as defined by the Construction (Design and Management) Regulations 2007. As only options are covered at this stage, and the possibility exists that only some or none of the proposals will proceed to construction, the project is considered to be in its initial design phase and thus not currently notifiable to the HSE. Further development of the project beyond the stage of this report would be considered detailed design work under the CDM Regulations.

Where options are carried forward that involve construction work that is likely to last more than 30 working days or involve more than 500 person days of work the project will be notifiable, and it is a Client duty to appoint a CDM Coordinator for the project prior to any further design work being carried out. On appointment, the CDM Coordinator will notify the HSE about the project, and assume his duties under the CDM Regulations.

Options that are likely to exceed the notifiable trigger points are all those involving highway construction namely:

- Widening of Church Lane
- Widening and signal changes of the A10 at any place
- Widening and signalisation of the A10/A121 roundabout
- Slip lanes at M25 Junction 25
- Widening and slip lanes at the Turnford Interchange.
- Widening at the New River Arms Roundabout.

Where the quantum of construction work is below the notifiable trigger points, it is a Client duty to make reasonable arrangements for managing the project to ensure that the construction work can be carried out safely. The Client may benefit from a CDM advisor to assist the Client with his duties in this case.

As the initial design proposals and options involve potential construction work, the project was reviewed by a Mouchel CDM Coordinator.

The CDM Coordinator found and recommended that the design team undertaking the initial designs and cost estimates have complied with their designer duties under the CDM Regulations, including compiling a hazard identification and management schedule. Health and safety issues were considered to a degree commensurate with the preliminary stage of the project. (A copy of the hazard identification and management schedule is included in Appendix I). This schedule needs to become part of the project files and passed on to the designers of following stages of the design

Traffic surveys were undertaken, but initial design work has been based on OS mapping only – no detailed land, ground condition or structural surveys have been carried out. Preliminary information has been obtained on existing underground services to inform the initial designs. If any of the schemes in the report are to be taken forward to more detailed design, a more thorough assessment of hazards and risks will be required. This may necessitate revision to the initial designs.

11.4 Cost Estimates

Costs given in this report are indicative costs, intended only for preliminary budget planning and should not be used for any other purposes. They are based on typical current costs per unit length of measures of similar standard and are not based on detailed quantities. The estimates are presented in line with the Design Manual for Roads and Bridges (DMRB) series numbers and the rates have been built up using a variety of different sources including SPON'S Civil Engineering and Highway Works Price Book, recent Schedules of Rates for highway works and experience of similar works. Costs are given in Quarter 3 of 2009 prices being the latest SPONs. The unit rates and item coverage are shown in Table 19.

Table 19: Rates Used in Preparation of Preliminary Cost Estimates

Series	Description	Rate
200	Site Clearance – includes for the removal of street furniture, foliage, existing highway features such as kerbing.	Assumed to be 2% of the works cost
300, 400	Fencing and Barriers – including Pedestrian guardrail and Road Restraint System	£68/m
500	Drainage and Service Ducts - included in 700	
600	Earthworks – including excavation of carriageway / footway or verge, fill to build up verge, disposal and land tax	£30/m^3
700	Pavements and surfacing – includes carriageway construction, planning and surfacing, antiskid materials and drainage	£105/m^2 (construction, planing & surfacing)
		£16/m^2 (anti skid surfacing)
1100	Kerbs, Footways and Paved Areas – including footway / cycleway, raising of covers and kerbing	£32/m^2 (construction)
		£17/m (kerbing)
1200	Traffic Signs and Markings	Signs £1,000 each
		Markings £1/m
	Traffic Signals	Item – each junction assessed
1300	Road Lighting and Electrical - including columns, lanterns, and connections,	£1,250/column
3000	Landscaping – including topsoil, and turf / seed	£6/m^2
	Structures	Item – each structure individually assessed
	Statutory Undertakers (STATS)	£2,000/m per service
	Preliminaries – including site establishment and disestablishment	Assumed to be 20% of the works cost
	Traffic Management	Assumed to be 10% of the works cost
	Environmental Management	Assumed to be 1% of the works cost

The cost estimates include notional allowances for preparation costs, land and service diversions with only preliminary enquiries made to owners of services. The costs of such items can vary considerably. Cost for option phase and development phase planning and design work is allowed for as a nominal 15% of base construction cost at this stage of conceptual design. Development cost can vary significantly according to conditions. The

costs indicated would allow for basic levels of surveys but not extensive environmental or geotechnical surveys and studies or ground penetrating radar surveys. Redesign and value engineering (to e.g. avoid need to relocate underground utilities) and extensive traffic management design would add significantly to development cost. The allowance would not include cost to consultation, project management, administration costs or legal fees.

A number of assumptions have been made during the cost estimating process and these are detailed below:.

Safety Fences:	It has been assumed that a "standard style" of pedestrian guardrail will be used throughout and no allowance has been included for powder coating in non-standard colours. It has been assumed that any existing Road Restraint System meets current standards and will remain in place where unaffected by the proposals. New barrier will only be installed where required by any carriageway re-alignment. This has been allowed for over the length of the re-alignment only. The use of single sided barrier has been assumed. Other street furniture were not considered at this early conceptual design stage.
Drainage:	All drainage works have been included within the Series 700 Carriageway Construction rate. It has been assumed that in most cases where carriageway widening is taking place new gullies will be installed utilising the existing gully connections to the main surface water sewer. Construction of new inspection chambers and drainage systems has been assumed as being only required where complete new sections of carriageway are being proposed so have been kept to a minimum.
Earthworks:	It has been assumed that all excavation will be in acceptable material for a depth of 0.5m. Disposal of material has been assumed at greater than 1km from site plus tipping charges. All spoil has been assumed to fall within the lower rate for landfill tax.
Pavements:	Pavement thickness and materials have not been designed and are only estimated for pricing purposes. Full depth carriageway construction has only been allowed for where there are areas of carriageway widening or new sections of carriageway are proposed. No allowance has been made for reconstruction of the carriageway within the surrounding areas. One depth of carriageway construction (500mm) has been assumed adequate for all areas of new construction throughout the scheme.

	Carriageway planing and surfacing to a depth of 40mm has been allowed for in certain areas however no pavement assessment has been carried out to determine whether the areas are sufficient or within appropriate locations.
Kerbs footways and paved areas:	Full depth footway reconstruction has only been allowed for where there areas of footway widening / realignment or new sections of footway are proposed. One depth and specification has been assumed adequate for all areas of new footway and / or cycleway construction throughout the scheme. No special surfaces such as “resin bound aggregate”, block paving or paving slabs have been used. It has been assumed that standard pre-cast concrete kerbing will be used throughout. Where footways are proposed or relocated a nominal 2m width was allowed for. Wider footways or introduction of cycleway will require additional construction and land acquisition.
Traffic Signs and Road Markings:	A nominal amount has been assumed for each link based upon the complexity of the link. As a minimum, “white lining” has been assumed as being required where the route is segregated and some signage where the route is shared. No allowance has been made for the provision of coloured surfacing within dedicated bus lanes.
Street Lighting:	It has been assumed that the existing street lighting systems meet current standards and new lighting has only been provided where carriageway widening / realignment is proposed. New lighting columns have been provided for at 30m intervals. The rate includes for new column, lantern, electrical equipment and electrical connection.
Traffic Signals:	An amount for signals based on the complexity of each junction has been used, under the assumption that all items, including posts signal heads and controllers will be provided as new.
Landscaping:	It has been assumed that landscaping is only required where any new areas of construction have occurred i.e. at areas of carriageway widening or footway realignment. 150mm of topsoil with either turf or seeding has been assumed for a width of 1m along all affected areas. Where areas of new carriageway intrude heavily into existing grassed islands resulting in small areas of grass remaining the whole of the island has been included for landscaping. The provision of new trees or decorative planting has not been allowed for.

Bus stops:	No provision has been made for refurbishing or providing new bus stops.
Structures:	No investigation has been carried out into the current condition of the structures or the exact measures required to achieve the proposals. An assumed lump sum has been provided for each location identified as requiring changes.
Traffic Management	No traffic management design have been considered or included at the conceptual design stage and provided for as 10% of construction cost.
Statutory Undertakes Apparatus:	No C3 budget estimates have been received at this stage and all estimated costs have been based on C2 records received from the individual companies.
	It has been assumed that any apparatus that was seen to be located within the footprint of any new areas of footway or carriageway construction will require diversion at the rate of £2,000/m.
Land acquisition	Areas that have been calculated for land acquisition where the proposals extend outside of the assumed existing highway boundary and a nominal cost per m^2 allowed.
Risk Contingency	A Risk contingency of 44% of construction cost is included, based on WebTAG Section 3.7.8 Table 9 guidance on optimism bias
Option / development phase ('design') costs	Allowed for as 15% of the base construction cost

A summary of the cost estimates undertaken for various options are shown in Table 21 with a more detailed breakdown shown in Appendix J.

Until further design work and enquiries have taken place, great uncertainty regarding statutory undertakers apparatus will remain. The assumptions here can be considered to be on the high side. To place its impact on overall costs into perpective, Table 21 also shows an estimate at £1,000/m for any diversion, i.e. 50% of the higher estimate and also illustrates the effect on the contingency amount.

11.5 Estimate Cost of M25 Junction 25 Improvements

A cost estimate for the proposed eastbound to northbound off-slip at M25 Junction 25 and widening of the A10 at the junction was obtained, attached to the Highways Agency comments to Broxbourne District Council Planning Application Ref 7/0078/05/F//W/X. This is shown in Table 20.

Table 20: 2006 Second Quarter Estimate of M25 Junction 25 Improvements

Option Phase Costs	200,000
Development Phase Costs	500,000
Base Construction Cost	9,518,684
Risk Allowance	4,393,239
Ancillary and Statutory Undertaker Costs	1,244,751
Residual Programme Risk	3,221,708
Inflation Allowance (Q2 2006 to 2020)	10,983,097
Total - Construction Phase	29,361,479
Nett Project Cost	**30,061,479**

This estimate does not include land acquisition costs but does include a total provision for risk of about 70%.

To make this estimate comparable with the other estimates in this report, the option and development phases were discounted and Inflation adjusted to 2009 Quarter 3. This resulted in an estimate of £20.44M as also shown in Table 21. With no information available on the proposed northbound to westbound slip lane, this was taken to be the same as for the eastbound northbound slip.

Table 21: Preliminary Estimates of Construction Costs at 2009 Q3 Prices

Junction / Improvements	Estimated Construction Cost	Estimated Cost with lower stats diversion cost
A10 / A121 / B198		
Signalised roundabout and westbound to southbound slip lane		
Construction Items	1,080,000	1,080,000
Statutory Undertakers Diversions	600,000	300,000
Land Acquisition	40,000	40,000
Risk Contingency	760,000	630,000
Provision for option and development phase costs	160,000	160,000
Total	**2,640,000**	**2,210,000**
Signalised 'Hamburger' junction		
Construction Items	1,090,000	1,090,000
Statutory Undertakers Diversions	200,000	100,000
Land Acquisition		
Risk Contingency	570,000	520,000
Provision for option and development phase costs	160,000	160,000
Total	**2,020,000**	**1,870,000**
A10 / College Road		
Separate signal stages on College Road approaches		
Construction Items	150,000	150,000
Statutory Undertakers Diversions	-	-
Land Acquisition	-	-
Risk Contingency	Low risk	Low risk
Provision for option and development phase costs	25,000	25,000
Total	**175,000**	**175,000**
A10 Widening to 3 through lanes per direction		
Construction Items	3,270,000	3,270,000
Statutory Undertakers Diversions	4,700,000	2,350,000
Land Acquisition	250,000	250,000
Risk Contingency	3,620,000	2,580,000
Provision for option and development phase costs	490,000	490,000
Total	**12,330,000**	**8,940,000**
A10 / Church Lane		
Additional westbound lane providing a right turn lane		
Construction Items	1,580,000	1,580,000
Statutory Undertakers Diversions	3,110,000	1,560,000
Land Acquisition	325,000	325,000
Risk Contingency	2,210,000	1,520,000
Provision for option and development phase costs	240,000	240,000
Total	**7,465,000**	**5,225,000**
A10 widening to three through lanes		
Construction Items	3,030,000	3,030,000
Statutory Undertakers Diversions	5,200,000	2,600,000
Land Acquisition	3,020,000	3,020,000
Risk Contingency	4,950,000	3,800,000
Provision for option and development phase costs	460,000	460,000
Total	**16,660,000**	**12,910,000**
A10 widening with no right turns from A1 with pedestrian stage		
Construction Items	2,800,000	2,800,000
Statutory Undertakers Diversions	5,200,000	2,600,000
Land Acquisition	280,000	280,000
Risk Contingency	3,640,000	2,500,000
Provision for option and development phase costs	420,000	420,000
Total	**12,340,000**	**8,600,000**
M25 Eastbound to Northbound slip lane		
Construction Items	9,520,000	
Ancillary Statutory Undertakers Costs	1,245,000	
Land Acquisition	Not included	
Risk Contingency	7,615,000	
Inflation Q2 2006 to Q3 2009	2,060,000	
Provision for option and development phase costs (as given)	700,000	
Total	**21,140,000**	
M25 Northbound to Westbound slip lane		
Taken as same as estimate above	**21,140,000**	

12 Summary of proposals and impact

This section summarises the option previously suggested and / or tested as part of this study and their respective impact, including on other users of the highway. The analysis of junction operations and search for options to attempt to address the forecast demand did not extend to specific strategies to improve conditions for other users of the A10, but the potential impact on such users have been considered as summarised below.

There are currently no local bus routes or stops on the A10. Passenger transport enhancements on the A10 itself is not covered here.

Table 22: Summary of Impact of Junction Improvement Proposals

A10 / M25	Notes / Comments	Impact on non-motorised users
Widening of the M25 eastbound off-slip and gyratory to provide a dedicated filter lane to the A10, previously proposed, and a dedicated lane from the A10 northbound to M25 westbound were tested in combination.	Tests indicate that improvements will be required to accommodate background growth. The suggested proposal will accommodate forecast 2031 Package 2 (LDF Core Strategy shorter term) demand but not more.	The M25, as a motorway, do not provide for non-motorised traffic. There is a rather unwelcoming crossing of the junction provided for via underpasses and using one of the bridges over the M25. The proposals will neither affect this detrimentally nor improve it. Measures to improve cycle and pedestrian access should be included in future options for improving the junction.
Widening approach links to the roundabout from two to three lanes; widening stop-lines from three to four lanes; and increase the number of circulating lanes from two to three lanes.	At a workshop on options (4/2/2011), it was indicated that the Highways Agency would not permit widening of the bridges carrying the circulatory carriageway over the M25and it was agreed that the option will not be pursued.	
Grade separation for the A10 north-south movement would be prohibitively expensive and not financially viable.	Very high cost project and not further explored in this study.	
A10 / A121 / B198 Roundabout	**Notes / Comments**	**Impact on non-motorised users**
Full signalisation, with three circulatory lanes, three southbound approach lanes and a dedicated eastbound to westbound left turn lane	Results show that this option will accommodate forecast background growth to 2031 and demand associated with Package 2 in the AM peak, but the junction will be stressed in the PM peak and not operating under forecast Package 5 demand.	Signalisation would provide some control that would allow additional crossings at or near the junction.
Signalised four-armed junction with three through lanes per direction.	This option was tested in LINSIG and shown to be performing worse than the signalised roundabout option.	
Signalised ‘Hamburger’ Junction.	Marginal improved operations compared to the signalised roundabout option. A concern about adequate advance information for right-turning vehicles needs to be resolved.	

A10 / College Road	Notes / Comments	
Revise signal timings on the College Road approaches to run separate stages	Brought a marginal improvement to operations but not adequate to accommodate forecast flows, either 2031 background growth any of the development packages tested.	Revised signalisation would not bring benefit to non-motorised users. Test indicated that the introduction of pedestrian phases would be very detrimental to vehicle capacity.
Banning right turns from College Road.	This option would cause diversion of traffic in the network which can only be tested with a model with assignment capability and was not explored further as part of this study	Banning turns would open the opportunity to introduce pedestrian phases or an all-round pedestrian stage, but it would negative impact on vehicle capacity.
In an effort to accommodate forecast flows an option of widening the A10 to three approach lanes at the junction was tested.	Adds significant capacity to the junction and will accommodate the Package 2 flows albeit with some streams under pressure. Require land acquisition and relocation of underground services. Require reconfiguration or demolition of existing pedestrian bridge, but could be an opportunity to decrease the separating affect of the A10 through the area by providing at grade crossings.	The sketch plans allow for nominal footway of 2m. This is not adequate to provide for e.g. a shared cycle / footway. Further widening will increase the extent of land required, but should be investigated in further design phases.
Grade separation of junctions or a longer grade separation including both Church Lane and College Road were not investigated in this study.	Very high cost option, with significant construction challenges, but would largely address community impact of the A10. Assignment modelling will be required to assess the impact of diverted traffic.	Grade separation, depending on the preferred layout, could open significant opportunities to provide for non-motorised users and reduce the segregating effect of the A10.

A10 / Church Lane	Notes / Comments (based on AM results due to unreliable PM forecasts)	Impact on non-motorised users
An additional lane on the westbound Church Lane approach to provide a separate right turn lane.	Brought a marginal improvement to operations but not adequate to accommodate forecast flows.	No direct impact on non-motorised users. The sketch plans allow for the existing advance cycle stopline on Church Lane to be retained
Banning right turns	Preliminary tests ignoring the reassignment of traffic indicated that it brought a marginal improvement to operations but not adequate to accommodate forecast flows. Banning turns may divert traffic to lower order roads and would require a model with assignment capability to assess.	Banning turns would open the opportunity to introduce pedestrian phases or an all-round pedestrian stage, but it would negative impact on vehicle capacity.
Widening both the A10 approaches to three lanes	Adds significant capacity to the junction and will accommodate forecast Package 2, but not Package 5. Would require land purchase and relocation of services.	The sketch plans allow for nominal footway of 2m. This is not adequate to provide for e.g. a shared cycle / footway. Further widening will increase the extent of land required.
Grade separation of junctions or a longer grade separation including both Church Lane and College Road were not investigated in this study.	Very high cost option, with significant construction challenges, but would address the separating effect of the A10. Assignment modelling will be required to assess the impact of diverted traffic.	Grade separation, depending on the preferred layout, could open significant opportunities to provide for non-motorised users and reduce the segregating effect of the A10.

A10 / Turnford Interchange	Notes / Comments	Impact on non-motorised users
Segregated left turn lanes added to the A10 slip roads and to the proposed link road and new southbound on-slip to the A10 in conjunction with the closure of the existing southbound slip.	Has been assessed as part of Brookfield Riverside TA. Growth of background traffic to 2031 and assessment with ARCADY in this study confirmed that these proposals will accommodate forecast flows in the critical PM peak.	The Turnford Interchange is not inviting for non-motorised users. The specific highway proposals will probably make the junction more difficult to negotiate or cross. The TA contains some proposals for the area.
New River Arms Roundabout	**Notes / Comments**	**Impact on non-motorised users**
Additional approach lane on the eastbound approach on the A10 link road.	Has been assessed as part of Brookfield Riverside TA. Growth of background traffic to 2031 and assessment with ARCADY in this study confirmed that these proposals will accommodate forecast flows in the critical PM peak.	This proposal has no significant detrimental impact for non-motorised users but it does not contain any element enhancing conditions for cyclist or pedestrians. The TA contains some proposals for the area.

13 Alternative Strategies to Address Vehicle Trip Generation

13.1 Introduction

Developing alternative strategies to address vehicle trip generation is outside the scope of the initial study, i.e. to analyse the impact of the LDF development proposals on key junctions. As however shown in preceding sections, key junctions on the A10 in the study area are operating close to capacity and any further vehicle demand on theses junction will be difficult and costly to accommodate. It is therefore imperative that strategies be developed to reduce vehicle trip generation, particularly during peak hours, not only of proposed new developments but also of the existing urban areas. For the discussion here, it is assumed that through traffic on the A10 falls in the remit of county and national policies and cannot be directly influenced by local planning decisions.

Both the Cheshunt and Waltham Cross Urban Transport Plan and the MVA Report on Delivering Strategies cover aspects of the need and opportunities for mode shift in the area. The Urban Plan based on 2001 Census data, points out that:

- 68% out of a total of the 18,700 employed residents of Cheshunt work outside the town and 71% using the car as mode of travel
- 73% out of a total of the 3,000 employed residents of Waltham Cross work outside the town, with 63% of those commuting by car
- Of the 12,750 people working in Cheshunt 52% commute into the town and 85% of those using the car
- Of the people living and working in Cheshunt 60%travel to work by car, with the corresponding figure for Waltham Cross 34%
- For the whole of Broxbourne, 50% of home to work trips over less than 2km are made by car or van.

It is clear that there are opportunities to alter mode choice of trips within and to and from the area and to manage demand, which have the potential to reduce vehicle trip generation.

13.2 Strategies

Following is a very brief overview of strategies that should be considered to address vehicle trip generation and potentially unacceptable level of traffic congestion.

It must be stressed that, based on the analysis described in this report, reduction of vehicle trip generation will have to be very significant to change the overall conclusion that key junctions will not be able to cope with forecast traffic demand.

Much has been written and researched into the subjects of travel demand management, but the following Government guidance provides a summary and an official view:

- Circular 2/07 Planning and the Strategic Road Network available at http://www.dft.gov.uk/pgr/regional/strategy/policy/circular207planningandstrategic
- Planning Policy Guidance 13: Transport, Department for Communities and Local Government, January 2011

- Planning Policy Statement 1: Delivering Sustainable Development, Office of the Deputy Prime Minister, 2005
- Planning Policy Statement 3: Housing, Department for Communities and Local Government, June 2010
- Travel Plans at http://www.dft.gov.uk/pgr/sustainable/travelplans/
- Smarter Choices at http://www.dft.gov.uk/pgr/sustainable/smarterchoices/

Below is a list from the palette of measures to influence travel demand and mode choice, all of which are probably applicable to the study area to a varying degree. Some of the measures will obviously best be delivered on national or regional level, but many are applicable to local level.

Pubic Transport

- Good route coverage and high frequency of public transport
- Reduced public transport journey times (e.g. by bus priority measures and reduced dwell time)
- Public transport reliability and punctuality
- Marketing of public transport
- Accurate, accessible and up-to-date public transport Information
- Mode integration and connectivity
- Ticketing initiatives (e.g. integrated ticketing)
- Public transport fare strategies to encourage use
- Quality of public transport vehicles and service
- Quality of bus stops
- Quality of environment at stops, along walking routes to stops and in vehicles, including accessibility, cleanliness, lighting, safety and security
- Shuttle buses to prominent destinations.

Personal, company, workplace and school travel plans

- Travel awareness campaigns
- Promotion of walking and cycling,
- Promotion, encouragement and facilitation of
- Encouragement and support of home working, tele-working, teleconferencing, home shopping.

Support of walking, cycling

- Accessibility, cleanliness, lighting, safety and security along routes
- Dedicated facilities, including cycle and walking paths and cycle lanes, cycle parking
- Reduced vehicle speeds
- Quality crossings places.

Discouraging of private vehicle usage

- Parking Management and Pricing
- Congestion Pricing
- Distance Pricing
- Fuel / Emission Taxes.

Promotion of shorter commuting trips

- Geographic location of dwellings and places of work
- Sequencing of supporting developments
- Employer, developer and community participation.

13.3 Recent Initiatives

TravelSmart Broxbourne has been launched reduce car use. It works by offering free information and support to enable people to walk, cycle and use public transport more often. The project is being delivered by Sustrans and Socialdata with funding from Defra's Greener Living Fund and support from Hertfordshire County Council, Broxbourne Borough Council and other local partners.

Between May and August 2010 the TravelSmart project team contacted about 8.000 households in the Borough. Local residents from Hoddesdon Town to Waltham Cross, were offered free personalised travel information to encourage them to walk, cycle and use public transport more often. The most popular item offered was the local travel map produced especially for the project, showing schools, shops and local green spaces and how to get to them on foot, by bike or by bus.

A baseline survey was conducted in Broxbourne before starting fieldwork, to get a good understanding of travel behaviour in the town. After-surveys are also taking place and the results will be available in Spring/Summer 2011. Previous TravelSmart projects have consistently achieves reductions in car trips of 10 per cent or more. This reduction is accompanied by increases in levels of walking, cycling and public transport use. It is anticipated this will also be the case for Broxbourne.

In December 2010 Mouchel completed a study 'Hertfordshire Rail Station Review' which included Waltham Cross, Theobalds's Grove and Cheshunt Stations. The study covered proposals to enhance stations and their access routes to encourage usage.

14 Intelligent Transport Systems

Intelligent Transport Systems (ITS) could be a cost effective measure to ease some of the problems experienced on the A10 and help to make optimal use of provided infrastructure.

ITS tools use modern computing and communications technologies to collect information about the current state of the transport network, process that information, and either directly manage the network (e.g. traffic signals), or allow people to decide how best to use the network (e.g. incident detection, travel news). ITS activities can broadly be categorised into the areas of Monitoring, Controlling, Information and Communications.

When correctly used, ITS can result in major improvements in safety, network management, environmental management, integration, accessibility and public perception. It can also address issues as diverse as social inclusion and freight vehicle management.

Increasingly, under the traffic management act and other legislation, authorities will be required to manage effectively the movement of traffic including pedestrians both within their authority and between authorities. ITS enables the intelligent management of traffic and provides quantifiable evidence of the success of management approaches.

Below is a list of some of the tools available within ITS:

- Access Control
- Adaptive Traffic Signal Control
- Asset Management Databases
- Broadcast Congestion Information
- Car Park & Roadside Security
- Common Databases
- Data Collection & Monitoring
- Dedicated Lane Enforcement
- Demand Responsive Management
- Emergency Vehicle Priority
- Environmental Traffic Management
- Freight & Fleet Management
- Incident Detection
- Intelligent Road Markings
- Lane Control
- Multimodal Trip Planning
- Parking Management
- Parking Payment Systems
- Passenger Information Systems
- Public Transport Payment Systems
- Public Transport Priority
- Public Transport Security
- Ramp Metering
- Red Light Monitoring
- Road User Charging
- Route Guidance & Navigation

- Speeding Detection
- Variable Message Signs
- Variable Speed Limits
- Vehicle Activated Signs

Specific to the A10 the following could be considered: to improve journey times and reliability:

- Observation and recording of vehicle journey times and variability by automatic number plate recognition (ANPR) system and or observation by CCTV. This information can be acted upon via the use of other ITS tools such as signal timing amendments via the UTC system or communicated to users by variable message signs.
- Vehicle actuated and variable message signs can be used to warn drivers of incidents, congestion and queuing and advising of route diversion or speed changes to avoid congestion and prevent the shunt type accidents prevailing on the A10. Signs advising drivers of congestion hotspots should be linked to system currently operational on the M25.
- Road user information about planned works to disseminate information about travel conditions radio stations, via the internet and mobile devices such as phones and other mobile devices and, satellite navigation systems.

15 Conclusions and Next Steps

This study was aimed at determining the impact of the Broxbourne LDF proposals on key junctions on the A10 in the Cheshunt and Waltham Cross area. The study also tested the mitigation measures that have previously been proposed within the Waltham Cross and Cheshunt Urban Transport Plan (UTP) to deal with congestion issues and suggest alternative proposals to mitigate the impact of LDF land use changes.

Forecast results from a Transport Assessment Model (TAM) developed for Broxbourne and a Transport Assessment for Brookfield Riverside were directly used as the source of future traffic flows, after adjustment with recent traffic counts. The transport model is described in a report *Delivering Strategies – Broxbourne Transport Modelling* by MVA for Broxbourne Borough Council, July 2010 and was referred to in this report as the TAM or the MVA report.

The impact of traffic flow for three 'Development Packages' was analysed, namely a 2031 Case with no development in Broxbourne (i.e. only background traffic growth occurring), with the LDF short term aspirations taking place (Package 2) and a package with all the developments in the LDF taking place (Package 5).

Analysis of the junctions from the M25 to the A10 / Church Lane junction showed that no set of low cost measures will accommodate the forecast growth in traffic by 2031. Specifically, the junctions of the A10 with College Road and Church Lane are the most severely stressed with increased traffic flows. As a result, further options including widening the A10 at these two junctions have been modelled and have been shown to accommodate development growth approaching Package 2 forecasts but not for Package 5. However, the College Road junction will still be stressed with Package 2 growth and significant works will also be required to accommodate Package 2 forecast demand flows at the A10 / M25 and the A10 / A121 junctions.

Testing of proposals to provide grade-separated junctions was outside the scope of the study as it would require modelling with capability of reassigning traffic in the network. The scale of forecast demand over existing flows is such that drastic proposals such as these should not be totally dismissed.

Based on available information, it is concluded that the proposals made in the preliminary transport assessments for the Brookfield Riverside development for the Turnford Interchange and the New River Arms Roundabout will provide adequate mitigation to accommodate forecast demand at these junctions. The transport assessments did not address the impacts of the Brookfield Riverside development on other junctions on the A10.

At all junctions, widening options would affect underground services and require purchase of land outside the existing highway. Widening of the A10 would also affect residents' accesses and parking and impact on existing structures.

Table 23 summarises the effect of the development proposals at the junctions tested.

Table 23: Summary of Junction Improvements Tested

Junction	Improvements tested	Accommodate 2031 Base	Accommodate Package 2	Accommodate Package 5	Land Required	Services Affected	Indicative costs
A10 / M25	Eb-Nb & Nb-Wb slips	Yes	Yes	No	N / A	Yes	£42.28M
A10 / A121 / B198	Full signalisation, 3 circulatory lanes and A10 southbound widening	Yes	Stressed	No	Yes	Yes	£2.64M
A10 / A121 / B198	Signalised 'Hamburger' junction	Yes	Yes	No	No	Yes	£2.02M
A10 / College Road	Separate Signal Stages	No	No	No	No	No	£175k
A10 / College Road	A10 Widening	Yes	Stressed	No	Yes	Yes	£12.33M
A10 / Church Lane[1)]	Additional westbound lane	Yes	No	No	Yes	Yes	£7.47M
A10 / Church Lane[1)]	A10 Widening & westbound lane	Yes	Yes	No	Yes	Yes	£16.66M
A10 / Church Lane[1)]	A10 Widening & westbound lane, southbound right turn ban with pedestrian stage	Stressed	No	No	Yes	Yes	£12.3M
Turnford Interchange[2)]	Dedicated left turn slip roads and new southbound on-slip	Yes	Yes	Not fully tested	Yes	Likely	Dev Proposal
New River Arms Roundabout[2)]	Widening on east bound approach	Yes	Yes	Not fully tested	No	Likely	Dev Proposal

Cost estimates are in 2009 prices – refer to Section 11

[1)] Based on AM only, forecast PM data unreliable

[2)] Based on PM data from Transport Assessment

[3)] 'Stressed' refers to the junction as a whole operating very close to capacity with demand exceeding on some arms.

There is no doubt that the A10 has a severe segregating effect on the local community. The study did not explicitly search for measures to address this and neither did the proposals developed include specific measures to improve conditions for pedestrians and cyclists. The impact of the proposals on these modes has however been considered. There are opportunities to provide additional controlled at-grade crossing places on the A10 and it is recommended that this be developed considering pedestrian and cycle movements and desire lines in the area.

High numbers of injury accidents are recorded on the junctions on the A10 in the study area. Signalisation of the A10 / A121 roundabout should address some of the problems at the junction. A review of speed limits taking into account results of speed surveys and new junctions on the A10 is recommended.

The study offers a brief overview of measures whereby demand for vehicle trips can be managed and technology used to reduce congestion. It is recommended that these measures be taken forward but it also needs to be emphasized that the impact of such measures will have

to be very significant to alter the overall conclusion that the junctions along the A10 from the M25 to Church Lane can be expected to suffer severe congestion in future.

The scope of this study was the junctions on the A10 in Cheshunt and Waltham Cross. Given the impact of the development proposals it is recommended that junctions on the A10 further north at Hoddesdon and Amwell also be investigated.

The general conclusion is that the developments in Package 2 will require extensive and expensive highway mitigation measures which will necessitate widening of the A10. Even with these, capacity problems remain and there is clearly a need for complementary measures to reduce trip generation at source, encourage mode shift and ensure that the highway is managed as efficiently as possible. Should a level of traffic growth be pursued beyond Package 2 then further consideration will need to be given to the feasibility of larger scale interventions such as grade separation.

Next Steps

This report has identified potential highway infrastructure schemes to mitigate against the additional traffic anticipated from LDF development. The findings should be taken into account when establishing planning requirements for taking developments forward in the A10 corridor. This could be in the form of an A10 Route Management Study that has been recommended by Broxbourne Borough Council in their Core Strategy to consider the wider impacts on the A10 and identify a strategy for delivery. Table 24 shows the sequence of studies undertaken to date and future work with the lead authorities identified.

Table 24: Sequence of Studies

Study	*Lead Organisation*	*Consultant*	*Summary of Study Area and Study*
Delivering Strategies Broxbourne Transport Modelling	`	*MVA*	*Study commissioned to further consider highway impacts of LDF traffic in the Borough following mock inspection comments. Study used a spreadsheet based model (TAM) and identified stress on A10 junctions in the Borough.*
Waltham Cross and Cheshunt A10 Study	*HCC in partnership with Broxbourne and the Highways Agency*	*Mouchel*	*Study commissioned to further consider impacts of LDF traffic and consider interventions on the A10 between the M25 and Turnford Interchange following recommendations from the Waltham Cross and Cheshunt UTP (Oct 2010) and the MVA study. Junction models produced to test interventions.*
A10 Route Management Strategy	*Broxbourne in partnership with HCC and Highways Agency*	*TBC*	*The need for an A10 Route Management Strategy is identified by Broxbourne Council in their Core Strategy. A funding mechanism for this study is still to be established.*

Strategic masterplanning is required on transport issues including improvements to all modes of transport and to identify highway improvements associated with specific areas of development. It is important that a timetable is agreed that sets out the delivery of developments and the phasing and trigger points of required highway improvements and interventions.

The development of an A10 Route Management Strategy could establish this and could also include investigation of other scenarios to verify the separate and cumulative impact of developments as they happen. One such scenario could be the combination of committed development and Greater Brookfield. Scenarios building up to Package 2 and scenarios between Package 2 and Package 5 could also be considered, however, traffic growth beyond that of Package 2 will require further consideration of larger scale measures such as grade separation of junctions.

A strategy should also consider mechanisms to safeguard and acquire land that is required for improvements.

In addition to the highway measures noted in this report, travel demand measures and sustainable transport initiatives would need to be costed and included. It is a prerequisite that funding mechanisms be found under which financial contributions to mitigation measures can be collected through planning obligations. Given the number of developments involved, a scheme set up under the Community Infrastructure Levy Regulations may be appropriate.

Therefore, it is a clear that further consideration needs to be given to scale and sequence of development and the consequences of the traffic growth on the A10 as well as the timing and funding of mitigation measures.

If developments (e.g. Greater Brookfield) come forward separately in the short term it would be necessary to assess their impact (together with other committed development).

Whilst this report concentrates on impacts and costs of mitigation measures on the A10, developments will also make demands on the local road network and public transport. Transport Assessment guidance requires development trips to be met as far as possible by sustainable means, and only residual trips to be catered for by car. Local road improvements may be directly linked to individual developments.

This report estimates that improvements to key links and junctions will cost in the order of 73 million pounds plus any works to the Turnford Interchange and the New River Arms Roundabout. However, consideration should be given to enhancing any estimates used for budget purposes to allow for improvements to public transport and ‘smarter travel’ on a wider basis in order to accommodate sufficient development trips to contain the impact on highways in general and the A10 in particular. This is outside the scope of this report but it is suggested for initial purposes that infrastructure estimates could be enhanced by at least 30% for this purpose

Therefore key matters for further consideration comprise:

- A timetable setting out the delivery of development and the phasing and trigger points of the required highway improvements.
- A funding mechanism for the highway improvements.
- Further scenarios may need to be tested if the sequence and extent of development differs significantly from those tested
- Impacts on junctions of the A10 further north at Hoddesdon and Amwell.
- Land issues relating to the capacity improvements to the A10

Appendices

(Separate Volume)

Appendix A: Traffic Survey Data

Appendix B: C2 Statutory Undertakers Search

Appendix C: Highway Boundaries

Appendix D: Forecast Junction Flows

Appendix E: Proposals for Highway Improvements from Recent Studies

Appendix F: Junction Model Results

Appendix G: Sketch Plans of Proposals

Appendix H: Notes of Meeting 4 April 2011

Appendix I: Hazard Identification Schedule

Appendix J: Construction Cost Estimates