Norfolk County Council
Planning and Transportation
County Hall
Martineau Lane
Norwich
NR1 2SG

Thetford Transport Study

Initial

December 2008

Norfolk County Council
County Hall
Martineau Lane
Norwich
NR1 2SG

Tel : 01603 222143
Fax : 01603 222240
www.norfolk.gov.uk

Breckland Council
Elizabeth House
Walpole Loke
Dereham
Norfolk
NR19 1EE

Tel : 01362 656870
www.breckland.gov.uk

Mott MacDonald
County Hall
Martineau Lane
Norwich
NR1 2US
Tel : 01603 767530
Fax : 01603 767463
www.mottmac.com

This project is part-financed by the European Union European Regional Development Fund

objectivetwo working together for a better east of england

[Intentionally Blank]

Thetford Transport Study

Initial

Issue and Revision Record

Rev	Date	Originator	Checker	Approver	Description
A	August 2008	G Smith/ E Taylor	C N Jolley	E T Tyrer	First Issue
B	December 2008	G Smith	C N Jolley	E T Tyrer	Amendment following comments from Breckland Council

List of Contents

Page

Summary

The purpose of this study is to assess given development options for the growth in Thetford and their likely impacts on the traffic and transportation networks. It is also to identify what infrastructure or mitigation measures would be required to enable those options to be developed.

This initial transport study concludes that for growth in Thetford:

- Public transport improvements for both railways and particularly buses are essential.
- All five scenarios require mitigation measures to the highway links and junctions within Thetford.
- Development scenario D would have the least impact on the highway links and junctions on the current road network around and within Thetford as it does not develop Key South East, and therefore is the preferred scenario to minimise transport infrastructure investment. However, it is understood that for land use purposes, there is an aspiration to develop Key Site South East.
- Further data and discussions with the Highways Agency and the local highways authority are required to agree key assumptions before committing to mitigation measures.
- It is recommended that further transport study and survey work should be undertaken to allow further development of the Master Plan.

[Intentionally Blank]

1 Introduction

1.1 Context of the Study

In 2006 Thetford achieved Growth Point Status, with a target of achieving of 6 000 new homes between 2001 and 2021. Extrapolating this amount suggests 9 000 new homes by 2031, almost double the current 9 950 households (CACI household income data 2007). Thetford will also seek to boost employment levels with approximately 5 000 new jobs created by 2021.

Meeting these growth targets will involve an unprecedented level of growth and change and require the funding and provision of extensive supporting infrastructure. The impact of transport choices and how movement takes place around the area is at the core of a growth strategy of this magnitude.

The scale of growth proposed for Thetford will place a significant burden on the existing transport networks. To accommodate the growth there will need to be a major shift in emphasis towards public transport, as recognised in the Regional Spatial Strategy.

A comprehensive review of the existing public transport system will be required to achieve this modal shift. The urban extensions will need to be integrated into an enhanced public transport system and will require high quality public transport links to the town centre, employment areas and key commuter destinations outside Thetford.

The Growth Point status of Thetford has so far received £6 million for 2008/2009; 2009/2010; and 2010/2011 and is expected to attract significant levels of grant funding from Central Government, while the growth itself will generate substantial developer contributions for infrastructure and services. There is thus an opportunity to both achieve an innovative pooling of contributions and implement a well planned programme of infrastructure delivery.

1.2 Purpose of the Study

The purpose of this study is to assess given development options for the growth in Thetford and their likely impacts on the traffic and transportation networks. It is also to identify what infrastructure or mitigation measures would be required to enable those options to be developed.

The background information provided by Breckland Council sets out a number of growth assumptions and scenarios. The primary aim of this study is to assess the five development scenarios for housing in the urban extensions, the infill housing development and the new employment areas.

The five housing development scenarios for the urban extensions to be assessed in the study are (Figure 1.1):

- Scenario A: Development of Key Site North (2010 – 2027) five years before Key Site South East (2015 – 2027)
- Scenario B: Key Site North developed to maximum (2010 - 2021) before development of Key Site South East commences (2021 – 2031)
- Scenario C: Both Sites developed in parallel between 2010 and 2027

- Scenario D: Development of Key Site North to maximum, followed by development of remaining housing development to meet 8 096 target in either Site E or part/all of Site C up to 2031
- Scenario E: Development of natural limit in Key Site North and Key Site South East areas up to 2021, with additional homes in either part of the rest of Site E or part/all of Site C up to 2031 to reach the maximum required new homes target of 8 096 (albeit less than would be the case under scenario D).

Table 1.1 below provides a summary of the housing development scenarios.

Table 1.1: Summary of Housing Development Scenarios

Scenario	A	B	C	D	E
Key Site North (broadly B, D part of E)	2010 - 2027	2010 – 2021	2010 – 2027	2010 – 2021	2010 – 2021
Key Site South East (broadly H, G part of F)	2015 – 2031	2021 – 2031	2010 – 2027	Not developed	2010 – 2021
(part of) Rest of Site E and/or Site C	Not developed	Not developed	Not developed	Site E or C post 2021	Site E or C post 2021

Figure 1.1: Development Area

Source: Thetford Masterplan Growth Framework and Infrastructure Study, September 2007

1.3 Thetford Growth Point

An earlier study – Thetford Growth Framework and Infrastructure Study (EDAW, Final Report September 2007) identifies growth options which align with and support the delivery of the growth set out in the Regional Spatial Strategy (RSS). The study focuses on planning how the residential and employment growth targets set to 2021 could be achieved and also considers and develops options that allow growth to continue post 2021.

It is expected with the substantial development in the town centre and in the urban extensions there will be significant impacts on traffic flows on the local highway network.

1.4 The Brief

The study brief is to develop a Transport Strategy to inform and take forward the Thetford Area Action Plan. In developing such a strategy, consideration should be given to:

- The identification of Thetford's current traffic and transport situation
- Development of a 'vision' and strategy for Thetford
- Assessment of growth options and their impacts
- Development and assessment of appropriate transport strategies and interventions.

Whilst agreeing that this is the correct process and approach time constraints have resulted in Breckland Council asking Norfolk County Council and Mott MacDonald to focus initially on a specific element of the strategy work; to strategically assess the impacts of the proposed development options on the transport network.

To meet the August deadline, this report focuses on the following key tasks, the outcomes of which will form the foundation of the transportation master plan:

- Undertake data collection from the Highways Agency's Traffic Information Database (TRADS) for the A11 and any available Annual Traffic Counts (ATC) on the A134, the A1075 and the A1066;
- Produce key traffic flow diagrams to illustrate 'base' traffic flows, trip assignments, 'design' traffic flows in the years 2021 and 2031;
- Carry out highway link and junction assessments using the Design Manual for Roads and Bridges
- Produce an area wide accident overview to identify accident patterns for vulnerable road users and areas warranting further detailed investigation, if any;
- Review of recent proposals affecting public transport in Thetford, eg Bus Station study and Norfolk rail capacity study and to consider other public transport measures that could be appropriate for the development scenarios; and
- Identify mitigation for the various scenarios based on high-level assessments.

1.5 Structure of the Report

Chapter 2 reviews the key findings of the EDAW Thetford Growth Framework and Infrastructure Study (TGFIS) concerning transport infrastructure and the Highways Agency Regional Network Report for East of England.

Chapter 3 broadly describes the baseline conditions in and around Thetford. The chapter aims to examine the development sites in terms of location in the context with Thetford Town Centre, current and permitted uses and site access layout.

Chapter 4 outlines the proposed development including highlighting the key developments and access options for input into the transport planning model. This section aims to provide an initial understanding of developmental and transportation impacts that may result.

Chapter 5 provides a summary of the development of calculations used in assessing the likely effects of the proposed development on the road network.

Chapter 6 discusses outputs from Chapter 5, in as far as available data allows, of which highway links and junctions could require improvement for the five scenarios identified by Breckland Council.

Chapter 7 assesses the requirements for improved public transport proposals to provide a sustainable transport system for the new settlement. The proposals build on TGFIS' recommendations (EDAW, September 2007) and the Thetford Bus Station Relocation (May 2007) and the Improved Rail Services in Norfolk – Ely Curve Diversion of Services (December 2007) reports undertaken for Norfolk County Council by Mott MacDonald.

Chapter 8 provides details of the key components of a high quality public transport connection. Major improvements to all aspects of service quality will be fundamental to making bus services more attractive.

Chapter 9 draws together the previous sections of the report and presents potential mitigations. It needs to be stressed that these are based upon data available and assumptions made in the highway and public transport assessments. Further data and an agreement of the assumptions made are essential to allow work to be carried out to refine the potential mitigations.

Chapter 10 pulls the previous chapters together by drawing out key conclusions within the assessment and by providing recommendations for the future assessments that are required.

2 Previous Studies

2.1 Thetford Growth Framework and Infrastructure Study (TGFIS)

The strategic transport implications of the proposed growth framework are discussed in the Part 3 – Chapter 7 Transport Infrastructure Testing of the TGFIS which was carried out by Peter Brett Associates (PBA). The report recognised the current tendency to a high level of car ownership and car reliance on many new developments situated in locations on the edge of urban areas and it emphasises that considerable investments in transport infrastructure improvements are necessary to achieve the sustainable transport objectives.

The TGFIS broadly looked at four aspects namely:

- Public transport including assessments and recommendations of bus services, bus station location, bus/rail interchange, bus stop improvements, routing of existing bus services and new bus services;
- Walking/cycling improvements;
- Road network; and
- Car parking

It is understood that no numerical analysis of link and junction capacities was undertaken as part of the TGFIS and that Peter Brett Associates only had limited existing traffic flow data available on which to make their qualitative judgements.

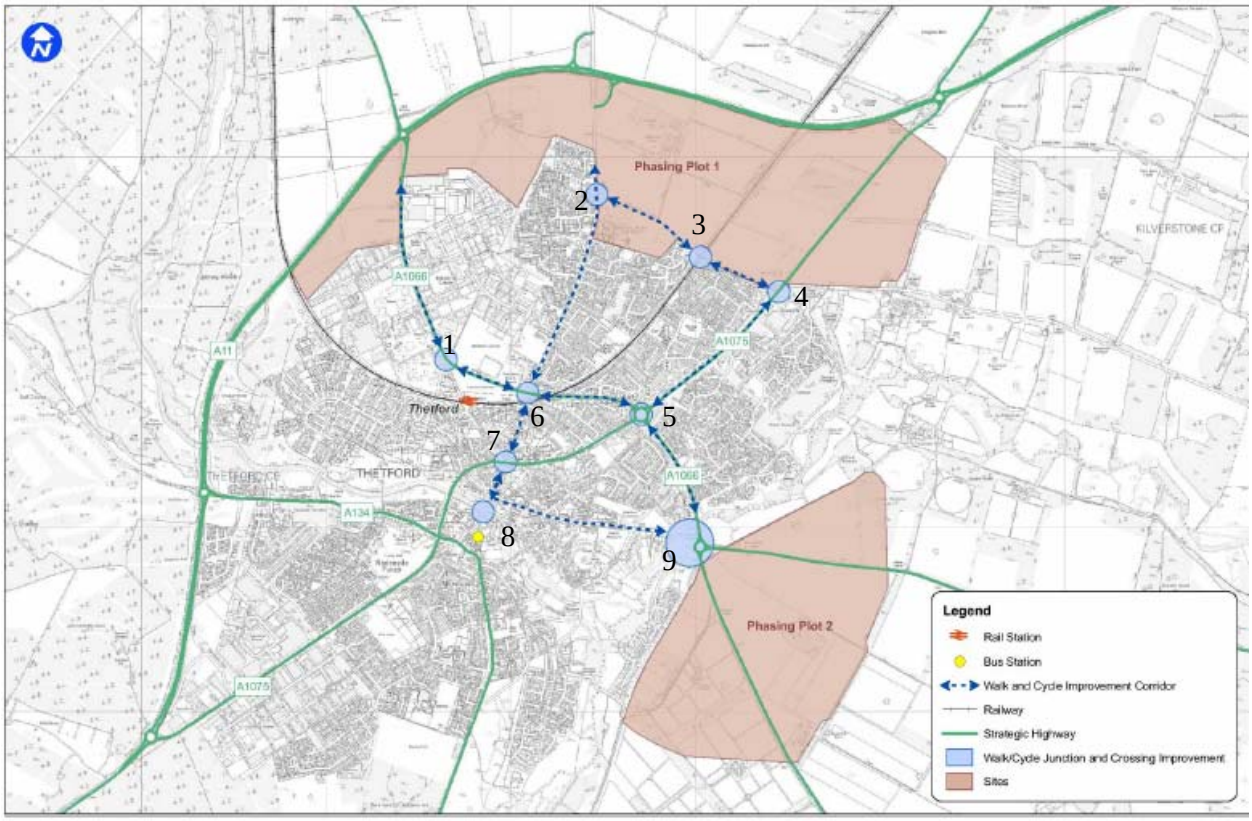
2.1.1 Walking/Cycling Improvement

Cycling and walking networks were considered to be well established and Thetford already has a high proportion of walking and cycling journeys within the town centre that need to be built upon. However, it was highlighted that it will be essential to introduce strong linkages to the new development sites that connect in with the existing networks, providing access to the town centre and key transport nodes.

As a summary, the TGFIS recommends the following improvements:

- To the northern development site: walking/cycling route alongside a proposed north-south bus priority link. This will include improvement at the Croxton Road/Mundford Road junction where general vehicle traffic will be prohibited from travelling south.
- To the eastern site: a route along Castle Street to the town centre, the rail station and the bus station.
- To the south of the northern development site: an opportunity for an east-west link across the railway link connecting Norwich Road and Croxton Road.
- Upgrade roundabouts in the area from non-signalised to signalised to facilitate the introduction of formalised pedestrian crossing points.

Figure 2.1: TGFIS Walk and Cycle Improvement Plan



Source: Thetford Masterplan Growth Framework and Infrastructure Study, September 2007

Keys to junctions:

- Junction 1 – A1066 Mundford Road/Station Lane junction
- Junction 2 – Croxton Road/unknown path junction
- Junction 3 – Path under existing railway bridge
- Junction 4 – A1075 Norwich Road/Kilverstone Road junction
- Junction 5 – A1075 Norwich Road/A1066 Mundford/A1066 Hurth Way roundabout
- Junction 6 – A1066 Mundford Road/Croxton Road junction
- Junction 7 – Croxton Road/White Hart Street junction
- Junction 8 – Narrow bridge on Bridge Street
- Junction 9 – A1066 Hurth Way /A1088 roundabout

2.1.2 Road Network

Recommendations were made based on the assessments which were achieved by cross referencing the annual average daily traffic (AADT) information available with the Design Manual for Roads and Bridges, Volume 5, Section 1, Part 3 ' Assessment and Preparation of Road Schemes'.

This report highlights traffic management solutions as the key factor that will have a positive influence on traffic flows. Additionally, the following key highway improvements have been identified as necessary, regardless of future development proposals:

- The dualling of the A11, south of the junction with the A1075 which is the only section of the A11 within the vicinity of Thetford that is not currently dualled.
- Mitigation measures to reduce the number of freight vehicles diverting from the A11 and using routes within Thetford, such as the A134. This could be achieved through the use of appropriate signage showing the best routes for freight to access locations in the town and new development areas and by placing restrictions on other roads that cannot satisfactorily accommodate freight vehicles.

Taking in to consideration the anticipated levels of growth up to 2021 and beyond, the TGFIS recommended the following measures:

- Certain sections of the A11 to the north and west of the northern development site may begin to reach capacity with the anticipated levels of growth up to 2021. Further widening may need to be considered, although alternative measures should be considered in the first instance.
- Upgrade layout of the access to the A11 from Croxton Road.
- The junctions of Norwich Road with the A11 and Mundford Road with the A11 will need to be widened and may need to be signalised to accommodate anticipated growth.
- The A1075 and the A1066 will need to be widened if further traffic management techniques are not introduced. Improvements will also extend to the roundabouts and key junctions within these sections of each of the roads, via widening and possible signalisation.
- The A1066 will provide the key vehicular, pedestrian access and bus priority routes to the eastern development site which will require widening of this road at certain points including widening of the bridge across the river and alterations at the adjacent roundabout.
- Without the introduction of further traffic management measures, the junction of the A134/A1075 will need to be widened and upgraded.

2.1.3 Car Parking

There are a number of existing car parks within Thetford Town Centre, most of which provide free parking. The TGFIS recognised that demand for car parking is a major contributor to the town centre congestion in Thetford and three key issues that were recommended are:

- The introduction of Pay and Display, with a focus on the provision of short stay parking to cater for essential users rather than long stay parking for commuters.
- Rationalisation of parking around the core of the town centre possibly by creating multi-storey car parks which would be clearly signed. This could reduce the traffic flow issues within the town centre.
- Investigation into the feasibility of a Park & Ride scheme to complement improvements on public transport, walking and cycling facilities.

The earlier, December 2006, Mott MacDonald 'Thetford Transportation Study' included similar recommendations for car parking, and for issues relating to other modes.

2.2 Bus

The TGFIS report states that bus travel within Thetford is not currently an attractive option. Services suffer from low patronage and the bus station facility is in need of improvement or replacement. Links between the bus interchange and the rail interchange are currently poor and need to be reviewed.

The May 2007 Mott MacDonald study 'Thetford Bus Station Relocation' assessed options for a new bus station in Thetford. Two of the key recommendations of this study are that:

- A new bus station should provide a minimum of five departure stands
- The best alternative locations to the current site are at St Nicholas Street and Minstergate

2.3 Rail

The TGFIS report states that rail services also experience low patronage levels and connections to the wider area are generally poor.

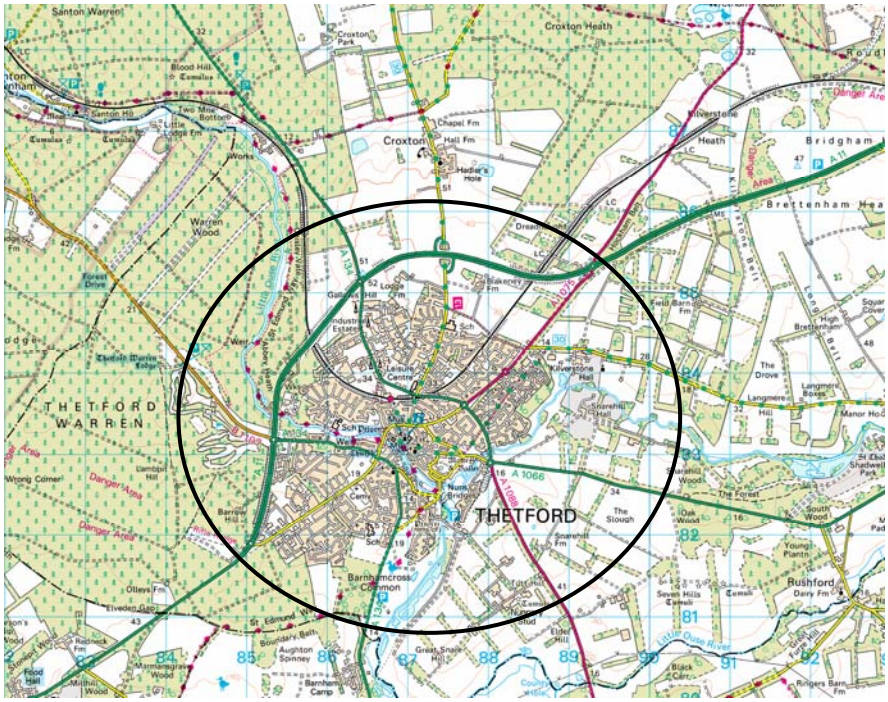
There are a number of infrastructure and operational constraints on the rail services through Thetford. These constraints are outlined in the Mott MacDonald report 'Improved Rail Services in Norfolk – Timetabling Exercise' (December 2007), which presents the results of a high-level timetable analysis to determine the ability of the present rail infrastructure to accommodate future additional rail services. Accessibility issues at Thetford station are discussed in the Mott MacDonald report 'Thetford Railway Station Accessibility' (March 2008) which considers a wide range of improvements that could create a more accessible station for all.

3 Baseline Conditions

3.1 Current Site Details

The study area encompasses Thetford and its surrounding areas. It is broadly bounded by the A11 to the north and to the west, the A1075 to the east and the Street to the south. The location and the extent of the study area are shown in Figure 3.1 below.

Figure 3.1: Location Map



Key to Symbols:

Extent of study area

Scale: NTS

3.2 Permitted and Existing Uses of the Growth Areas

3.2.1 Landscape

This section broadly summarises the existing landscape characteristic of the north and south east growth areas contained in the EDAW report.

(i) Key Site North

The landform rises subtly in the north to form the upper crests of the Thet Valley. The area is large scale Brecks agricultural land with distinctive pine tree belts and rows. A 'potentially significant' archaeological site (Boudicca) is located at Gallow's Hill south of the A11 and north of Fison Way industrial estate. There is a smaller scale field pattern and historic field boundaries adjacent to Croxton Road, and good green/tree boundaries along the A1075 corridor.

The northeast area of Thetford has the least open space and green infrastructures, and the A11 provides a barrier for pedestrian routes from the north to the town centre.

There are historic drove roads and greenways across the site extending out from Thetford, including:

- The Shipwalk track which is an ancient public right of way running alongside the railway to connect Thetford and Brettenham Heath, East Wrexham Heath and Peddar's Way;
- Maiden's Walk from Kilverstone Hall; and
- Croxton Road, a quiet rural road and low key access to Thetford and to Hereward Way. This Road is also signed as Sustrans Route 13, heading north out of Thetford to join the Route 1 at Gateley near Fakenham.

The arable land north of the A11 is not designated and is away from the Special Protection Areas (SPA) but it is suspected as nesting farmland birds (especially Stone Curlew).

(ii) Key Site South East

Similar to the north site, the landform rises gently to form the upper crests of the Thet Valley. The area is mostly managed estate farmland with plantation blocks, shelterbelts and pine rows with small farm copses and distinctive roundel plantations at Snarehill. To the east, Nunnery Stud is a typical stud landscape of small grazed paddocks contained by linear plantations and post and rail fencing. Breckland Farmland SSSI – SPA (Stone Curlew, Woodlark, Nightjar) is also located to the east of the proposed development area.

In creating a new urban edge, it is important to consider the following:

- Natural ecological system function of the river corridor and floodplain;
- Historic designed character of Shadwell Park;
- Strong rural character of the managed, intact estate farmland (this is not an urban fringe);
- Plantation blocks, lines of Pines and designed tree features such as copses and roundels of the managed estate landscape (although it is equally important to note that although these features are individually sensitive, collectively they create enclosure and containment for new development); and
- Archaeological sites including the round barrows at Seven Hills (SAM), tumuli in the grounds of Nunnery Stud and parkland landscape associated with Snarehill

3.3 Existing Site Access Layout

Key Site North would have direct access to the A11 via the A1066 Mundford Road, Croxton Road and the A1075 Norwich Road. Key Site South East would be connected to the A1066 or the A1088. Both roads join at the A1066/A1088/Castle Street roundabout which is the gateway to the town centre from the southeast.

3.4 Current Transport Facilities

The TGFIS report concluded that Thetford is generally characterised by moderate levels of car ownership, and although car use is lower than in the surrounding district and region there is a higher dependence on the private car than would be expected for an urban environment.

Thetford has enjoyed the benefits of excellent road connections to the rest of East Anglia due to its location on the A11. It is also in close proximity to the A47, designated as part of the Trans-European Road Network, proving that the area has working links with the rest of Europe as well as to Norwich, Great Yarmouth and the ports to the east. Norwich Airport and Stansted Airport are also closely located to Thetford.

3.4.1 Road Network

Thetford is well connected to outside settlements, market towns and employment areas by primary road network of 'A' roads and primary local distributors. The A11 is a dual carriageway which is located to the north of Thetford. The A11 runs north easterly towards Norwich and south easterly towards Cambridge. The A134 is a single carriageway which runs north westerly from Thetford towards King's Lynn and southerly towards Bury St Edmunds. The A1066 is a single carriageway which runs across Thetford. The road runs north easterly to join the A11 and runs south easterly towards Diss. The A1088 is a single carriageway and it runs southerly from its junction with the A1066 to Ixworth.

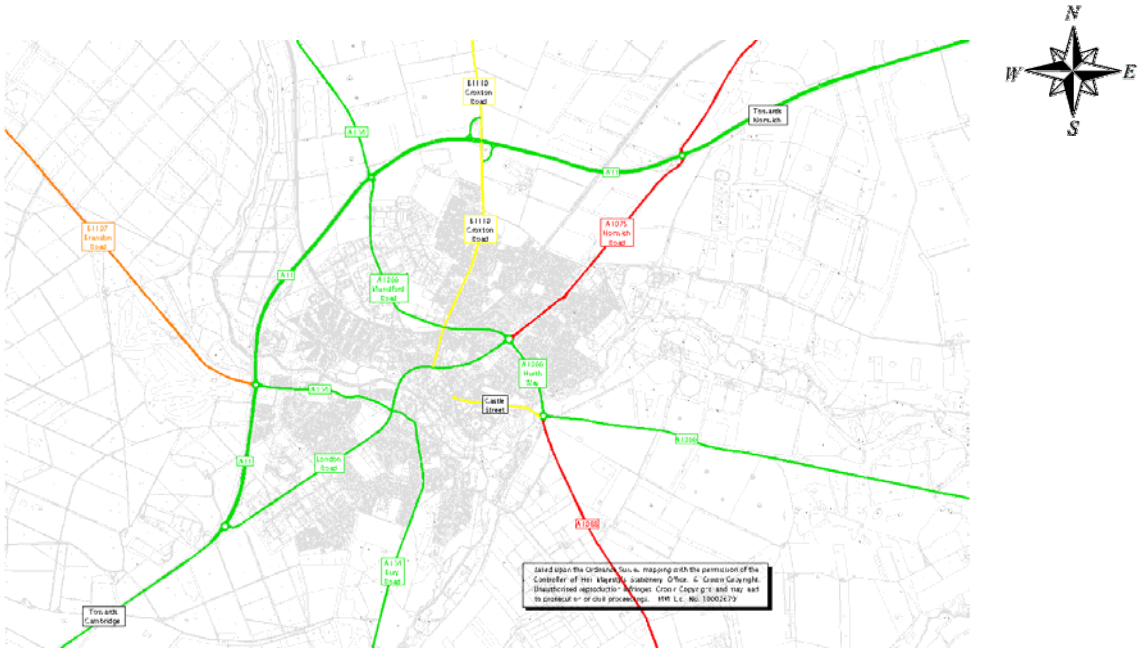
There are five junctions on the A11 which are expected to be directly affected by the new development in Thetford. These are:

- The A11/ London Road 3-arm at-grade roundabout;
- The A11/B1107 Brandon Road 4-arm at-grade roundabout;
- The A11/A134/A1066 Mundford Road 4-arm at-grade roundabout;
- The A11/The St Road/Croxton Road grade separated junction; and
- The A11/A1075 Norwich Road 4-arm at-grade roundabout

The two junctions on the A1066 that are expected to be affected by the growth traffic are:

- The A1066/A1075 4-arm roundabout; and
- The A1066/A1088/ Castle Street 4-arm roundabout

Figure 3.2: Primary Roads



Scale: NTS

3.4.2 Safety and Accident Analysis

There has been significant progress in reducing road accidents in Thetford, led by the Norfolk County Council Casualty Reduction Team. This has been achieved by prioritising cluster sites and working in partnership with other organisations that have a stake in Road Safety. This method may have reduced original accident totals by 33% so that one cluster site remains at the Brandon Golf Club on the B1107.

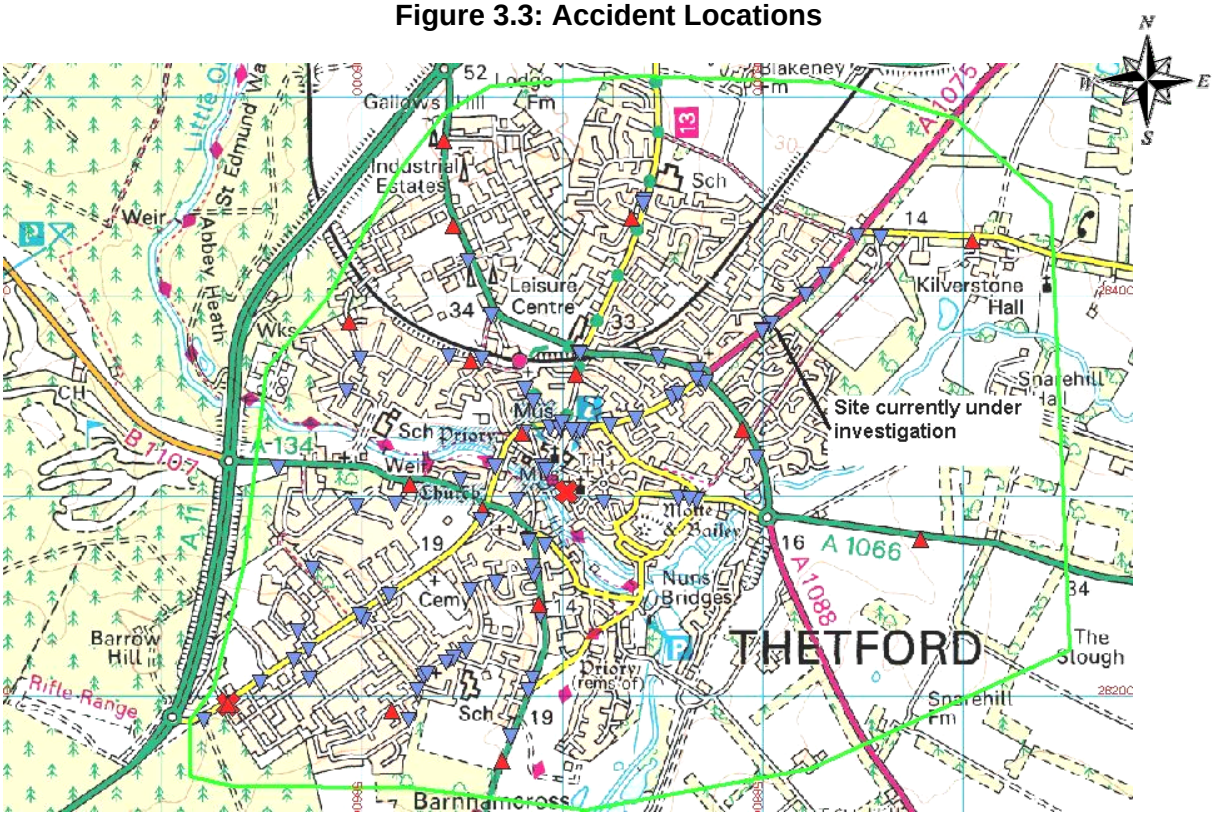
Although this approach has been successful it has been less so in reducing the thinly spread accidents on routes and in the residential areas. The totals and break down of these are summarised in the table below.

Table 3.1: Summary of Accident Totals and Break Down

Accidents in Thetford 1 Jun 05 to 31 May 08	
Total number of accidents	107
Total number of fatal injuries	2
Total number of serious injuries	16
Total number of slight injuries	89
Total number of casualties	144

The spread of these accidents is illustrated below in Figure 3.2, below, which shows their locations for the three year period 1 June 2005 to 31 May 2008.

Figure 3.3: Accident Locations



Scale: NTS

Key to Symbols:

Area of safety and accident analysis

Slight

Serious

Fatal

It is estimated that approximately 17% of these accidents resulted in Killed and Serious Injuries (KSI) which is higher than the expected average of 13% in Norfolk but, nonetheless, is equal to the National average of 17%.

It is important to note that Norfolk County Council Casualty Reduction Team are now concentrating on route action measures which may reduce these accidents by an additional 15%. However, these routes support the commercial, shopping and residential life of the town and the complex activities that occur on and alongside them will make their treatment particularly difficult. This will be further compounded by the perceived need to maintain maximum capacity traffic flows and speeds.

It is difficult to compare these accidents against a national accident figure, because of the lack of definition in the road accident record 'Stats 19' forms, but it is thought that approximately 30% of all casualties may occur on these types of road.

With regard to the scattered accidents in the residential areas of Thetford it is probable that 40% of these will occur once at locations in a 3 year period. Nevertheless the exposure to risk may be measured by pedestrian and cyclist activity against motorised traffic flows and average speed levels in this area. It is usual for less than half of accidents in towns to occur at the centre where vehicles and pedestrian flows are high. However in Thetford 20mph zones have been established in the historic town centre which makes this less likely.

In conclusion therefore, accident liability is being effectively managed by Norfolk County Council Casualty Reduction Team and there are no known unresolved issues that would affect which housing development scenarios to adopt.

3.4.3 Public Transport

The poor conditions noted in section 2.2 and 2.3, above, are addressed in chapter 7.

3.4.4 Walking and Cycling

The TGFIS report also looked at the pedestrian links in Thetford town centre. It concluded that the town has a large mixture of historic and new land uses with man-made and natural barriers which have an influence on existing movement patterns. These include the river and lack of crossing points across the railway line for vehicles, pedestrians and cyclists. However, it was considered that the pedestrian and cycle facilities are good in the town centre, which is reflected by high levels of walking.

3.4.5 Parking

There are a number of small car parks within Thetford town centre, most of which are not signed and provide free parking. There is evidence of problems with on street parking, causing obstructions for buses in some urban areas in Thetford.

4 Proposed Development

4.1 Development Context

As previously described, Breckland Council specified that the developments in Thetford are to be comprised of new residential developments, new employment areas and 'social infrastructure', eg education.

4.1.1 New Residential Development

The Brief describes the new residential developments to consist of:

(i) Completed Development

There are 904 dwellings that have already been built within Thetford between 2001 and 2007. The brief states that it is assumed that the infrastructure requirements for the 904 completed dwellings are already in place.

(ii) Infill Development

Approximately 1 073 new dwellings will be provided from 2007 onwards in the existing urban area of Thetford. This will be completed by 2015 and is referred to as 'infill development'.

(iii) Urban Extensions

The TGFIS identified two key areas as having most potential for development – Key Site North and Key Site South East.

Breckland Council specified five development scenarios to be assessed in this study. These are summarised in the Table 4.1 below.

Table 4.1: Summary of Housing Development Scenarios

Scenario	A	B	C	D	E
Key Site North (broadly B, D part of E)	2010 - 2027	2010 – 2021	2010 – 2027	2010 – 2021	2010 – 2021
Key Site South East (broadly H, G part of F)	2015 – 2031	2021 – 2031	2010 – 2027	Not developed	2010 – 2021
(part of) Rest of Site E and/or Site C	Not developed	Not developed	Not developed	Site E or C post 2021	Site E or C post 2021

Source: Breckland Council

4.1.2 New Employment Areas

The Brief also includes a requirement for 5 000 new jobs to be delivered up to 2021 alongside housing growth:

- Approximately 20% of all jobs (ie 1 000 jobs) delivered in A use class employment (retail and services) accommodated on vacant sites within the town centre;
- Approximately 4 000 jobs delivered on new Greenfield sites to 2021, predominantly office-based (2 800 jobs) with a smaller number of industrial jobs (600 in Industry and 600 in Warehouse and distribution).

The TGFIS recommends that Key Site North is the most suitable for most employment development. The TGFIS also concluded that 33 hectares would be required for employment growth in Key Site North with the remaining five hectares allocated elsewhere, dependent on which development scenario is adopted. This Transport Study places all the employment development in Key Site North to correspond with the land suitability assessment in the TGFIS.

4.1.3 'Social Infrastructure', eg Education

The location of social infrastructure, eg education has not yet been determined but given the overall size of Thetford, even after growth, it is assumed that social infrastructure would mostly be within walking or cycling distance from the majority of homes.

4.2 Land Allocation and Suitability

4.2.1 Land Allocation

The 2021 and 2031 land allocation targets for residential, employment, social infrastructure and open space as recommended by EDAW in the TGFIS report are shown in Table 4.2. Table 4.3 summarises the TGFIS land suitability assessment.

Table 4.2: Development Targets

Land Use Type	2021 Targets (hectare gross)	2031 Targets (hectare gross)	Additional Land Required to Meet 2031 Targets (hectare gross)
Residential	114.7	194.70	80
Employment	38.2	38.20	-
Social Infrastructure	8.53	18.38	9.85
Open Space	22.30	35.60	13.30
Total	183.73	286.88	103.15

Source: Thetford Growth Framework and Infrastructure Study (EDAW, September 2007)

Table 4.3: Land Suitability

Land Use Type	High	Medium	Low
Housing	Sites D, G	Sites B, F, H	Sites A, C, E, I, J
Employment	Site B	Sites D, E, G	Sites A, C, F, H, I, J

Source: Thetford Growth Framework and Infrastructure Study (EDAW, September 2007)

Breckland Council has also provided indicative boundaries of the extent of land that could be utilised. This information has been cross referenced with the development targets and land suitability to prepare land allocation plans as shown in the drawing numbers 233902AY01/001 to 005 in Appendix A.

For calculation purposes, the land use types have been allocated as clusters, ie with open space and social infrastructure discrete from residential areas. Drawing numbers 233902AY01/001, 002, 003 and 005 show that the land boundary has to be extended to the east to achieve the numbers of housing units required by the year 2031 at the density of 45 dwellings/ ha given in the TGFIS.

4.3 Initial Traffic Impact Assessments

The East of England Regional Spatial Strategy sets out the Regional Transport Strategy objectives, which are to ensure that the East of England benefits from increased mobility and access whilst minimising the impact on the environment and inhabitants of the region.

Policy T1: the Regional Transport Strategies give a clear priority to increase passenger and freight movement by more sustainable modes, while reflecting the functionality required of the region's transport networks:

- to manage travel behaviour and the demand for transport to reduce the rate of road traffic growth and ensure the transport sector makes an appropriate contribution to reducing greenhouse gas emissions;
- to encourage efficient use of existing transport infrastructure;
- to enable the provision of the infrastructure and transport services necessary to support existing communities and development proposed in the spatial strategy;
- to improve access to jobs, services and leisure facilities.

The successful achievement of the objectives will lead to the following outcomes:

- improved journey reliability as a result of tackling congestion;
- increased proportion of the region's movements by public transport, walking and cycling;
- sustainable access to areas of new development and regeneration;
- safe, efficient and sustainable movement between homes and workplaces, education, town centres, health provision and other key destinations;
- increased proportion of freight movement by rail;
- safe, efficient and sustainable movement of passengers and freight to and from the region's international gateways
- economic growth without a concomitant growth in travel;

- improved air quality; and
- reduced greenhouse gas emissions.

To meet these objectives, it is essential to plan the transport infrastructures within Thetford town centre and within the development areas to reduce 'car dependency'. However, considering the numbers of housing and jobs that will be created, it is expected that the development scenarios will have significant impacts on the existing road network even after the introduction of measures to promote sustainable transportation have been introduced.

4.3.1 Infill Residential Development

The infill residential development would increase traffic within the town and therefore careful planning should be encouraged.

It is assumed that the infill development opportunities will most likely occur in the following areas, and therefore these have been investigated accordingly:

- Sector 1 – The Abbey Estate
- Sector 2 – Barnham Cross
- Sector 3 – East of Croxton Road
- Sector 4 – West of Norwich Road
- Sector 5 – Vicarage Road
- Sector 7 – Priory
- Sector 8 – Bury Road
- Sector 11 – Redgate

Weaknesses and opportunities of these infill residential development sectors are summarised in Table 4.4 below.

Table 4.4: Infill Residential

Sector	Street characteristics	Weaknesses	Opportunities
1. The Abbey Estate	Canterbury Way is the only principal route, linking the housing estate to the A134 Brandon Road. Several traffic calming measures have been introduced along Canterbury Way towards the railway station. Internal streets are mainly cul-de-sacs. Adopted a street characteristic of housing estates built in the decades following the Second World War where buildings were set back from the streets to segregate pedestrians and	The extra traffic created from the new development will put more pressure on Canterbury Way and its junction with the A134 Brandon Road	Canterbury Way provides a direct link to the rail station

Sector	Street characteristics	Weaknesses	Opportunities
	buildings from motorised vehicle traffic.		
2. Barnham Cross	St John's Way / St Martin's Way is the only principal route to the A134 Brandon Road and London Road. London Road joins the A11 at a three arm roundabout. The section of the A11 to the south of London Road roundabout is the only section of the A11 that is still a single carriageway	The movement of traffic is restricted by the current capacities at St John's Way/A134 Brandon Road T- junction and at St Martin's Way/London Road T-junction	London Road connects the A11 to the town centre.
3. East of Croxton Road	Highlands, Fairfields and Woodlands Drive are the three principal routes to the estates from Croxton Road. Croxton Road joins the A11 at the grade separated junction	The junctions of Highlands, Fairfields and Woodlands Drive are all priority T-junctions. Only on the section of Croxton Road opposite its junction with Woodlands Drive that a right turn lane has been provided. The existing layout of the slip roads to the A11 might not be able to accommodate the extra traffic	Currently does not have a direct connection to the town centre, the rail interchange and the bus interchange.
4. West of Norwich Road	Churchill Road is the only principal route from a number of cul-de-sacs to the A1066 Mundford Road and the A1075 Norwich Road.	Although there are two exits from the estate, there is still a limited access option from and to the estate. Current and future traffic movement rely on capacities at Churchill Road's junction with the A1066 Mundford Road and its junction with the A1075 Norwich Road.	The estate has two direct connections to the A11 via the A1066 Mundford Road and the A1075 Norwich Road. The A1075 Norwich Road/A1066 Mundford Road/Hurth Way roundabout is the gateway to the town centre.
5.Vicarage Road	Vicarage Road serves as a principal route for a number of residential accesses. Vicarage Road also connects the estate to Norwich Road and to Croxton Road	Increase of traffic on Vicarage Road could increase pressure at its junction with Croxton Road and at its junction with Norwich Road	Relatively close to the railway station. There is an opportunity to improve walking and cycling access to the railway station.
7. Priory	Canterbury Way and Station Road are principal roads for several cul-de-sacs	Increase of traffic at St Nicholas Street/London Road junction.	The development is within close distance to the railway station

Sector	Street characteristics	Weaknesses	Opportunities
		Also, increase of traffic on Station Road and at its junction with London Road	
8. Bury Road	Several principal routes for otherwise cul-de-sacs within the residential site	The increase traffic from this development could put more pressure on existing principal routes.	An opportunity to improve public transport link along Bury Road to reduce car journeys between Thetford and Bury St Edmunds.
11.Redgate	Some of the access roads are directly connected to Norwich Road. Green Lane and Castle Lane are principal roads from residential access roads to Castle Street. Currently access to Hurth Way from this estate is via the A1066 Hurth Way/A1088 roundabout.	Will put more pressure on the existing principal roads. The infill development will also increase traffic at the A1066 Hurth Way/A1088 roundabout.	There might be a scope to introduce a public transport corridor along the A1066 Hurth Way. There is an opportunity to introduce a direct link from the estate to the A1066 Hurth Way for buses only.

4.3.2 Development Scenarios A, B, C, D and E

Development scenarios A, B, C and E use both Key Site North and Key Site South East and therefore should have similar traffic impacts. On this basis, these scenarios have been grouped together for this initial transport study. Although scenario D is only utilising land in Key Site North, this scenario is likely to have the similar impacts as the rest of the scenarios, although the scale of the impact would be different. Table 4.5 below provides summary 2021 and 2031 targets for the five development scenarios.

Table 4.5: Scenarios for Development

Scenario	Target	
	2021	2031
A	4 800	8 816
B	5 828	8 816
C	5 705	8 816
D	5 155	8 759
E	5 811	8 811

5 Transport Planning Calculations

5.1 Key Assumptions

Various other factors, such as: regulations, construction costs and the economy are generally the main drivers for housing affordability, which will determine the income level of the people living in these new housing units, and may affect the projected mode splits.

Phasing of the development will also play an important role in establishing the mode splits from the new growth areas. New employment sites may not become fully utilised at a time which coincides with the first occupancy of the development area, affecting the numbers of commuting trips within Thetford. During this time, the level of inter-urban commuting trips is expected to remain high. Improving inter-urban public transport such as train services to Norwich and Cambridge are dependent on removal of constraints elsewhere along the line, leaving cars and buses as the only options available for inter-urban trips.

Considering the aforementioned factors, in developing the key diagrams to assess the impacts of the growth framework on the existing road network it has been assumed that all of the trips generated from the new growth areas will be in cars. On this basis, these diagrams will show a 'worst-case' scenario, or in other words will represent a 'do-nothing' scenario.

The following assumptions have been used in developing the transport planning calculations:

- Trip rates from the national TRICS database (TRICS is a system that challenges and validates assumptions about the transport impacts of new developments. It is the only national (UK and Ireland) trip rate / generation and analysis database, containing trip rate / generation data and site information, for over 2 700 sites, that has been used for various categories of land use. Dialogue with the TRICS consortium has confirmed that there are not yet 'settlement-wide' surveys that would provide appropriate inter- and intra-settlement trip rates for a 'growth point' or similar, eg 'eco-town'.
- Trip rates for residential and social infrastructures are based on trip rates for privately owned houses in TRICS.
- Trip distributions are based on journey to works census 2001 data. The growth areas have been assumed not to change the census 2001 journey to work pattern in the early assessment.
- Traffic flows are derived from the Automatic Traffic Counters (ATC) supplied by Norfolk County Council. The majority of the data is based on 2006 counts. When 2007 counts are available, this supersedes the 2006 counts.
- Growth factors are calculated by multiplying the relevant NRTF growth factors with the local factors from TEMPRO trip end models.
- Forecast traffic flows are only calculated for the years 2021 and 2031, to represent the development targets.

5.2 Trip Generation

5.2.1 Residential

It has been considered that the development sites would generate the number of trip rates comparable to those generated from a residential site in St Bury Edmunds derived from TRICS database. There are a number of geographical similarities between this site and Thetford.

> This site is located at the northern edge of Bury St Edmunds, off Barton Hill, which heads east out of town via the junction with the A134. Other local routes head towards all parts of the town. The site has a vehicle access off Barton Hill and a pedestrian access at the rear.
>
> The site is surrounded by open land, with some industrial and residential development also nearby. A bus stop is situated close to the vehicle access on Barton Hill.
>
> (TRICS, 2008)

The residential trip rates per housing unit are summarised in Table 5.1 below.

Table 5.1: Residential Trip Rate (vehicles per Housing Unit)

Time	Arrivals	Departures
Morning Peak (08:00 – 09:00)	0.109	0.554
Evening Peak (17:00 – 18:00)	0.525	0.228
Daily	2.95	2.951

Source: TRICS database

Dialogue with the TRICS consortium has identified that starting in 2008 their surveys will include journey purpose type from which the proportion of commuting and other trips can be established. The total daily arrival and departure rates of 2.95 will include a commuting rate of greater than 1.0 and a mix of other uses.

5.2.2 Employment

The Brief describes that the new employment areas aim to create up to 5 000 jobs by 2021 alongside housing growth. The preferred option for employment growth identified in the TGFIS suggests:

1. Approximately 20% of all jobs delivered in A use class employment (retail and services), ie 1 000 jobs (accommodated on vacant sites identified within the Breckland Council Retail and Town Centre Study)

2. Approximately 4 000 jobs delivered on new Greenfield sites to 2021, predominantly office based (2 800 jobs) with a smaller number of industrial jobs (600 in Industry and 600 in Warehouse and distribution)

Based on the above requirements, the trip rates from employment sites have been calculated as the following.

(i) Within the Town Centre

It has been assumed that the new combined retail and services will occupy vacant sites within the town centre. The TRICS database, however, does not have any data for a similar type of development. The calculated trip rates have been based on available data in TRICS for shopping centre and local shops within 15 minutes journey trips from the town centres as shown in Table 5.2 below.

Table 5.2: Shopping Centre and Local Shop Trip Rates (vehicles per Job)

Time	Arrivals	Departures
Morning Peak (08:00 – 09:00)	1.112	1.067
Evening Peak (17:00 – 18:00)	1.471	1.459
Daily	16.359	16.282

Source: TRICS database

(ii) On Greenfield Sites

TRICS' trip rates from employment land use type 02/A – Office, type 02/C – Industrial Unit and type 02/F- Warehousing (commercial) shown in Table 5.3 have been used to calculate the total trip rates from employment sites.

Table 5.3: Employment Trip Rates (vehicles per Job)

Time	Arrivals	Departures
Office (Type 2/A)		
Morning Peak (08:00 – 09:00)	0.318	0.03
Evening Peak (17:00 – 18:00)	0.032	0.281
Daily	1.098	1.065
Industrial (Type 2/C)		
Morning Peak (08:00 – 09:00)	0.126	0.033
Evening Peak (17:00 – 18:00)	0.033	0.113
Daily	0.823	0.923
Warehouse and Distribution (Type 2/F)		
Morning Peak (08:00 – 09:00)	0.309	0.149
Evening Peak (17:00 – 18:00)	0.044	0.283
Daily	1.652	1.694

Source: TRICS database

5.3 Trip Distribution

It is not feasible to calculate the precise trip distributions for the development areas. The trip distributions used in this study have been based on the journey to work data from census 2001 for trips into and out of the settlement which has been considered as the best factual data available at the time of writing to produce traffic flow models which are relatively robust. A simple gravity analysis has been carried out for census data extracted for wards.

5.3.1 Trip Distributions from Housing Sites and Social Infrastructures

Journey to work data from census 2001 for journeys to work made by people living in Thetford indicates that 61% of journey to work stays within Thetford and the remaining 39% travels to other destinations. Out of the 39% leaving Thetford, the highest proportion is going towards Cambridge (34.96%). This number is followed by trips towards Bury St Edmunds (18.13%), Brandon (14.69%), Ixworth (10.08%), Norwich (8.82%), King's Lynn (7.71%), Watton (3.19%) and Diss (2.42%). The same proportions have also been used to calculate the distribution of traffic to the housing sites. It has been assumed that even with the considerable growth in employment opportunities in Thetford a large percentage of all journeys to work will continue to areas outside Thetford, as Cambridge and Norwich would remain key employment trip attractors due to the knowledge based economy that thrives in these areas.

House Prices

Generally, house price is the one of the major factors which determines where people live. It is also a factor that is quantifiable. In order to understand how the house prices in Thetford compare with prices in cities and towns nearby, such as Cambridge, Bury St Edmunds and Norwich which are the key contributors of out-of-Thetford journey to works, house price trends at the aforementioned locations have been looked at.

The house price trends shown in Table 5.4 representing the average sold house prices according to house types based on the Land Registry's records for April 2008. The figures in the brackets highlight the changes from the January 2008 to April 2008 prices.

Table 5.4: House Price Trends

	Thetford	Cambridge	Bury St Edmunds	Norwich
Detached	£194 699 (+6%)	£415 615 (+20%)	£266 200 (-7%)	£259 823 (-12%)
Semi-detached	£144 900 (-2%)	£291 705 (+8%)	£181 222 (-6%)	£176 996 (+1%)
Terraced	£110 783 (-7%)	£235 709 (-14%)	£177 727 (+3%)	£167 294 (-1%)
Flat	£81 600 (-30%)	£195 764 (-4%)	£146 200 (-15%)	£145 111 (+10%)
All	£132 625 (-5%)	£278 562 (+6%)	£182 257 (-8%)	£190 688 (-1%)

Note: (xxx) percentage of change from January 2008 prices

Source: www.home.co.uk

Table 5.4 shows that overall the house prices in Thetford are around 27% less than Bury St Edmunds, 30% less than Norwich and 52% less than Cambridge. These figures, combining with the new high quality specifications that the new housing will have to comply with, will make Thetford a more attractive area to buy houses for those who are currently unable to afford similar type of properties in nearby cities and towns.

The above table also shows that contrary to the current downturn trend occurring nationally, the house prices for detached properties have increased by 6% since January 2008. This could be interpreted as a positive sign that Thetford is seen as an upcoming town.

The significant decline in prices for flats could be seen as an indicator that the current employment sectors in Thetford do not attract enough younger people to stay in Thetford.

Discussion

Journey to work 2001 census data already illustrates that whilst the majority of people living in Thetford commute within the town (61%) there is a significant proportion leaving Thetford. The proportion of the journey to work within Thetford however is slightly lower than the average figure for Breckland District (70%). This may be due to current house prices in Thetford which are relatively cheap compared to other towns or cities nearby such as Bury St Edmunds, Norwich and Cambridge.

It is unlikely, however, that the prices of the new housing will remain the same as the existing stocks due to changes to legislation, regulations and standards. Building regulations, for example, have continuously updated requirements (ie insulation, double glazing windows and doors, sustainable drainage systems, biomass or other sustainable energy resources) in order to meet the government's commitments to dealing with climate change. These requirements will contribute to increased prices of new housing. The provision of significant numbers of new residential properties in Thetford even if not as low as the existing housing stock will be attractive to those seeking to work in nearby towns and cities. In addition the planned provision of new employment opportunities in Thetford is only approximately half the number of economically active people that would be expected to occupy the new housing. As a result the 60% within Thetford and 40% outside Thetford split (60 : 40 split) from the census 2001 has been adopted as an initial analysis, though this may be an under-estimation of journeys to work outside the settlement.

In the AM peak it has been assumed that the 60% of trips that remain within the settlement end in the town centre and in the PM peak that 60% start in the town centre.

5.3.2 Trip Distributions from Employment Sites

A similar approach used in calculating trip distribution from the housing sites has also been adopted for the new employment sites. Journey to work data from census 2001 have been collected to calculate journeys to work made from outside Thetford to Thetford. The current journey to work trips from people living outside Thetford to Thetford are from the directions of Brandon (22.79%), Norwich (17.84%), King's Lynn (15.40%), Watton (10.28%), Ixworth (9.65%), Cambridge (9.09%) to Diss (7.58%) and Bury St Edmunds (7.37%).

These proportions have been used as the base to distribute trips from outside Thetford to the new employment sites.

For the AM peak it has been assumed that 40% of vehicle journeys to work to the new employment sites would be from outside the settlement and the remaining 60% start from the town centre, this absorbs a significant number of the journeys to work from the new residential areas which are assumed to be completed within the town centre. The remainder of the journeys from the new residential areas which are assumed to be completed within the town centre being assumed to be a combination of commuting to new town centre employment opportunities and non commuting trips within the town in the peak hour.

A similar logic has been used for the PM peak.

5.3.3 Trip Distributions from the Infill Development

Breckland Council specified that approximately 1 073 of new housing (2007 onwards) will be provided in the existing urban area of Thetford and this will be completed by 2015. However, the total number of dwellings calculated using the land area and density in the TGFIS gives 8 816 dwellings by 2031, close to the 9 000 figure that Breckland Council aspired to achieve.

The infill development would be located within the town centre so it is expected that the trips from the infill development will only have a marginal contribution to the total trips in Thetford, and these trips could be contained to a minimum level by introductions 'soft measures' (eg promotions of walking and cycling to work places building upon Thetford's already high level of walking journeys). Therefore, the infill development has not been included in the calculation to avoid overestimating the number of trips generated from the development areas.

5.3.4 Generation Check

The 8 816 new dwellings, which have an approximate occupancy of 20 000, generate an AM peak hour total of 4 884 vehicle trips. Of these 4 884 vehicle trips 1 954 are for journeys outside Thetford. This compares with the 2001 census data, for a population within Thetford of 19 800, that 4 027 work outside Thetford, of which 3 271 are car drivers; assuming on any one day 10% of individuals do not travel to work due to holiday or sickness and assuming the peak hour represents 60% of trips then in the 2001 AM peak hour there would have been 1 766 trips. It is considered that this check, 1 954 compared with 1 766, provides confidence in the trip rate used in this transport study.

It should be noted that the census data shows that nearly 50% of journeys to work that are within the settlement, ie by residents of Thetford who work within Thetford are as car drivers.

5.4 Traffic Flow

The trip generations and trip distributions previously mentioned have been used to calculate traffic flows, which are the base of the transportation planning models for the highways and junction assessments. The transportation models are briefly comprised of: base flow, design flow and forecast flow information.

5.4.1 Base Flow

The 'Base Flow' information is a terminology commonly used to describe existing traffic on the current road network. As it suggests, this information is the foundation of any traffic assessments so it is essential that the base flow should represent the current situation of the road network as accurate as possible. As a general rule, the more data available to develop a base model, the more accurate the model is, and therefore it is more robust.

However, often sufficient data is not available to develop the base models so assumptions have to be made. Although these are not ideal, assumptions are quite commonly used when developing a wide-area model as it would be too costly to have surveys for all links and junctions.

The 'Base Flow' information in Thetford has been developed based on the data from existing Automated Traffic Counters (ATC) on the A11 and other major links within Thetford. The Brief states that 904 dwellings have already been built within Thetford between 2001 and 2007. It is assumed that the infrastructure requirements for the 904 completed dwellings are already in place. The ATC data provided, however, are based on 2006 and one 2007 counts. This would mean that the completed development was not included in the ATC data. However, it is approximately less than 15% of the 904 dwellings that will be constructed during the 2006 – 2007 period, which equates to 136 dwellings, or 401 vehicle trips per day. It is considered that this additional traffic is within the natural growth rates, within a range of 1.2 – 2 % annually.

Annual Average Daily Traffic

While the 12-hour flows are provided by the ATC, these flows are converted to the Annual Average Daily Traffic (AADT) using the procedures described in the Cost Benefit Analysis (COBA) guide in the Design Manual Roads and Bridges, Volume 13, Economic Assessment of Road Schemes.

Junction Turning Counts (JTC)

No junction turning counts data were available for this study.

Existing Transport Assessments from Committed Developments

The study has not included any other committed development or any committed highway schemes within Thetford and along the A11, as no data was available for this study.

Peak Hour Flow

The Highways Agency's East of England Regional Model (EERM) includes assessments of the A11 capacity during the peak periods based on the infrastructure and traffic data in September 2003. This report has identified the morning peak period between 08:00 to 09:00 hours and the evening peak between 17:00 to 18:00 hours.

The development area is unlikely to cause as significant effects in the inter peak period, so this period has been excluded from the assessments.

Base AADT and base hourly flows have been calculated for years 2007, 2021 and 2031; examples of these calculations are included as Appendix C.

5.4.2 Design Flow

Design flow information has been calculated by assigning the trips generated from each development scenario and from the infill development using the calculated trip distributions previously described.

5.4.3 Forecasts

It is essential to calculate the future traffic flows in Thetford so that opportunities for investments in the infrastructures could be identified and be planned accordingly. The TGFIS identified targets for years 2021 and 2031. On this basis, the years 2021 and 2031 have been used as the assessment years in this study.

Generally speaking future traffic should consider traffic growth which occurs naturally and additional traffic that is generated from any new developments from the base year to the assessment year. This study considers future traffic forecast includes natural growth factor and generated flows from the growth framework.

The National Road Traffic Forecasts (Great Britain) 1997 calculates traffic forecasts which would occur naturally and these figures are commonly accepted. The traffic forecasts were calculated based on policies, the best available evidence of behaviour and the capacity of the current road network. The growth factors in the NRTF do not consider local situations and policies and therefore need to be tailored to Thetford.

The Department for Transport has published TEMPRO (Version 5) System. This system provides forecast data on trips for transport planning purposes for national and local levels (ie for Thetford).

To calculate the 'localised' growth factor for Thetford for years 2021 and 2031, the local factors from TEMPRO have been applied to the growth factors from the NRTF. It is understood that there are development planned in the areas near to Thetford which would contribute to the background growth, it was considered that the high growth would give a better representation of the upward trend. These 'localised' factors are summarised in the Table 5.5 below.

Table 5.5: 'Localised' Growth Factors

Period	High Growth
2007 – 2021	1.285
2007 – 2031	1.443

Generation flows from development scenarios A to E for years 2021 and 2031 have been calculated for residential and employment sites and examples of the spreadsheets are included at Appendices D and E respectively. Design flows for years 2021 and 2031 have been calculated and examples of the spreadsheets are included as Appendix F.

6 Highways and Junction Assessments

Highways assessments have been carried out based on the design flows calculated using the methodology and assumptions previously described. These flows were then compared with the link and junction capacities derived from the Design Manual Roads and Bridges, or the diagram in the IHT's 'Transport in the Urban Environment' guide or the Congestion Reference Flow (CRF) received from the Highways Agency TRADS database where applicable.

6.1 The A11 Links and Junctions

The link capacities of the A11 have been based on the Congestion Reference Flow (CRF) in the Highways Agency's TRADS database, and the diagram in the IHT's 'Transport in the Urban Environment' guide has been used to identify junctions warranting more detail analysis.

6.1.1 The A11 Links

(i) Existing Conditions

Apart from the section of the A11 to the south of its junction with the London Road, the A11 section around Thetford is already dual carriageway and subject to national speed limit.

(ii) Highway Link Assessments

The Highways Agency's TRADS database contains calculations of the Congestion Reference Flow (CRF) which is based on the Annual Weekly Traffic Flow in year 2007. The 2-directional CRF values have been calculated by the Highways Agency to be in the region of 67 000 vehicles per day. Although this figure would have changed for the year 2008, it is acceptable to assume that the new figure for the year 2008 would be similar.

The Annual Daily Traffic Flows (AADT) in year 2031 with high growth factor for all development scenarios A to E are significantly less than the CRF value for the A11. Hence, it could be assumed that all the A11 links, with the exception of the single carriageway section to the south of the A1075 roundabout, would be able to accommodate the development traffic and the background growth regardless of which development scenario is chosen. This conclusion is also inline with the forecast that was carried by the Highways Agency as part of their assessments for the Strategic Route Network (SRN) for East of England.

The Regional Network Report for East of England (the HA, 2008) includes a forecast daily stress in year 2016, which has been developed with an assumption that the dualling scheme of the A11 Fiveways to Thetford is constructed. It has also considered increases of traffic due to background growth and developments based upon RSS, LDF proposals and other identifiable from land-use changes that increase pressure on the Strategic Route Network (SRN) as shown in Table 6.1. The trend from 2006 to 2021 has been extrapolated linearly up to 2026 to provide a forecast beyond 2021.

Table 6.1: Summary of forecast planning data for the East of England used in the HA model

	Increase in dwellings 2001 – 2021	Increase in jobs 2001- 2021
Bed & Luton	59 100	50 000
Cambridgeshire & Peterborough	98 300	95 000
Essex & Unitaries	127 000	131 000
Hertfordshire	83 200	68 000
Norfolk	78 700	55 000
Suffolk	61 700	53 000
East of England Total	508 000	452 000

Source: The Regional Network Report for East of England (the Highways Agency, 2008)

With the above assumptions, the HA predicts that the daily stress on the A11 along Thetford in year 2016 will be less than 90%.

6.1.2 The A11 Junctions

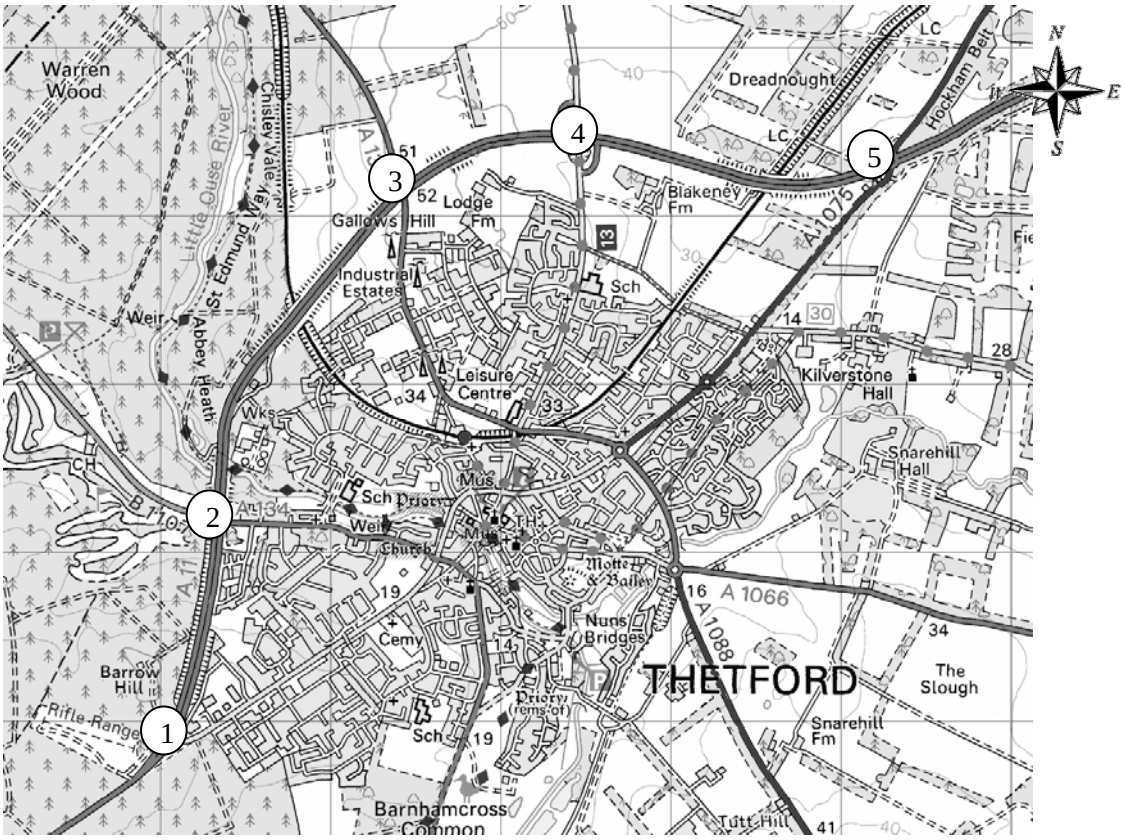
(i) Existing Conditions

The five junctions on the A11 assessed in this study are:

- Junction 1: the A11/London Road a 3-arm at-grade roundabout with an Inscribed Circle Diameter (ICD) of approximately 70 metres.
- Junction 2: the A11/B1107/A134 Brandon Road a 4-arm at-grade roundabout with an ICD of approximately 65 metres.
- Junction 3: the A11/A1066 Mundford Road a 4-arm at-grade roundabout with an ICD of approximately 60 metres.
- Junction 4: the A11/Croxton Road grade-separated junction.
- Junction 5: the A11/A1075 Norwich Road a 4-arm at-grade roundabout with an ICD of 65 metres.

Locations of these junctions are shown in figure 6.1, below.

Figure 6.1: Locations of the A11 Junctions



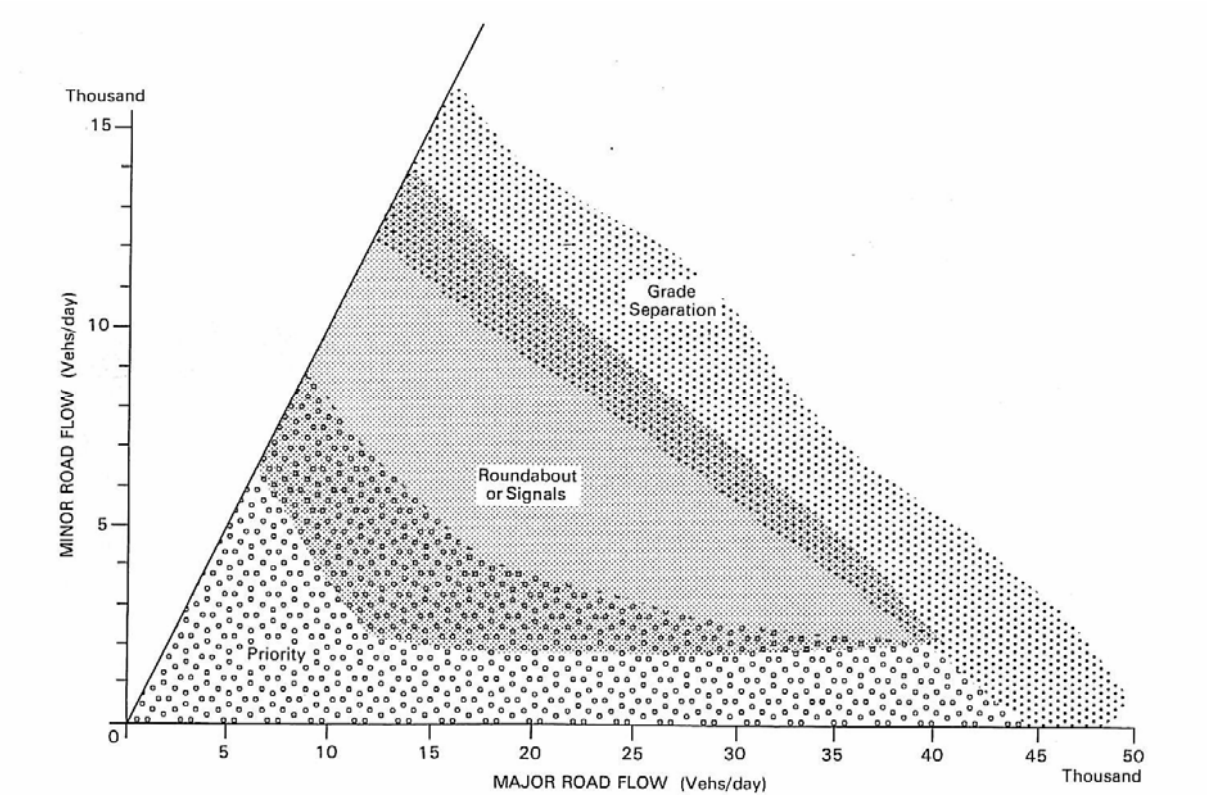
Scale: NTS

With the exception of junction 4, Croxton Road grade-separated junction, it appears that the roundabouts have been designed to cope with a large volumes of traffic, hence the ICD are in the regions of 60-70 metres. Croxton Road slip-roads, however, are sub-standard and will require to be upgraded even without the traffic from the growth framework.

(ii) Junction Assessments

A rough junction assessment for the five junctions on the A11 has been carried out based on the information from the link data. However, it should be noted that with no junction turning counts available, various assumptions have been made in order to calculate the flows at the junctions in the year 2031. These calculated flows were then compared with the diagram shown in figure 6.2 below, which has been taken from the IHT's 'Transport in the urban environment' published in June 1997. Although this diagram provides an approximate guide to the magnitudes of major and minor road traffic that can be accommodated by particular types of junction, this diagram does not consider turning movement so should not be taken literally.

Figure 6.2: Type of junction appropriate for different traffic flows



Source: Transport in the Urban Environment (IHT, June 1997)

Using the diagram above, a grade separated type of junction is shown as the appropriate type of junction for the level of traffic flows that have been calculated for the A11 for development scenarios A to E. It is re-emphasised that this approach is very basic and has not considered any turning movements. This exercise, however, illustrates the needs for further discussions with the Highways Agency to agree further assessments to be carry out at the five junctions with the A11.

6.2 Road Network within Thetford

Link capacities of primary highway links within Thetford have been assessed by comparing the design flows with the urban link capacities in the TA 79/99 of the Design Manual for Roads and Bridges. In the absence of junction turning counts at most of the junctions, the junctions have been assessed to highlight the level of impact of the trips from the development scenarios would have at these junctions.

6.2.1 Primary Routes within Thetford

(i) Existing Conditions

The assessment concentrates on the eight primary local distributors within Thetford:

- Link 1 - the London Road section between its junction with the A11 and its junction with the A134. This section of the London Road is a 7.3 metre wide single carriageway road. The road widens at junction approaches to provide an additional lane at its junction with the A11 and at the traffic signal junction with the A134. The middle section of the road is also wider to accommodate right turn pockets at priority junctions with primary routes to residential estates.

- Link 2- the A134 Brandon Road section between its junction with the A11 and its junction with the London Road. This section of the A134 Brandon Road is also a 7.3 metre single carriageway road. The road widens at the approach to its junction with the A11 junction and at the approaches to the mini roundabout outside Canterbury Way. A number of residential properties have direct access to the A134 Brandon Road at some of its part.

- Link 3 – the London Road section between its junction with the A134 Brandon Road and its junction with the A1066 Mundford Road. This section of the London Road is a single carriageway road. In northwards direction from its junction with the A134 Brandon Road, the road narrows from 7.3 metres wide to approximately 6.5 metres wide (where the road changes to Norwich Road). For the assessments purposes, the criteria for 6.75 metres wide road have been used to give a midway assessment. A number of properties also have direct access to the A1075 Norwich Road.

- Link 4 - the A1075 Norwich Road section between its junction with the A1066 Mundford Road and its junction with the A1066 Mundford Road and its junction with the A11. This section of the A1075 Norwich Road is a 7.3-metre wide single carriageway, and widens at junction approaches. On its section between the A1066 roundabout and a roundabout at its junction with Mallow Road, the residential properties on the north side of the A1066 have direct access to the A1075 Norwich Road. To the north east of the Mallow Road roundabout, accesses to the A1075 Norwich Road are limited between 0 to 2 accesses per km.

- Link 5 - the A1066 Mundford Road section between its junction with the A11 and its junction with Croxton Road. The typical road width along this section is around 6.75 metres wide, although the road widens at junction approaches to provide right turn pocket. The surrounding land use is predominantly industrial units, which can be access from side roads.

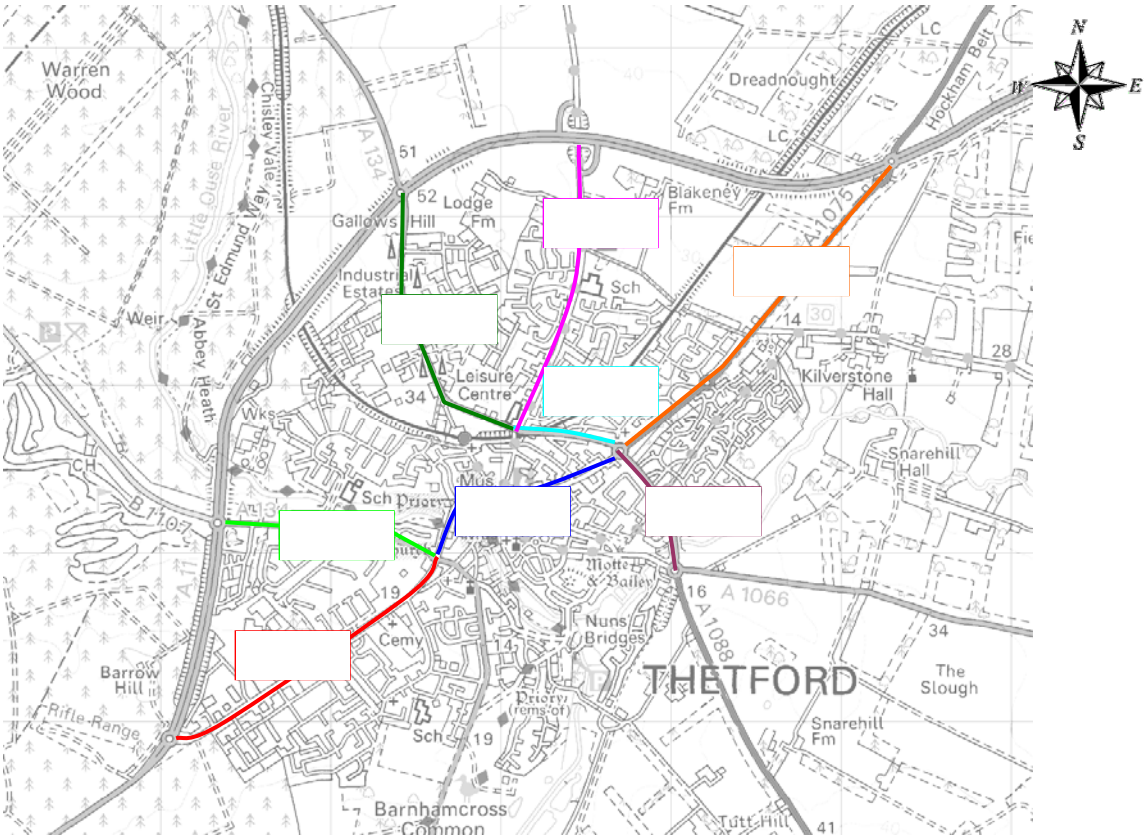
- Link 6 – the A1066 Mundford Road section between its junction with Croxton Road and its junction with the A1075 Norwich Road. The total length of this section is less than one kilometre and only has one side road access. So, it could be assumed that the number of side road accesses per kilometre would be less than two. Although this section of the A1066 Mundford Road is single carriageway, the majority of its length is widened to provide right turn pockets at a priority junction with a side road and an extra lane at the approach to the A1066/A1075 roundabout. The section that has not been widened is typically 6.75 metres wide.

- Link 7 – the A1066 Hurth Way section between the A1075 roundabout and the A1088 roundabout. This section is a 7.3-metre wide single carriageway and has 0 to 2 number of side road accesses per kilometre.

- Link 8 – Croxton Road between its junction with the A11 and its junction with the A1066 Mundford Road. Along the settlement area, the road is approximately 6.1 metre wide, and at one point there is a pinch point reducing the road to one lane. Outside the settlement area the surrounding land use is mainly green spaces, and at this section the road width widens to around 6.75 metres.

The locations of these links are shown in Figure 6.3 below.

Figure 6.3: Locations of Primary Links within Thetford



Scale: NTS

In order to assess whether any of these highway links would require infrastructure investments in years 2021 and 2031, forecast traffic flows for years 2021 and 2031 have been compared with the link capacities for urban roads described in the TA 79/99 of the Design Manual for Roads and Bridges. The forecast traffic flows for years 2021 and 2031 have included background growth (high growth factor) and development traffic from the growth framework. The results of these assessments for all the development scenarios for years 2021 are shown in Table 6.2 and for years 2031 are shown in Table 6.3. Red shading has been used to mark links with forecast flows exceeding the DMRB urban road capacities (ie where links are predicted not to cope), yellow shading for those exceeding the DMRB urban capacities marginally (maximum of 200 vehicles per hour) and green for those below the DMRB urban capacities (ie where links are able to cope).

Table 6.2: Forecast Urban Capacities in Year 2021 (High) for Development Scenarios

Highway Links	Descriptions	DMRB Road Type	DMRB Capacities of Urban Roads *	A	B	C	D	E
Link 1	the London Road (from the A11 junction to the A134 junction)	UAP 2 – 7.3m	1470					
Link 2	the A134 Brandon Road (from the A11 junction to the London Road)	UAP 3 - 7.3m	1300					
Link 3	the London Road (from the A134 Brandon Road junction to the A1066 Mundford Road roundabout)	UAP3 - 6.75m	1110					
Link 4	the A1075 Norwich Road (from the A1066 Mundford Road roundabout to the A11 junction)	UAP3 – 7.3m	1300					
	- to the south of Mallow Road roundabout							
	- to the north of Mallow Road roundabout	UAP1 – 7.3m	1590					
Link 5	the A1066 Mundford Road (from the A11 roundabout to the Croxton Road junction)	UAP2 - 6.75m	1260					
Link 6	the A1066 Mundford Road (from the Croxton Road junction to the A1075 Norwich Road roundabout)	UAP1 - 9m	1860					
Link 7	The A1066 Hurth Way (from the A1075 roundabout to the A1088 roundabout)	UAP2- 7.3m	1470					
Link 8	Croxton Road (from the A11 junction to the A1066 Mundford Road roundabout)	UAP 3- 6.1m	900					
	-along the settlement							
	-outside the settlement	UAP1- 6.75m	1320					

Note: * Capacities of Urban Road for hourly flows on the busiest direction

Table 6.3: Forecast Urban Capacities in Year 2031 (High) for Development Scenarios

Highway Links	Descriptions	DMRB Road Type	DMRB Capacities of Urban Roads *	A	B	C	D	E
Link 1	the London Road (from the A11 junction to the A134 junction)	UAP 2 – 7.3m	1470					
Link 2	the A134 Brandon Road (from the A11 junction to the London Road)	UAP 3 - 7.3m	1300					
Link 3	the London Road (from the A134 Brandon Road junction to the A1066 Mundford Road roundabout)	UAP3 - 6.75m	1110					
Link 4	the A1075 Norwich Road (from the A1066 Mundford Road roundabout to the A11 junction)	UAP3 – 7.3m	1300					
	- to the south of Mallow Road roundabout							
	- to the north of Mallow Road roundabout	UAP1 – 7.3m	1590					
Link 5	the A1066 Mundford Road (from the A11 roundabout to the Croxton Road junction)	UAP2 - 6.75m	1260					
Link 6	the A1066 Mundford Road (from the Croxton Road junction to the A1075 Norwich Road roundabout)	UAP1 - 9m	1860					
Link 7	The A1066 Hurth Way (from the A1075 roundabout to the A1088 roundabout)	UAP2- 7.3m	1470					
Link 8	Croxton Road (from the A11 junction to the A1066 Mundford Road roundabout)	UAP 3- 6.1m	900					
	-along the settlement							
	-outside the settlement	UAP1- 6.75m	1320					

Note: * Capacities of Urban Road for hourly flows on the busiest direction

Tables 6.2 and 6.3 indicate that in year 2031 the majority of the primary routes within Thetford would require to be upgraded for all the development scenarios. But, with the scenario D the number of links that would be overcapacity would be the least. This is due to the fact that scenario D does not include Key Site South East. The development scenario A, however, would allow infrastructure works to be delayed at some of the highway links to post 2021.

6.2.2 Junction Assessments

(i) Existing Conditions

There are four junction assessed in this study, namely:

- Junction 6 – the A1066 Mundford Road/Croxton Road junction is a T-junction. A ghost island is provided on the A1066 Mundford Road approaches to create a right turn pocket for traffic turning right on to Croxton Road. This junction is referred in the report as the Croxton Road t-junction.

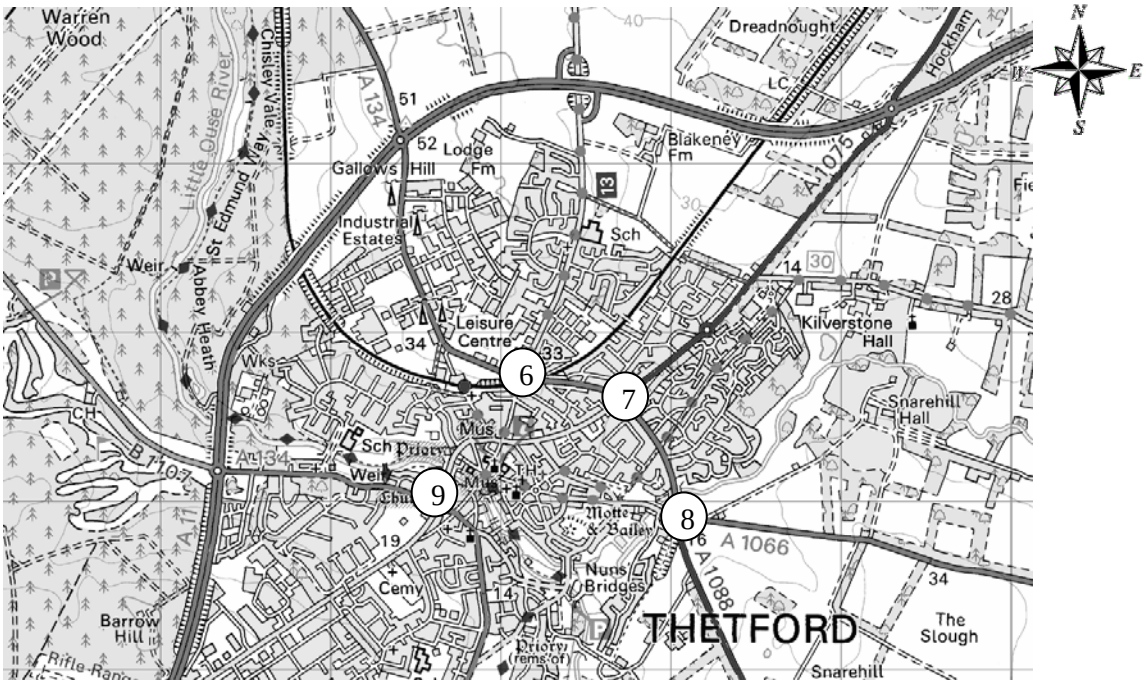
- Junction 7 – the A1066 Mundford Road/A1075 Norwich Road (the Norwich Road roundabout) is a 4-arm roundabout with an ICD of 80 metres.

- Junction 8 – the A1066 Hurth Way/A1088/Castle Street roundabout is also a 4-arm roundabout. The roundabout has an ICD of 67 metres. This junction is referred as the Castle Street roundabout in this report.

- Junction 9 – the London Road/A134 Brandon Road junction is a 4-arm signalised junction. This junction is referred the Brandon Road traffic signal junction.

The locations of these junctions are shown in Figure 6.4, below.

Figure 6.4: Locations of Junctions within Thetford



Scale: NTS

In order to forecast the impact of the development traffic at these junctions, without junction turning counts being made available, the junction assessments were based on the increase of traffic caused by the background growth and the growth framework. If the increase of the Annual Daily Traffic compared with year 2007 flows on the major road is less than 3 000 vehicles daily, it is considered as low impact (green shading), around 3 000 vehicles daily as medium impact (yellow shading) and above 5 000 vehicles as high impact (red shading). Forecast increase of traffic for scenarios A to E are presented in Tables 6.4 (for year 2021) and 6.5 (for year 2031).

Table 6.4: Summary of Increase for Traffic in year 2021 (High Growth)

Junction No	Descriptions	A	B	C	D	E
6	Croxton Road T-Junction					
7	Norwich Road roundabout					
8	Castle Street roundabout					
9	Brandon Road traffic signal junction					

Table 6.5: Summary of Increase for Traffic in year 2031 (High Growth)

Junction No	Descriptions	A	B	C	D	E
6	Croxton Road T-Junction					
7	Norwich Road roundabout					
8	Castle Street roundabout					
9	Brandon Road traffic signal junction					

6.2.3 Summary

Based on the data available in this study, all the A11 links (except the section of the A11 to the south of its junction with the London Road) would cope with forecast traffic in years 2021 and 2031generation flows regardless which development scenario to be chosen. This forecast traffic includes background growth, and generated trips from new residential and employment sites from the growth areas.

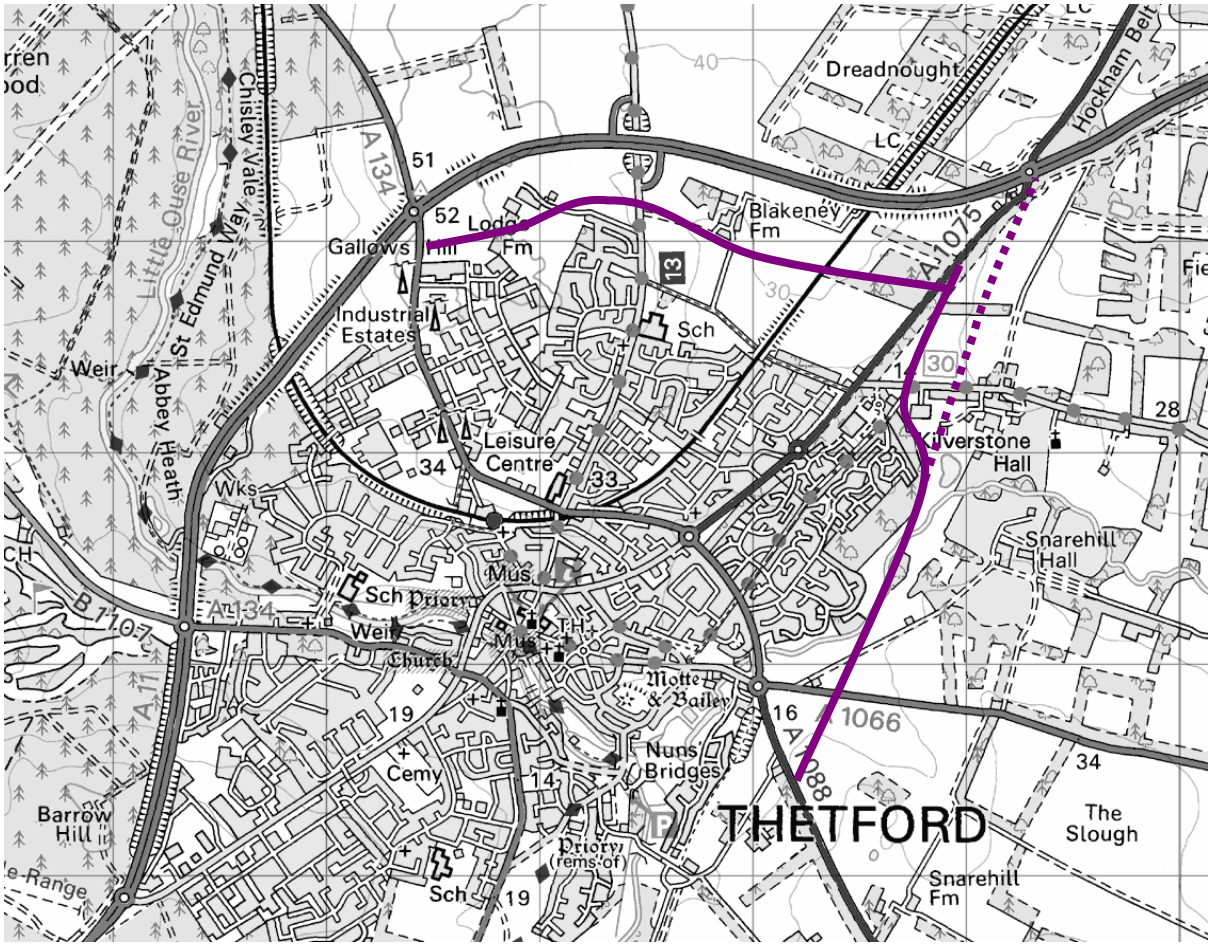
Based on the available data and assumptions made, most of the primary highway links within Thetford would be over capacity in year 2031. Out of the five scenarios, scenario D would have less impact on the section of the A1066 to the south of Croxton Road in year 2031. This would mean that a bridge widening could potentially be avoided.

However, it is understood that for other land use reasons, there could be an aspiration to develop Key Site South East and therefore scenario D may not be acceptable. Scenarios A, B, C and E utilise both Key Site North and Key Site South East. Scenario E also goes north of the A11. Of these four scenarios, scenario A gives a more balanced number of trips from both key sites so it minimises the number of links require infrastructure investments in year 2021, but it has same impacts as scenarios B and C in year 2031.

Table 6.3 identifies that the majority of the primary links would require to be upgraded to accommodate the increase traffic in year 2031. The London Road between its junction with the A134 Brandon Road and the A1066 Mundford Road (Link 3) is a critical link as it is the main link to the town centre for both key sites, the main link for trips towards Bury St Edmunds (18.13% of the out of settlement journeys to work trips) for Key Site North and for trips towards Bury St Edmunds; Cambridge and Brandon (total of 67.78% of the out of settlement journeys to work trips) for Key Site South East.

Traditionally, link capacities are increased by widening the road width or by limiting the number of accesses along the road. While this approach potentially could be applied on the northern parts of the A1075 Norwich Road between the A11 and the A1066 roundabout (Link 4), the A1066 Mundford Road between the A11 and Croxton Road (Link 5) and Croxton Road (Link 8) widening or restricting access on the south part of these links is not ideal. There is a possibility to create a new link from a point south of Key Site South East (or within Key Site South East) to the A11/A1075 roundabout or to a new junction on the north part of the A1075 Norwich Road, and a new link from Key Site North as shown in Figure 6.5. This option includes a new bridge across River Thet. However, mitigation measures to lessen the impact on the London Road (Link 3) are less obvious.

Figure 6.5: Location of Potential New Eastern Links



Scale: NTS

Key:

Proposed new links

Alternative layouts

7 Public Transport

7.1 Housing Growth

Our initial calculations for the potential increase in public transport demand arising from the proposed level of residential growth is based on the assumption that the AM Peak hour residential trip rate, of 0.554 vehicles per household, given in table 5.1, above, equates to 60% of peak hour home-based person trips by all modes. Table 7.1 below show the five development scenarios.

Table 7.1: Scenarios for Development

Scenario	Target		
	2021 (A)	2031 (B)	Differences (B-A)
A	4 800	8 816	4 016
B	5 828	8 816	2 988
C	5 705	8 816	3 111
D	5 155	8 759	3 604
E	5 811	8 811	3 000

Table 7.2 below provides projections of peak hour home-based person trips based on 2021 and 2031 targets for scenario C, which has been chosen as an example and the 9 950 households in 2001. These projections reflected the modal characteristics of the recent past rather than those that could be achieved by adopting more sustainable policies. Modal splits were derived from 2001 Census data for the Thetford area.

Table 7.2: Projected Peak Hour Home-based Person Trips for 2021 and 2031 For Scenario C Based on Current Mode Shares

Mode	Current Mode Share %	Journey to work figures Predicted trips for new household totals using same mode %		
		2001	2021	2031
Walking and cycling	22	2 021	3 180	3 812
Bus	2	184	289	347
Home working	6	551	867	1 040
Train, taxi, and motor cycle	3	276	434	520
Car driver	60	5 512	8 673	10 396
Car passenger	7	643	1 012	1 213
Total	100	9 187	14 455	17 327

Table 7.3: Projected Peak Hour Home-based Person Trips for 2021 and 2031 For Scenario C Based on Revised Mode Shares

Mode	Current Mode Share (%)	Proposed modal share 2021 (%)	Predicted trips 2021 revised modal share	Proposed modal share 2031 (%)	Predicted trips 2031 revised modal share
Walking and cycling	22	25	3 614	27	4 678
Bus	2	7	1 012	10	1 733
Home working	6	7	1 012	10	1 733
Train, taxi, and motor cycle	3	5	723	5	866
Car driver	60	50	7 228	43	7 451
Car passenger	7	6	867	5	866
Total	100	100	14 455	100	17 327

Table 7.3 assumes that the current high levels of walking and cycling are developed within the Thetford area. The proximity of new development to existing infrastructure such as schools combined with a package of measures to improve the safety and attractiveness of these modes should ensure these targets are attained.

Changes in mode share are based on the following assumptions:

- A steady increase of 3% and 2% for walking and cycling
- For bus an 5% increase by 2021 and a further 3% by 2031
- Home working to increase by 1% in the period to 2021 and a further 3% by 2031
- An increase of 2% by 2021 in train, taxi and motor cycle mode shares, stabilising at 5% of all trips between 2021 and 2031.

Thetford currently suffers from extremely low levels of bus and rail usage. This is compounded by low bus frequencies and poor infrastructure in the town, and rail services that suffer from poor accessibility, particularly for mobility impaired users. A significant shift towards these modes would be required in order to keep car usage to a manageable level. We have suggested that a realistic target for public transport usage would be represented as an increase in bus use to 7% of all journeys by 2021 and 10% by 2031. Rail growth has been set at a 2% increase to 5% of all journeys by 2021 and 2031. No further increase has been predicted for rail use due to capacity constraints that exist on the network.

Whilst the overall percentage of journeys made as a driver or passenger of a car reduces from 67% in 2001 to 56% in 2021 and 48% in 2031, there is still a large increase in the actual number of car based journeys. Whilst it cannot be assumed that all of these journeys will be for travel into Thetford from the new growth areas, we would agree with the findings of the TGFIS that recommend that a town centre parking management system would be required to accommodate demand.

Under these assumptions buses will have to play a leading role in securing the necessary level of modal shift. Table 7.4 shows the projected increases in peak hour bus patronage for the periods 2001 to 2021 and 2021 to 2031 if the current mode share is maintained and with the assumed changes in mode share.

Table 7.4: Projected Increases in Peak Hour Bus Patronage

	2001 to 2021	2021 to 2031
Current mode share maintained	105	58
Assumed changes in mode share	828	721

7.1.1 Distribution of Additional Trips between Growth Locations

The figures for additional trips by mode are based on a summary of the total number of residential peak hour trips for each mode for the Thetford area as a whole averaged across each growth scenario.

The assessment of future transport infrastructure demand in the growth infrastructure study has been based on the following major considerations:

- A review of the baseline transport situation and current transport policies
- The effect of housing growth and employment growth on the quantity of vehicle trips that could potentially be generated
- The accessibility of the locations in the proposed growth scenarios to public transport.

Using the numbers for the scenarios given in table 7.1, above, gives figures as shown in table 7.5 (distribution of additional trips) and the total number of bus trips based on the current 2% bus mode share.

Table 7.5: Geographical Distribution of Additional Trips

	Increase in Peak Hour Home-based Person Trips Based on Current Mode Share									
	2021 Target Scenario					2031 Target Scenario				
Location	A	B	C	D	E	A	B	C	D	E
N	3 588	5 828	3 771	5 155	3 400	2 715	1 975	2 056	3 604	1 755
SE	1 121	0	1 934	0	2 411	1 392	1 013	1 055	0	1 245
Total	4 709	5 828	5 705	5 155	5 811	4 107	2 988	3 111	3 604	3 000
Total Bus Trips (@ 2% modal share)	94	117	114	103	116	82	60	62	72	60

Using the overall peak hour figures from each growth area in table 7.5 and the 60 : 40 split discussed in 5.3.1, above, gives figures as shown in tables 7.6 (journeys in Thetford) and 7.7 (journeys out of Thetford) below.

Table 7.6: Geographical Distribution of Additional Trips – Thetford Journeys

	Increase in Peak Hour Home-based Person Trips Based on Current Mode Share for travel within Thetford (60%)									
	2021 Target Scenario					2031 Target Scenario				
Location	A	B	C	D	E	A	B	C	D	E
N	2 153	3 497	2 263	3 093	2 040	1 629	1 185	1 234	2 162	1 053
SE	673	0	1 160	0	1 447	835	608	633	0	747
Total	2 826	3 497	3 423	3 093	3 487	2 464	1 793	1 867	2 162	1 800

Table 7.7: Geographical Distribution of Additional Trips – Outside Journeys

	Increase in Peak Hour Home-based Person Trips Based on Current Mode Share for travel out of Thetford (40%)									
	2001-2021 Scenario					2021-2031 Scenario				
Location	A	B	C	D	E	A	B	C	D	E
N	1 435	2 331	1 508	2 062	1 360	1 086	790	822	1 442	702
SE	448	0	774	0	964	557	405	422	0	498
Total	1 883	2 331	2 282	2 062	2 324	1 643	1 195	1 244	1 442	1 200

As outlined in section 7.1, the biggest shift in modal share would be for bus based journeys. Projected increases in bus mode share across Thetford as a whole would deliver 7% of peak hour journeys by 2021 and 10% by 2031. This would be crucial in managing the level of car journeys that could be created by such a large growth scheme.

By developing our projected distribution of additional trips to incorporate the increased modal share for buses we have identified the number of peak hour journeys that would be made by bus from each growth area. The results are shown in tables 7.8 and 7.9 below, detailing trip numbers for journeys in and out of Thetford.

Table 7.8: Increase in Peak Hour Bus Trips by Growth Scenario, Thetford Trips (60%)

	Increase in Peak Hour Home-based Bus Trips Based on Proposed Mode Share Targets for Growth Locations : Travel in Thetford									
	2021 Target (7% Bus Mode Share) Scenario					2031 Target (10% Bus Mode Share) Scenario				
Location	A	B	C	D	E	A	B	C	D	E
N	151	245	158	217	143	163	119	123	216	105
SE	47	0	81	0	101	84	61	63	0	75
Total	198	245	239	217	244	247	180	186	216	180

Table 7.9: Increase in Peak Hour Bus Trips by Growth Scenario, Trips Out of Thetford (40%)

	Increase in Peak Hour Home-based Bus Trips Based on Proposed Mode Share Targets for Growth Locations : Travel out Thetford									
	2021 Target (7% Bus Mode Share) Scenario					2031 Target (10% Bus Mode Share) Scenario				
Location	A	B	C	D	E	A	B	C	D	E
N	100	163	106	144	95	109	79	82	144	70
SE	31	0	54	0	67	56	41	42	0	50
Total	131	163	160	144	162	165	120	124	144	120

We would suggest that it may be easier to influence travel behaviour in the new growth locations by providing high quality public transport from the outset of development than it will be to change mode choice for journeys within Thetford town. The new growth locations should therefore be expected to outperform the existing urban area in terms of their contribution to overall mode share target. It may also be assumed that the infill developments offer a greater opportunity for walking and cycling journeys due to their close proximity to existing facilities, and may outperform other areas on this mode share target.

The CfIT Affordable Mass Transit Guidance report compares a number of public transport options against a maximum system capacity. The levels of public transport use predicted for Thetford are well within the maximum system capacity of a standard bus service of 2 500 to 4 000 passengers per hour per direction. A standard bus service would therefore be the most appropriate and cost effective option.

Current journey predictions do not suggest that a busway or guided bus system would be required, however a number of bus priority measures along key corridors linking growth areas to key trip attractors would be recommended.

Table 7.10 below compares the system capacity of a standard bus service with those of various forms of bus rapid transit, light rail/tram and heavy rail.

Table 7.10: System Capacity

Mode / Technology	Maximum System Capacity (passengers per hour per direction)
Standard bus	2 500 – 4 000
Busway	4 000 – 6 000
Guided bus	4 000 – 6 000
Tram/Light Rail	12 000 – 18 000
Heavy Rail	10 000 – 30 000

Source: CfIT Affordable Mass Transit Guidance

7.1.2 Requirements for Additional Bus Services

Based on predicted journey levels for public transport services, we have considered the number of additional bus services required to accommodate the projected additional peak hour bus trips with the proposed changes in mode share. To achieve a high quality, user friendly network of bus services, we would recommend that:

- A minimum of a 10 minute service on key corridors to create a 'turn up and go' service
- The capacity and comfort levels of services be considered for the type of journey being undertaken.

The definition of a 'turn up and go' service as one with a daytime service frequency of at least every ten minutes is consistent with that used in the Norfolk Bus Strategy and we would concur that this is the threshold at which customers generally have enough confidence to wait at a bus stop without first consulting a timetable. This should however be a minimum frequency and, particularly during peak times, higher frequencies on individual services should be considered.

Assuming passengers arrive at bus stops at random intervals, the average wait time for a bus service is half the service frequency ie five minutes for a ten minute headway service. Increasing service frequency beyond the ten minute 'turn up and go' threshold up to at least five minutes delivers worthwhile reductions in wait time that can have a significant beneficial impact on the generalised cost of bus travel. For this reason ten minute headway services should not be the default choice and higher frequencies should be considered where justified.

The capacity and comfort of a journey is another key factor in modal choice. For longer journeys (30 minutes or greater) such as those for travel out of Thetford, comfort will be an important aspect of consumer choice. Seating capacity, leg room and work space should all be considered when planning journeys for this purpose. The Commission for Integrated Transport's Affordable Mass Transit Guidance states:

'*It is important to note that the practical capacity is significantly less than the absolute capacity. In practice therefore only 75% of the theoretical capacity should be assumed when undertaking analyses. Consideration should be given to the comfort levels for passengers, particularly in relation to the alternative travel choices available to potential passengers and the length of the journeys being made.*'

The practical capacity of services is less than the absolute capacity because in practice demand is not evenly distributed throughout the peak period and so additional capacity is required to avoid overloading at the peak of the peak. The provision of sufficient capacity based on a 'comfortable' rather than 'crush' level of loading is particularly important for longer journeys, or routes where the vehicle may be travelling at speed, as the carriage of standing passengers on these routes may be considered unacceptable on safety grounds. This would be of particular note for journeys travelling along the A11 to destinations such as Norwich and Cambridge.

For example, based on a practical vehicle capacity of 75% of the absolute maximum capacity, the capacity of a bus service operating at a frequency of every ten minutes using double deck vehicles is reduced from 540 to 405 passengers per hour per direction.

Using bus mode share targets for the growth areas of 7% by 2021 and 10% by 2031 and the distribution of additional bus trips between the major growth locations set out in Tables 7.8 and 7.9, we have identified the service levels and vehicle capacity required to meet the projected level of demand from each location in each of the five development scenarios in 2021 and 2031. These figures assume a 60:40 split in total growth between trips within Thetford and outside Thetford.

The proposals for trips in Thetford for 2021 (Table 7.11) are based on the use of: 7.1m midi-buses with an absolute maximum capacity of 33 (23 seated plus 10 standing) and a practical capacity of 24, 7.8m midi-buses with an absolute maximum capacity of 39 (27 seated plus 12 standing) and a practical capacity of 29 and 12m semi-low floor buses with an absolute maximum capacity of 69 (44 seated plus 25 standing) and a practical capacity of 52. These practical capacities are in accordance with the CfIT guidance.

Table 7.11: Proposed Peak Service Levels in 2021 for each Growth Scenario – Trips in Thetford (60%)

Scenario	A				B				C				D				E			
Location	Demand (trips per hour)	Frequency (minutes)	Practical Vehicle Capacity	Service Capacity (trips per hour)	Demand (trips per hour)	Frequency (minutes)	Practical Vehicle Capacity	Service Capacity (trips per hour)	Demand (trips per hour)	Frequency (minutes)	Practical Vehicle Capacity	Service Capacity (trips per hour)	Demand (trips per hour)	Frequency (minutes)	Practical Vehicle Capacity	Service Capacity (trips per hour)	Demand (trips per hour)	Frequency (minutes)	Practical Vehicle Capacity	Service Capacity (trips per hour)
N	151	10	29	174	245	12	52	260	158	10	29	174	217	12	52	260	143	10	29	174
SE	47	15	24	96	-	-	-	-	81	15	24	96	-	-	-	-	101	12	24	120
Total	198				245								217				244			

The projected level of demand could be accommodated by a 10-15 minute interval service operated by midi-buses and semi-low floor buses, or a lower frequency service operated by larger buses. Small vehicles have been proposed to offer a level of service that is as close as possible to a ‘turn up and go’ frequency.

The proposals for trips in Thetford for 2031 are shown in table 7.12.

Table 7.12: Proposed Peak Service Levels in 2031 for each Growth Scenario – Trips in Thetford (60%)

Scenario	A				B				C				D				E			
Location	Demand (trips per hour)	Frequency (minutes)	Practical Vehicle Capacity	Service Capacity (trips per hour)	Demand (trips per hour)	Frequency (minutes)	Practical Vehicle Capacity	Service Capacity (trips per hour)	Demand (trips per hour)	Frequency (minutes)	Practical Vehicle Capacity	Service Capacity (trips per hour)	Demand (trips per hour)	Frequency (minutes)	Practical Vehicle Capacity	Service Capacity (trips per hour)	Demand (trips per hour)	Frequency (minutes)	Practical Vehicle Capacity	Service Capacity (trips per hour)
N	163	10	29	174	119	20	52	156	123	12	29	145	216	12	52	260	105	15	29	116
SE	84	15	24	96	61	15	24	96	63	15	24	96	-	-	-	-	75	15	24	96
Total	247				180								216				180			

186

By 2031, an additional 10-20 minute frequency service would be required to meet demand, creating a 5 to 8 minute headway in departures from each growth area to town (except for scenario B) which exceeds the 'turn up and go' frequency level.

The proposals for trips out of Thetford for 2021 (Table 7.13) and 2031 (Table 7.14) are based on the use of 10 m coaches with an absolute maximum capacity of 41 seats. These services offer no standing capacity and will operate on a limited stop basis from Thetford to their final destination. As such we consider that the practical capacity of 41 is achievable for this type of service. We also considered on the used of 12 m coaches with a practical capacity of 48, 13 m coaches with a practical capacity of 52 and 13.5 m coaches with a practical capacity of 56.

Table 7.13: Proposed Peak Service Levels in 2021 for each Growth Scenario – Trips out of Thetford (40%)

Scenario	A				B				C				D				E			
Location	Demand (trips per hour)	Frequency (minutes)	Practical Vehicle Capacity	Service Capacity (trips per hour)	Demand (trips per hour)	Frequency (minutes)	Practical Vehicle Capacity	Service Capacity (trips per hour)	Demand (trips per hour)	Frequency (minutes)	Practical Vehicle Capacity	Service Capacity (trips per hour)	Demand (trips per hour)	Frequency (minutes)	Practical Vehicle Capacity	Service Capacity (trips per hour)	Demand (trips per hour)	Frequency (minutes)	Practical Vehicle Capacity	Service Capacity (trips per hour)
N	100	30	56	112	163	20	56	168	106	30	56	112	144	20	48	144	95	30	48	96
SE	31	60	41	41	-	-	-	-	54	60	56	56	-	-	-	-	67	30	41	82
Total	131				163								144				162			

160

Table 7.14: Proposed Peak Service Levels in 2031 for each Growth Scenario – Trips out of Thetford (40%)

Scenario	A				B				C				D				E			
Location	Demand (trips per hour)	Frequency (minutes)	Practical Vehicle Capacity	Service Capacity (trips per hour)	Demand (trips per hour)	Frequency (minutes)	Practical Vehicle Capacity	Service Capacity (trips per hour)	Demand (trips per hour)	Frequency (minutes)	Practical Vehicle Capacity	Service Capacity (trips per hour)	Demand (trips per hour)	Frequency (minutes)	Practical Vehicle Capacity	Service Capacity (trips per hour)	Demand (trips per hour)	Frequency (minutes)	Practical Vehicle Capacity	Service Capacity (trips per hour)
N	109	30	56	112	79	40	56	84	82	40	56	84	144	20	48	144	70	40	48	72
SE	56	30	41	82	41	60	41	41	42	60	56	56	-	-	-	-	50	30	41	8 2
Total	165				120								144				120			

124

[Intentionally Blank]

The peak demand for services from each growth location to destinations out of Thetford in 2021 can be accommodated by a service level of 2-3 buses per hour, a 20 - 60 minute frequency. Whilst this is well below the 'turn up and go' frequency level, it is a good level of service for interurban journeys and a longer waiting time is likely to be more acceptable to passengers undertaking a journey of longer duration. In 2031, the requirement grows to accommodate an extra 20-60 minute frequency service to meet demand across all scenarios.

The number of trips generated by the infill developments by 2021 in Thetford does not necessitate extra bus services but may contribute to an increase of frequency on the core corridor services.

In practice some of the demand provided for in the above proposals will be for services to the strategic employment sites rather than wholly on the main corridors linking the major growth areas with Thetford town centre. It is envisaged that in some cases dedicated public transport links will be provided between growth locations and strategic employment sites, but a proportion of trips to strategic employment sites will involve interchange to and from the main corridor services.

Travel plans, bus priority measures and park and ride facilities can all play a part in reducing the number of car journeys to and from employment sites and would complement the provision of new direct bus links.

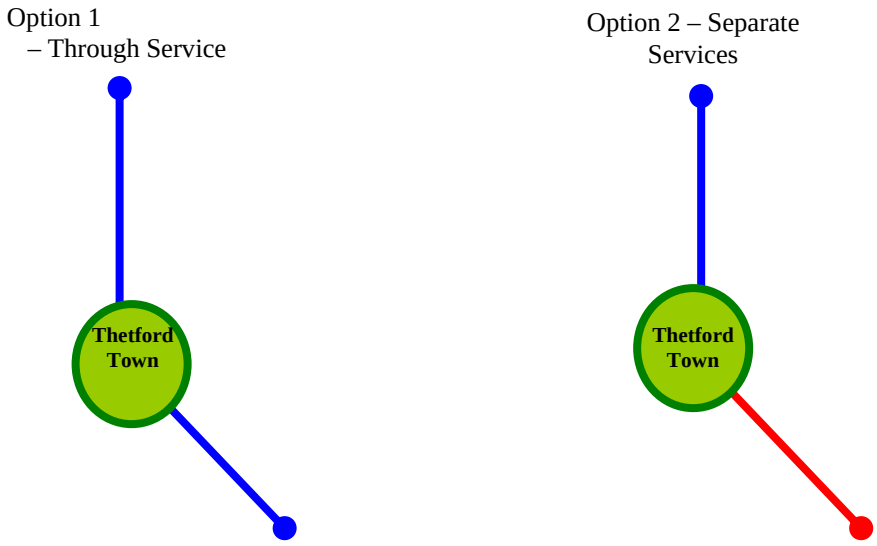
The spatial relationship between housing and employment areas in the growth areas can be controlled through the planning process and 'local' bus services provided to link the residential and industrial zones, but this does not necessarily mean that those occupying the new houses will have jobs in the adjacent employment areas. Self-contained development with low levels of in and out-commuting can be encouraged, but not guaranteed.

We have concluded that there is insufficient data available on employment trips to permit an assessment to be made of the distribution of public transport trips between the major growth locations and employment sites under each of the scenarios.

There may be scope to accommodate a proportion of the additional trips generated by growth in Thetford on rail services, using bus services to link Thetford station to growth areas. However it should be noted that there are a number of infrastructure and operational constraints on the enhancement of rail services. These constraints are outlined in the Mott MacDonald report 'Improved Rail Services in Norfolk – Timetabling Exercise' (December 2007), which presents the results of a high-level timetable analysis to determine the ability of the present rail infrastructure to accommodate future additional rail services. Accessibility issues at Thetford station are discussed in the Mott MacDonald report 'Thetford Railway Station Accessibility' (March 2008) which considers a wide range of improvements that could create a more accessible station for all.

Vehicle Requirements (Scenario C as an Example)

As an example, to achieve a 10 minute frequency for services linking the new growth areas with Thetford town centre in 2021 a minimum of 4 low floor midi-buses (7.8 metre) would be required for Key Site North and a minimum of 3 low floor midi-buses (7.1 metre) would be required to achieve a 15 minute service to and from Key Site South East. This is based on a journey time of 20 minutes from each growth location to town. A cross-town through service operation as shown in Option 1 would require 8 of the larger buses. This is the preferred option as it offers the greatest operational efficiency and scope for journeys between growth areas and their corridors.



Option 2 shows how two separate services could also be used to operate journeys from each growth location to town. This option would require less vehicles but by operating two separate services, removes the opportunity for through-travel from growth areas to destinations beyond the town centre.

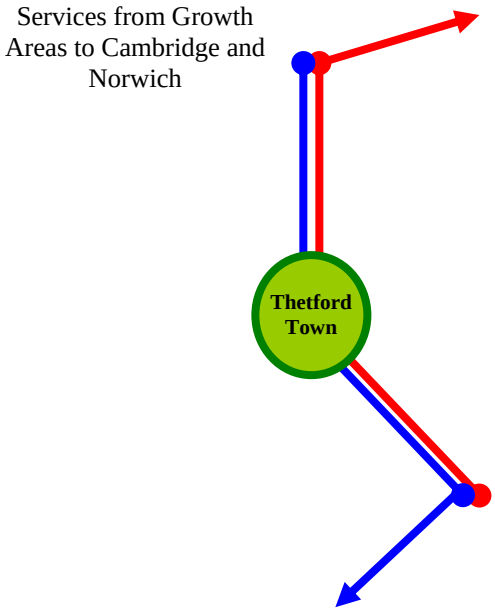
By 2031, the demand for bus travel within Thetford will have grown to an additional requirement for another 12 minute service using 7.8m low floor midi-buses to serve Key Site North and an extra 15 minute service using 7.1metre low floor midi-buses to Key Site South East. This new service would combine with existing routes to create a combined 7/8 minute headway from each growth area to Thetford town centre. Again applying the cross town principle, an extra 7 vehicles will be required to operate this service.

For travel to locations outside Thetford we have shown that there is a predicted demand for a 30 minute service using 13.5 metre coaches to Key Site North and a 60 minute service using 13.5 metre coaches to Key Site South East. By 2031, the same frequency and type of vehicles are required to maintain the same level of services as in year 2021 to both Key Site North and Key Site South East. At this stage, we have assumed that there are likely to be two destinations; Norwich and Cambridge (subject to further detailed studies), which effectively halves the frequencies for each route. Clearly this falls outside the 'turn up and go' frequency and further studies may be required to establish if there will be sufficient market demand to justify the extra investment required to meet a 10 minute frequency on each service.

At this stage we can assume that services to destinations out of Thetford in 2021 are likely to consist of an hourly bus service to both Norwich and Cambridge. Based on a journey time of 60 minutes to Cambridge and 45 minutes to Norwich, a total of 9 vehicles (5 vehicles to Cambridge and 4 vehicles to Norwich) would be required to operate a 30 minute service.

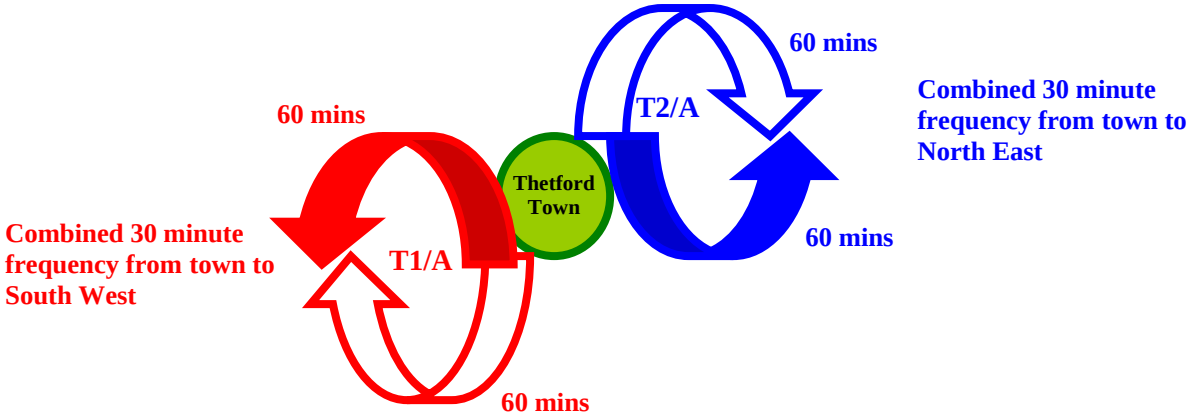
By 2031 demand is predicted to have grown to require extra services for journeys out of Thetford. A further 9 vehicles would be required to operate these services.

The total requirement for bus services for travel out of Thetford is predicted to be 9 vehicles in 2021 and a further 9 vehicles in 2031. This delivers two services to link Thetford with Cambridge and Norwich.



Existing Thetford Bus Services

At the time of this report, Thetford is primarily served by two town bus services operated by Coach Services using midi buses (33 seats). The T1 and T2 services operate in a fairly circuitous manner to the North East and South West of the town. Services T1A and T2A offer the same loop in reverse. Both T1 and T2 loops operate hourly in each direction, combining to provide a 30 minute service.



In order to meet the predicted increase in journeys over the period to 2031, we would suggest that consideration be given to increasing the frequency of town services. The creation of new services to key employment sites has been discussed earlier but it is worth noting that more direct services to these areas could result in changes to the town circular services, bringing time savings for all passengers and potentially freeing up resources to consider services to other areas. For example, a new service could link Key Site North to Stephenson Way via the town centre, allowing the T1 and T1A services to provide a more direct service to and from Barnham Cross.

There may also be scope to replace services T1/A and T2/A with a new circular service operating via Barnham Cross, Abbey Estate, Ladies Estate, East of Norwich Road, Rosecroft Way and Nuns' Bridges. This would require further detailed studies but initial analysis suggests that this may be feasible and provide a number of new links.

7.1.3 Thetford Bus Station

We have reviewed the May 2007 Mott MacDonald study 'Thetford Bus Station Relocation' whilst developing this report. Two of the key recommendations of this study are that:

- A new bus station should provide a minimum of five departure stands
- The best alternative locations to the current site are at St Nicholas Street and Minstergate

We would concur that a location in St Nicholas Street or Minstergate would be easily accessible and practical for the new services required as part of the growth area.

With the increase in bus services of 15 journeys per peak hour by 2031, we would consider that five bays should be sufficient for the smooth operation of the bus station. This can be broken down as follows:

- Bay 1: Town centre circular and other local services
- Bay 2: Key Site North services (up to 10 departures per hour)
- Bay 3: Key Site South East services (up to 10 departures per hour)
- Bay 4: Coach services to Norwich and Cambridge (up to 5 departures per hour)

- Bay 5: National Express and Suffolk County Council services

We would also recommend that an urgent review of the facilities at the current bus station in Bridge Street, and interchange facilities at the rail station be undertaken. There are a number of simple and cost effective improvements that could be delivered to improve the overall passenger experience and raise the profile of public transport services in Thetford.

Figure 7.1: Thetford Bus Station – Current Shelter and Publicity

7.2 Thetford Railway Station

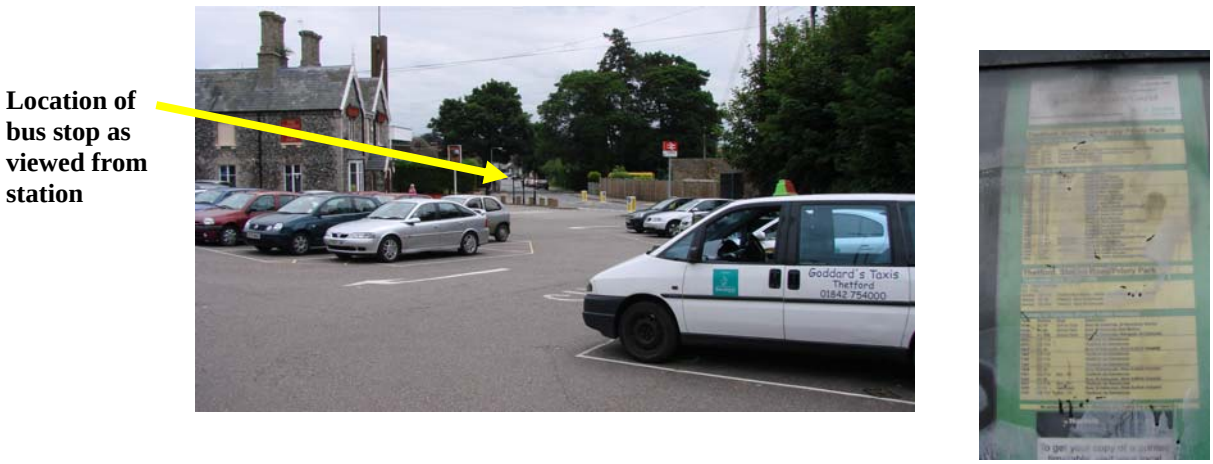
The Thetford growth areas are likely to increase the potential for greater numbers of rail based journeys. Whilst the station is some distance from the town centre there is a considerable opportunity for walking, cycling and bus links to be improved and the development of a multi-modal interchange facility at the station. Our predicted trip rates allow for a modest increase of 4% by 2021, creating a 5% modal share for rail and other modes in 2021 and 2031. In terms of journey numbers, this would deliver an increase of 105 peak hour journeys by 2021 and a further 144 by 2031.

At present the station site as a whole looks uninviting and neglected, with one building boarded up and in poor repair. Cycling facilities are limited to an uncovered rack and access to the North bound platform is via a bridge with no ramp.

Figure 7.2: Railway Station

Bus interchange facilities consist of a bus shelter and timetable case approximately 300m from the main station buildings. There is no signage from the station to the bus stop, and it is not clearly visible from the station. The timetable information displayed at the bus stop is barely legible due to damage of the timetable case.

Figure 7.3: Bus stop at Railway Station



Whilst we concur with the recommendations the 'Thetford Railway Station Accessibility' study we would also suggest that signage to the bus stop should be improved as part of any ongoing works. To ensure the quality of passenger journeys, the bus shelter itself should also be improved to accommodate the increase in journeys and provide a more modern, practical facility for users. The quality of information should be improved to include maps, fares data and ideally a real-time information display.

A previous study by Mott MacDonald for Norfolk County Council identified the following key network constraints on the introduction of additional train services between Wymondham and Norwich. The same constraints also apply to north bound services from Thetford. These are outlined below:

- Platform capacity at Norwich Station
- Bottleneck created by track layout at Norwich Station throat
- Single track section over Trowse Swing Bridge
- Single lead junction at Trowse Lower Junction

A timetabling exercise undertaken as part of this study identified potential train paths for one additional morning peak service in each direction between Wymondham and Norwich. One additional service would provide three trains from Wymondham arriving in Norwich between 0800 and 0900, but would not meet the aspiration for a train every 15 minutes at peak times.

The provision of a 15 minute interval train service between Wymondham and Norwich at peak times would require investment to remove one or more of the constraints identified above, plus up to two additional train units.

[Intentionally Blank]

8 Vision for a High Quality Public Transport Connection

There are a number of components which should be considered in developing a high quality public transport network. Service and vehicle specification and the general infrastructure and priority measures that should be expected for the routes are outlined below.

8.1 Image and Branding

The vision for a high quality public transport service should start with the overall image, visual identity and branding of the service. This is fundamental to the perception of the service as offering a step change in quality relative to existing bus services.

The visual identity and branding of the service should be co-ordinated across vehicles, infrastructure and information so that the service is perceived as an integrated system even if in practice different parties are responsible for operations and infrastructure.

The Kent Thameside 'Fastrack' network in the Thames Gateway area (Figure 8.1) is an excellent UK example of this approach.

Figure 8.1: Co-ordinated Branding of Vehicle and Infrastructure (Kent Thameside Fastrack)

The Nantes 'BusWay' scheme in France also demonstrates what can be achieved in terms of raising the visual appearance of essentially standard buses to stand out from an existing bus fleet. Figure 8.2 shows how the appearance of a standard Mercedes Citaro articulated bus similar to those used in central London has been transformed by a radical livery design and covering the non-steered wheels.

Figure 8.2: Nantes BusWay Vehicle

8.2 Service Specification

Hours of operation for any service should be comprehensive so that public transport would meet almost every journey requirement. Whilst a 24 hour service may be preferable there may not be sufficient demand during the first few years to justify this and so a service operating from 0500 to 0100 may be a more realistic aspiration. During the interpeak period a minimum daytime service interval of 10 minutes should be maintained to meet the requirement for a 'turn up and go' service. During the evening, a 20 minute service should operate from 1900 onwards, possibly reducing to half-hourly after 2300.

It is important that employers based within the growth areas and at the strategic employment sites are contacted regularly in order to ascertain the shift patterns and work trends within their workforce. By doing so, bus services and timetables can be kept in harmony with travel patterns, even extending to operating on a 24 hour basis if a clear demand is demonstrated.

8.3 Vehicle Specification

In developing vehicle specifications for the services to the growth areas the opportunity to deliver a safe, accessible and attractive service with a quality ambience and the lowest possible environmental impact should be maximised. However, it is important that specifications are based on tried and tested technology to ensure that requirements are practical and cost effective. The reliability of the service must not be compromised by innovative but unproven equipment on vehicles.

Vehicle suppliers are already offering innovative variants of standard buses that can transform them in appearance, comfort and overall ambience. This trend is likely to continue and accelerate, and so any detailed specification based on the best that manufacturers can currently offer will need to be reviewed at regular intervals.

8.3.1 Accessibility

Regulations made under the Disability Discrimination Act (DDA) require all new buses to be fully accessible to disabled people so accessibility will be a given for new vehicles of any type.

8.3.2 Emissions

The use of environmentally friendly vehicles with low emissions should be considered for use on routes in Thetford. The baseline position for early 2010 will be a clean diesel vehicle meeting the Euro V emissions standard applicable from 1 October 2009. The Euro V standard requires a reduction in emissions of oxides of Nitrogen (NOx) of over 40% relative to the current Euro IV standard (see Table 3.1). Some bus manufacturers are already offering a Euro V engine as an option for new vehicles.

In addition to the mandatory 'Euro' emissions standards, there is a more stringent, but voluntary, 'Enhanced Environmentally friendly Vehicle' (EEV) standard. This is now only slightly more stringent than the Euro V standard and some Euro V engines need little or no adjustment to meet the EEV standard.

Table 8.1: Euro IV, Euro V and EEV Emission Limits for Buses (g/kWh)

	Carbon monoxide	Non-methane hydrocarbons	Methane	Oxides of Nitrogen	Particulate matter
Euro IV (current standard)	4.0	0.55	1.10	3.5	0.03
Euro V (October 2009)	4.0	0.55	1.10	2.0	0.03
EEV (voluntary)	3.0	0.40	0.65	2.0	0.02

As an example of what is currently available on the market, VDL Bus are now offering a single deck bus chassis built to EEV standard with full production status. Five of these vehicles were delivered to operator Arriva Midlands in October 2007 for use on hospital services in Staffordshire.

It is likely that there will be further European legislation to tighten emission standards for buses from 2013/14.

We would suggest that the vehicle specification for services to the growth areas should incorporate the EEV standard on the basis that this represents the cleanest possible diesel fuelled vehicle in current series production.

The potential to implement a fleet of hybrid or alternative-fuelled vehicles should be also be explored, with costs and benefits compared against EEV as a benchmark. The need for new bus depot infrastructure as identified in the growth infrastructure report will create opportunities for specialised refuelling or recharging points to be built-in to any new depot developments. Alternative fuels are considered in more detail in section 3.6 below.

8.3.3 Interior

All vehicles should be air conditioned, and have high quality seating, potentially with leather seats throughout. Leather seating is a recent innovation in the UK bus industry to offer passengers a tangible improvement in the quality of the bus interior environment and a feature that is found in many private cars. Operators have found leather to be a practical material that is easy to clean and have not generally experienced problems with vandalism of leather seats. In specifying vehicle seating capacities a balance should be struck between maximising seating capacity and offering adequate legroom.

8.3.4 ICT Equipment

Vehicles should be fitted with electronic exterior route number and destination displays at front, side and rear in accordance with DDA standards. Electronic variable message signs or colour TFT screens should be fitted to the interior of the vehicle to provide information to passengers during their journey.

The level of crime on the public transport system in Norfolk is low, but operators are increasingly specifying CCTV equipment on new buses to provide additional security for driving staff and passengers and evidence for use in the investigation or accidents and claims. The cost of such equipment has now fallen to the point at which it should be considered as a standard feature of a 'high quality' service rather than a response to a problem of crime or fear of crime in a local area or on a specific service.

Vehicles should be fitted with GPS tracking and communications equipment to facilitate the management and control of services on a day to day basis, the monitoring of historic service performance and the provision of real time information at bus stops. Such equipment should be compliant with Real Time Information Group (RTIG) standards. This equipment can also provide a voice channel for vehicle to base communication, but the usefulness of such a facility depends on the willingness of operators commit staff resources to the central control of services.

Ticketing systems and equipment are considered in section 8.5 below.

Transport for London have developed the concept of the 'Intelligent Bus' (Bus) under which all of the systems described above are fully integrated with a single computer and shared data storage medium on each vehicle. This approach to the installation of ICT equipment on vehicles is likely to be commonplace by the time that public transport connections for the major growth locations are implemented.

8.4 Alternative Vehicle Designs

We have considered a range of alternative vehicle designs that offer trade-offs between capacity, accessibility and passenger comfort.

In assessing the practical capacity of each vehicle type we have adopted the CfIT recommendation that the practical vehicle capacity for assessment of the overall capacity of the service should be 75% of the absolute maximum capacity.

8.4.1 Full Length Low Floor Bus

Based on a 12 metre low floor vehicle with a seating capacity of 44 and maximum standing capacity of 25 restricted to eight spaces to reflect the practical capacity of the vehicle as recommended by CfIT, the maximum number of passengers that can be carried by each bus is 52. For a 10 minute headway service, that represents a practical service capacity of 312 passengers per hour per direction.

Figure 8.3: 12m Full Length Low Floor Bus

Figure 8.4: Interior of Full Length Low Floor Bus

8.4.2 Semi-Low Floor Interurban Bus

Based on a 13.5 metre interurban bus with a seating capacity of 49 and maximum standing capacity of 28 restricted to nine spaces reflect the practical capacity of the vehicle as recommended by CfIT, the maximum number of passengers that can be carried by each bus is 58. For a 10 minute headway service, that represents a practical service capacity of 348 passengers per hour per direction.

To increase the service capacity, the standing capacity could be increased or larger vehicles specified. For example, increasing the vehicle size from 13.5 metres to 15 metres can offer an extra eight seats whilst still retaining a significant level of low floor space availability.

Figure 8.5: Examples of Interurban Bus Layout and Design

8.4.3 Interurban Coach

Based on an accessible 12 metre coach with a wheelchair space incorporated within the passenger entrance, a seating capacity of 46 seats and no standing passengers, the maximum number of passengers that can be carried by each coach is 46. This would equate to a practical capacity of 34 for assessment purposes as recommended by CfIT, but we consider that it would be appropriate to use a higher ratio of practical to absolute maximum capacity of 85% for a vehicle with no standing capacity, giving a practical capacity of 39. For a 10 minute headway service, that represents a practical service capacity of 234 passengers per hour per direction.

This type of vehicle would only be suitable for use on express or limited stop services.

Figure 8.6: Examples of Coach Interior Specification and Ambience

8.4.4 Low Floor Double Deck Bus

Based on a 10.5 metre low floor double deck vehicle with a seating capacity of 69 and maximum standing capacity of 21 restricted to a practical capacity as recommended by CfIT, the maximum number of passengers that can be carried by each bus is 68. For a 10 minute headway service, that represents a practical service capacity of 408 passengers per hour per direction.

Double deck vehicles are efficient people movers but may not offer the best overall passenger experience. Customers often prefer to travel downstairs where they feel safer due to proximity to the driver and to exits. Double deck vehicles can also suffer from increased dwell time at stops with passengers exiting delaying the boarding of other passengers as they file down the stairs.

The use of such vehicles may make it more difficult to portray the new services for the growth areas as offering a step change in quality relative to existing bus services.

Figure 8.7: Low Floor Double Deck Bus

Figure 8.8: Double Deck Bus Interior with Leather Seats

8.4.5 Low Floor Articulated Bus

At this stage we have focused on the operation of any new bus services with rigid chassis vehicles. The use of articulated buses would offer extra seating capacity of up to 15 seats per vehicle (18 m articulated v 12 m rigid vehicle) but could create problems in negotiating narrow roads and tight turns. For example, a 12 metre rigid bus has a turning clearance circle of 22.3 metres, whereas an 18.75 metre articulated vehicle requires 24.4 metres to make the same manoeuvre. Articulated vehicles also require significant additional kerb space at bus stops and interchanges and could not be easily accommodated within the historic layout of Thetford.

A recent UK innovation in bus design has been the development of a tram-like vehicle for bus rapid transit services based on a standard articulated bus chassis but adopting a radical approach to the body design and interior layout. The Streetcar FTR vehicle developed by Wrightbus and FirstGroup is an 18.7m articulated vehicle with segregated driver's cab, air conditioning, upgraded lighting and side-on lounge style seating.

These vehicles have only 37 seats but space for 76 standing passengers. Given the length of journey and nature of the roads used it is not felt that a vehicle with such a low proportion of seating would be well suited to use on the services to the growth areas.

Table 8.2 below presents the typical dimensions and capacities of a selection of vehicle types which may be suitable for the services to and from the growth areas.

Table 8.2: Typical Vehicle Dimensions and Capacities

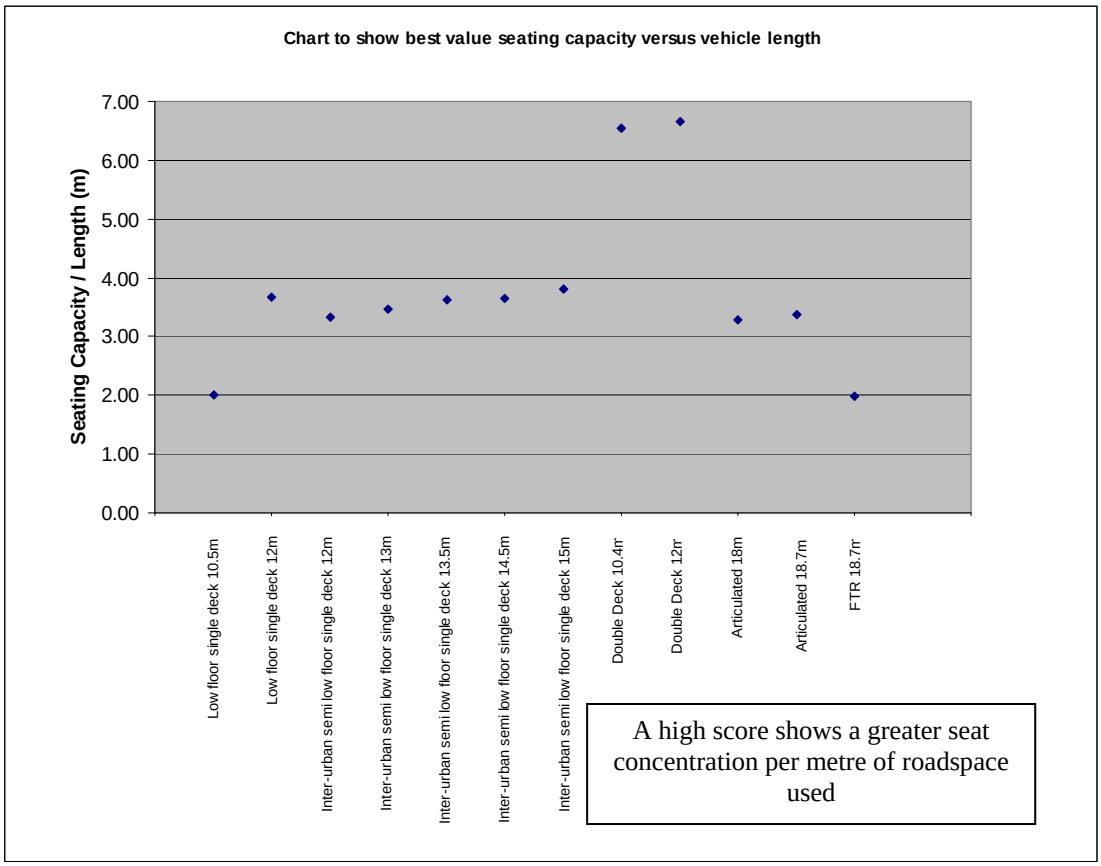
Vehicle Type	Length (m)	Seating Capacity	Standing Capacity	Seating Capacity/ Length
Low floor single deck	10.5	37	10 *	3.52
	12.0	44	12 *	3.66
Inter-urban semi low floor single deck	12.0	40	14 *	3.33
	13.0	45	16 *	3.46
	13.5	49	17 *	3.63
	14.5	53	18 *	3.66
	15.0	57	19 *	3.80
Low floor double deck	10.5	69	21	6.57
	12.0	80	44	6.66
Articulated low floor single deck	18.0	59	23 *	3.28
	18.7	63	25 *	3.37
Streetcar FTR	18.7	37	76	1.98

* conservatively estimated, no official figures supplied

The right-hand column shows which vehicles provide the most and least seating capacity for use of a given level of road space / kerb space. As expected, double deck vehicles are the most efficient in this respect but, as discussed above, they may not offer the best overall passenger experience.

Articulated buses generally and the Streetcar FTR vehicle in particular are the least efficient vehicles in terms of seating capacity for use of road space. Such vehicles are well-suited to intensive urban operations where many passengers are travelling for short distances, operating speeds are relatively low and standing passengers can travel in relative safety, but when their limited seating capacity is combined with the issues of manoeuvrability and limited availability of city centre kerb space, these vehicles are not considered suitable for the services to and from the Growth Areas.

Figure 8.9: Comparison of Seating Capacity against Vehicle Length



8.5 Ticketing Systems

Ticketing systems can make an important contribution to a high quality public transport service by:

- Offering customers a range of convenient cash and electronic payment options
- Improving journey speeds and reliability by reducing dwell times at bus stops.

Long bus stop dwell times associated with on-bus ticket sales and cash handling by drivers can have as great an adverse impact on journey times as that of congestion and traffic queues. The implementation of ticketing systems to assist rapid boarding by eliminating driver involvement in ticketing transactions can therefore complement the time savings delivered by bus priority measures as part of the development of a bus-based rapid transit system.

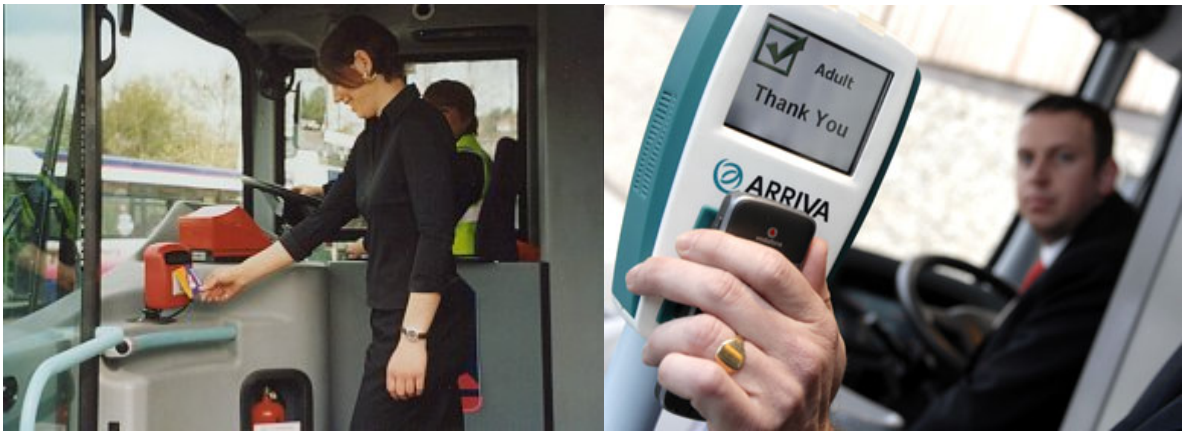
Pre-paid ticketing for local bus services has traditionally taken the form of paper tickets sold through retail outlets, ticket vending machines and (more recently) online. This approach has been successful in reducing bus stop dwell times but still involves visual inspection of tickets by the driver.

The latest paperless ticketing systems remove this constraint by using readers to check tickets upon entry and, where appropriate, exit. Two alternative technology options are available. Smart card ticketing systems have been developed over the last decade, with mobile phone ticketing technology ('m-ticketing') emerging more recently.

Both technologies offer rapid boarding times, greater flexibility for passengers and reduce the need for passengers to find and carry cash for fares. An advantage of m-ticketing is that it avoids the logistics and cost of issuing smart cards by using hardware already owned by the customer together with existing communications infrastructure and billing systems.

In the context of providing public transport services for the major housing growth areas, each new household could be issued with smart cards and/or receive information packs about the type of tickets on offer and how to use the system. Weekly, monthly, annual, multi-journey and stored value tickets should be available through these systems. The aim should be to ensure that all residents of the growth areas have a minimum of a stored value smartcard. Payment for both local bus travel and park and ride use should be included. This entire process could potentially be developer-funded.

Figure 8.10: Smartcard and Mobile Phone Ticketing Technology in Use



Smart cards and m-ticketing offer great potential for developing multi-operator and multi-modal integrated ticketing by offering a solution to the problem of apportioning revenue between the companies participating in an integrated ticket scheme.

There is also scope to develop an on-street bike hire system (such as the 'Vélib' system in Paris) which could involve payment being made and security deposits guaranteed via smart card or mobile phone transactions.

Figure 8.11: 'Vélib' Cycle Rental Infrastructure

School transport could also be operated using a smart card system with each pupil receiving a card at the beginning of the school year. Adopting such a system for this market creates a cashless process and removes the possibility of a pupil not entitled to free travel losing his/her transport money for the journey home.

8.6 Alternative Fuel Vehicles

With the climate change agenda receiving an increasingly high profile, the provision of a public transport service using environmentally friendly vehicles will be expected by residents of the major growth areas and by stakeholders concerned about the sustainability of large scale growth on greenfield sites. Whilst not a significant driver to behavioural change on its own for the majority, there is an associated benefit or 'reward' for the user of such a service which creates a feel-good factor and sense of pride in the transport choice.

The costs, benefits, opportunities and risks of using alternatives to diesel fuelled vehicles to serve the major growth areas should therefore be considered before key investment decisions are made regarding the provision of depot infrastructure and procurement of vehicles.

While there have been numerous demonstration and research projects involving the trial operation of alternative fuel vehicles, the cost of operating such vehicles will need to be comparable with that of diesel powered vehicles for large scale market uptake to become likely in the absence of financial incentives for operators. This tipping point has yet to be reached, but recent increases in world oil prices may have brought it much closer.

The future market for alternative fuel vehicles for bus operations in the UK will be strongly influenced by:

- The commercial acceptability of such vehicles to both operators and customers
- The future extent of access restrictions in urban centres for all but low-emission vehicles
- The future fuel tax and subsidy regime applicable to the UK bus industry (Government proposals for changes to the current Bus Service Operators Grant are the subject of a current consultation).
- The influence of future European legislation on emissions control.

The lack of a strict business case for the provision of the necessary infrastructure to support the use of alternative fuels has frequently proved to be a barrier to their uptake. However, the planning of public transport infrastructure and services for the growth areas from first principles may offer a unique opportunity at a local level to kick-start a shift to the use of alternative fuels and provide a fleet of modern and environmentally friendly vehicles in keeping with the overall look and feel of the new developments they will serve.

An increasing number of trials have been undertaken around the world with the aim of identifying the most practical and reliable alternatives to diesel passenger transport vehicles. Table 8.3 below summarises the main options available and categorises them as emerging (E) or proven (P) technology. A high level assessment of costs, risks and environmental benefits has been made for each fuel type.

Table 8.3: Assessment of Alternative Fuels

Fuel Type	Advantages	Disadvantages
Liquefied Petroleum Gas (LPG) - P	Low CO_2 emissions, similar to diesel; generally low levels of other pollutants; low levels of engine noise; low fuel duty compared with diesel; ease of refuelling relative to CNG.	Limited but expanding refuelling infrastructure (circa 1500 UK sites); lower fuel economy; often loss of some load space; issues regarding toxicity and the combination of high density and flammability of the gas; vehicles more expensive to purchase than diesel buses.
Compressed Natural Gas (CNG) - P	Low CO_2 emissions, similar to diesel; generally low levels of other pollutants; low levels of engine noise; low fuel duty compared with diesel. Vehicles widely used in Europe. Potential for use of biogas from municipal waste, agricultural waste or sewage.	Limited refuelling infrastructure; need for dedicated refuelling equipment; lower fuel economy; loss of some load space (more than LPG); vehicles more expensive to purchase and maintain than diesel buses; buses in early UK trials proved unreliable.
Electric (Battery or Super-capacitor) - E	Zero emissions at point of use; power cost lower than fossil fuels; low noise levels.	Requires recharging systems; batteries and vehicles can be expensive; pollution created at power station not exhaust pipe unless electricity from renewable sources; limited range between charges; battery durability; super-capacitors still at experimental stage of development.
Diesel-Electric Hybrid - E	Low CO_2 and other pollutants; very fuel efficient; driving experience very similar to diesel vehicle; only fuel required is diesel therefore plentiful - no need to recharge batteries separately although some require charge stabilisation, once or twice per week; could operate within air quality management areas in zero emission battery mode; hybrid buses expected to be in series production for UK use by 2012.	New technology, so at present vehicles are expensive; also currently limited vehicle choice, but cost expected to fall if economies of scale can be realised and vehicle choice to increase within next few years. The widespread introduction of hybrids would require new skills for maintenance staff and electrical technicians.
Electric Trolleybus - P	Proven technology widely used in Europe; zero emissions at point of use; power cost lower than fossil fuels; low noise	Cost and visual impact of overhead line equipment; need for OLE limits flexibility; vehicles can be expensive

Fuel Type	Advantages	Disadvantages
	levels; acceleration and hill climbing performance superior to diesel vehicles; vehicles have high mechanical reliability and efficiency with long service life and low maintenance costs. Overhead line equipment provides sense of permanence.	(although whole life cost may be lower than diesel vehicles); pollution created at power station not exhaust pipe unless electricity from renewable sources.
Biofuels (Biodiesel and Bioethanol) - P	Lower CO_2 emissions on a 'life-cycle' basis plus a reduction in particulate matter and hydrocarbons; driving experience very similar to diesel vehicle; no modifications needed to most diesel engines to run on biodiesel; lower fuel duty for the biofuel component compared with diesel. Bioethanol used as a bus fuel in Sweden for 10 years. 100% biodiesel successfully used in UK trials.	Development of refuelling infrastructure still in early stages; a blend of only up to 5% biodiesel is acceptable to some engine manufacturers under existing warranties. Slight increase in NOx emissions for biodiesel compared to standard Ultra Low Sulphur Diesel.
Hydrogen - E	Offers possibility of zero emissions other than water; performance comparable with diesel vehicles; first generation hydrogen fuel cell buses successfully trialled in London; hydrogen internal combustion engines under development.	Commercially viable versions of this technology still some years away; on-board storage of hydrogen challenging; concerns regarding volatility of fuel; no distribution network currently exists for hydrogen for transport use; planning permission required for hydrogen refuelling facilities.

Figure 8.12: Examples of Alternative Fuel Vehicles


Powered by Cleaner Electric Hybrid Technology
MAYOR OF LONDON
Another red bus going green for LONDON


The Bio Bus
do your part, be Bio smart

8.7 Passenger Infrastructure

To maximise the attractiveness of the public transport service for the growth areas it will be imperative to offer a high quality journey experience from origin to final destination. The quality of the waiting environment at bus stops is a crucial part of the overall journey experience and sets the tone for the standard of the travelling experience to come.

The specification and provision of high quality passenger infrastructure is therefore of equal importance to the specification of vehicles in influencing overall perceptions of service quality.

Passenger infrastructure should be designed as an integral element of all new developments within the growth areas and should not have to be added in retrospectively.

Bus stops and waiting areas should be designed to complement their surroundings whilst remaining prominent, well-lit and fit for purpose in terms of size of bus, level of enclosure and sufficiency of space to accommodate all waiting passengers.

Stops outside the growth areas but served by the new services should also be upgraded to ensure maximum growth potential along the full length of the routes.

8.7.1 Bus Stop Accessibility

All bus stops along the route should be fully accessible in accordance with the Disability Discrimination Act. Raised kerbs should be provided to facilitate access to low floor buses without the need for an on-vehicle ramp to be deployed. Tactile paving should be used to assist the blind and partially sighted. The following publications provide detailed guidance on the design of accessible bus stops:

- Inclusive Mobility: A Guide to Best Practice on Access to Pedestrian and Transport Infrastructure, Department for Transport, September 2002

- Accessible Bus Stop Design Guidance, Bus Priority Team, Transport for London, January 2006

Consideration should also be given to road markings at bus stops as a means of increasing the profile of stops. One possible approach is the use of coloured surfacing in bus stop cages as seen in the example from London shown in Figure 3.13. Research has shown that highlighting the bus stop cage indicates to other road users that the area is for buses only and is a strong visual deterrent to illegal parking.

Figure 8.13: Bus Stop with Coloured Bus Cage and Footway Guidance Line

Also shown in Figure 3.13 is a yellow footway guidance line, offset 450mm from the kerb edge and 100mm in width. Guidance lines can aid drivers on their approach to stops by providing a reference point, and can also encourage pedestrians to stand away from the kerb edge. They are particularly useful at stops where limited stop services are passing without stopping.

8.7.2 Terminal and Interchange Facilities

The provision and design of passenger infrastructure at terminal points and at stops where interchange occurs between buses and other modes should be given a high priority as their appearance will be important in encouraging greater patronage. It is envisaged that there may be a bus station or major interchange within each of the major growth areas. This should be centrally located within the growth area, adjacent to a district centre and other local facilities such as supermarkets, schools, and health centres. It is likely that it will be served by a number of local routes connecting with services to the city and beyond.

Bus stations and interchanges should offer facilities to meet the needs of passengers who may be waiting for longer periods than at a regular bus stop. As such well-lit shelter, a heated waiting area, toilets and the opportunity to purchase food or drinks should be made available to enhance the travelling experience. Where appropriate the provision of shower facilities and changing rooms should be considered to enable cyclists using the site as an interchange between modes to continue their journey in suitable attire. The provision of televisions and wi-fi access at interchange sites would further enhance their attractiveness and appeal to the commuter market.

The recently completed interchange facility at Norwich Railway Station (Figure 3.14) provides a useful model for the design of future small scale interchange facilities. A post-implementation survey has confirmed that this facility is highly rated by users.

Figure 8.14: Norwich Railway Station Interchange

There should be scope to create advertising opportunities within interchange sites, either through static advertising panels or through alternative media such as television or scrolling messages, potentially as part of a real time passenger information system. Advertising revenue has the potential to contribute significantly to the ongoing maintenance cost of interchange facilities.

Suggested essential and desirable requirements for major interchanges are summarised in Table 3.4.

Table 8.4: Infrastructure Requirements for Major Interchanges

	Essential	Desirable
Enclosed waiting area	✓	
Lighting	✓	
Heating		✓
Seating	✓	
Cycle parking	✓	
Vending machine		✓
Television		✓
Ticket vending machine	✓	
Real time information	✓	
Maps and static information	✓	
Wi-fi access		✓
Toilets	✓	
Changing rooms and lockers		✓

The provision of real time information (RTI) for all public transport modes at major interchanges will assist passengers in making the appropriate travel choices, particularly where there is a choice of different levels and modes of service leaving from the same area, for example a limited stop coach service or a stopping service operated by low-floor buses. RTI also helps build confidence in public transport services and contributes to the overall impression of a modern and efficient service.

8.7.3 Bus Stop Facilities

Regular bus stops along the whole route of the new services for the major growth areas should be upgraded to reflect the overall improvement in service quality and to attract passengers living in areas local to the route corridor. Some services from the growth areas may operate on a limited stop basis but this should not preclude the upgrade of all stops along the route to maintain a consistent image throughout.

Consideration should be given to the distance between bus stops within the growth areas and along the corridors linking the growth areas with the city centre. Industry best practice recognises a target of a bus stop every 400 metres for regular stopping services.

It is likely that the services for the growth areas will be a combination of limited stop and stopping services. The optimal distance between stops will very much depend on whether the services are required to improve overall public transport links along the full length of the corridor served or if they are to supply a service primarily for travel to and from the Growth Areas.

Figures 8.15 to 8.17 show a range of examples of quality bus stop infrastructure.

The provision of RTI at bus stops is highly desirable. RTI will give accurate arrival times for all services passing the stop and is likely to contribute to passenger growth on all passing bus routes. RTI could also potentially give advice on the approach of limited stop buses which do not serve the stop in order to avoid passenger confusion.

Lighting could be provided either through existing mains supplies where available, or in the case of new stops there is potential to use solar power to provide flag lighting and on-demand LED lighting for the timetable panel.

Where possible some form of shelter should be provided at bus stops in order to provide waiting passengers with protection from the elements. However, it is appreciated that there may be practical difficulties in providing shelters in certain locations. As such an overall target should be set for the percentage of shelters along a route. Given the urban nature of the proposed route corridors, a target for at least 50% of all stops within the Thetford area to have shelters is suggested, with the remaining 50% being either major interchanges or stand-alone bus stops.

Thorough enforcement of parking and waiting restrictions at bus stops must also be considered to protect bus users from delay and inconvenience and ensure that buses can stop adjacent to the kerb. This is particularly important in residential areas where there is a greater risk of the obstruction of bus stops by parked vehicles.

Suggested essential and desirable requirements for regular bus stops in urban and rural areas are summarised in Tables 8.5 and 8.6.

Figure 8.15: Stop with Built-in Shelter, Flag and Static Information Display

Figure 8.16: Example of Bus Stop with Integrated Information Display and Electronic Variable Message Sign for Real Time Passenger Information

Figure 8.17: Example of Bus Stop with Static Information Panel

Table 8.5: Infrastructure Requirements for Regular Bus Stops – Urban Areas

	Essential	Desirable
Enclosed waiting area		✓
Covered waiting area	✓	
Lighting	✓	
Seating	✓	
Cycle parking		✓
Real time information		✓
Maps and static information	✓	

Table 8.6: Infrastructure Requirements for Regular Bus Stops – Rural Areas

	Essential	Desirable
Covered waiting area		✓
Lighting		✓
Seating		✓
Cycle parking		✓
Real time information		✓
Maps and static information	✓	

Regular bus stops along the more rural section of the routes of the new services should be upgraded to reflect the overall improvement in service standards and to attract passengers living in areas local to the route corridor. In some cases, services from the growth areas will operate on a limited stop basis but this should not preclude the upgrade of all stops along the route as a consistent look should be maintained throughout. Where possible a target of a bus stop every 400 metres should be applied in accordance with industry best practice.

The provision of RTI at these stops is highly desirable. At rural sites there is potential to utilise RTI flags as per Figure 8.18 rather than a full-sized RTI information panel.

As shown in Figure 8.19 RTI flags and bus stop lighting can be supplied with solar panels so the lack of a mains electricity supply to a site does not preclude it from being suitable for RTI.

Figure 8.18: Real Time Information Flag on King's Lynn – Hunstanton Corridor

Figure 8.19: Solar-powered Real Time Information Flag

It is essential that every stop should have a static display of timetables, route maps and location maps for every service utilising the stop, along with any relevant information such as that relating to limited stop services. All publicity provided should be branded to reflect the services at the stop. This builds upon the identity of the services and helps to create an impression of a fully integrated public transport network.

8.8 Reliability and Priority Measures

In order to provide a public transport service that offers an attractive and feasible alternative to the car, the bus must have priority over other traffic in congested areas. This enables faster journey times and improves public perception of the service amongst both users and non-users.

A package of priority measures should be put in place to ensure that the bus can reach its destination quickly and in a punctual manner. Priority measures can assist bus services in two ways; by reducing overall journey times, and by increasing reliability.

With the potential number of new journeys created by the new growth areas, it is essential to consider how priority measures can improve the public transport experience and encourage greater use of the services.

To complement a robust package of highway measures it is also important to consider other factors impacting on overall bus journey times. These include:

- **Passenger boarding and alighting** – The speed at which passengers board and take a seat can have a big impact on overall running time.

- **Ticket purchase and validation** – Ticketing transactions involving the driver can be lengthy, particularly where the passenger may be searching for cash whilst encumbered by bags or children.

- **Passenger queries** – A general lack of information about the service and ticket options available may contribute to a greater number of enquiries made to the driver.

- **Vehicle type and suitability** – The layout of a vehicle, the number of doors, and availability of low floor access can all affect passenger boarding and alighting times.

To minimise potential delays to the service the following interventions should also be considered as part of an integrated package of reliability measures:

- Development of a smartcard or mobile phone based ticketing system as outlined in Section 8.5.

- Installation of ticket vending machines at interchanges and other key bus stops used by large numbers of passengers.

- Providing comprehensive timetable and fares information at bus stops so that customers have all the relevant information for their journey before boarding the vehicle. This will be an essential part of any pre-paid ticketing system.

- RTI can also contribute to journey speed and reliability as passengers will know when their next bus is due, the number and destination and will be better prepared to board immediately.

- The type of vehicle and chosen interior layout will greatly affect boarding and alighting times. A low floor bus will make it much easier and quicker for older people, young children, disabled people and parents with pushchairs to board and find a seat. Vehicles with multiple doors are also credited with expediting the boarding and alighting process. Double deck vehicles can be slower to board as many passengers will need to climb stairs to reach their seats and descend to alight, and this can frequently block the flow of passengers through the vehicle.

- Interurban coaches will be slower to board and alight from, but this is of less importance on limited stop/express services with few intermediate stops and for which journey quality will be the key attractor.

8.9 The Internal Layout of Growth Areas

The planning of the internal layout of developments within the growth areas will provide the opportunity to create a Public Transport-Oriented Development (PTOD) and to build in public transport from day one. This increases the likelihood of generating passenger journeys, with public transport services operating to the right places at the right times with modern infrastructure and seamless transition from mode to mode.

All distributor roads within the new development should be designed to incorporate bus services. Design considerations should include suitable street width, designated areas for bus stops, turning facilities where required and no inappropriate use of traffic calming measures. There should be a bus stop within 400m of every property within the development.

Figure 8.20: Example of Conceptual PTOD Layout

Consideration should be given to the provision of bus boarders throughout the development. A bus boarder consists of a section of pavement built out in to the road to create a narrowing of the carriageway at the site of the bus stop. The key benefits of bus boarders are:

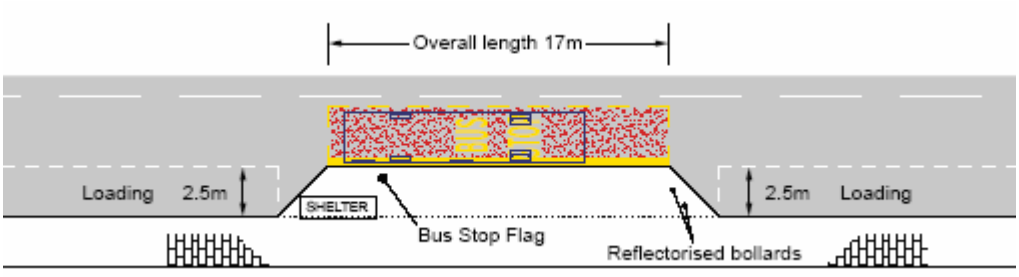
- They create a designated area of footway for passengers waiting for the bus and minimise the kerb space required for a bus to pull in and out of a stop
- They can deter illegal parking at the bus stop as the build out makes it more obvious that parking there would cause an obstruction
- They raise the prominence of bus services in the area
- They maintain the place of the bus in the traffic flow, reducing the time taken to rejoin the flow
- They allow the bus to stop parallel with the kerb, without complex manoeuvres which in turn makes it easier for older and disabled passengers, and those with children and pushchairs to board and alight from the vehicle
- By stopping in the correct place, at the correct angle boarding and alighting time can be reduced as passengers can easily step on and off the vehicle

- They can be helpful in reducing the overall speed of traffic on the road
- They are helpful in reducing the overall time spent at the bus stop.

Figure 8.21: Bus Boarder in London

Given the residential nature of large sections of the development, bus boarders offer a practical and attractive way to integrate public transport into the internal layout of the development in a way that should be consistent with road safety objectives.

Figure 8.22: Diagram of Bus Boarder



Bus priority should be incorporated into the development, with a particular emphasis placed on links to employment zones and along the entrance and exit routes to the growth area. All bus lanes would be accessible to cyclists and designated 'safer routes to school' would also feature strongly.

Public transport delivery issues are addressed further in Appendix B.

9 Mitigations

The following mitigation measures are based on the forecast flows in years 2031 for development scenarios.

9.1 Journeys to Work Out of Thetford

Key Site North has direct accesses to the A11 will make commuting trips towards Norwich and Cambridge relatively easy.

The increase of traffic on the A11 will increase the need to upgrade the section of the A11 to the south of its junction with London Road to dual carriageway. The Highways Agency has started their consultation process on this road scheme, which is expected to start on site in 2011. The forecast flows for year 2031 on the remaining of the A11 links around Thetford are less than the Congested Reference Flow (CRF) which could be interpreted that these links would cope with the increase of traffic partly caused by the growth area.

The current layout of the A11/Croxton Road grade-separated junction needs to be modified to provide longer lengths for merging traffic onto the A11 regardless of the development areas. The improvement needs to include widening the A11 under bridge in order to widen Croxton Road and to create footways (or shared use paths for pedestrians and cyclists) on either one or both sides. The remaining junctions on the A11 probably need to be upgraded.

The majority of junctions and links within Thetford would not cope with the forecast traffic in year 2031. Based on the data available and assumption made in this study, the London Road section between the Brandon Road junction and the A1066 Mundford Road roundabout (link 5) is a bottleneck link for journeys to work from Key Site North and Key Site South East. Highway mitigation measures to lessen the impact on this link are not obvious. Potentially, new eastern links are required from Key Site North and Key Site South East to lessen the impacts on the primary highway links (ie links 4, 5, 6, 7 and 8).

It was agreed that a southern by-pass option would not be considered in this study due to environmental constraints, so infrastructure investments on public transport to serve trips towards Brandon, Cambridge and particularly towards Bury St Edmunds from Key Site North and Key Site South East is absolutely essential to lessen the impacts on the London Road (link 5). Proposed mitigation measures are summarised in Table 9.1, below.

Table 9.1: Summary of Proposed Mitigation Measures for Journeys to Work Out of Thetford

Mitigations	A	B	C	D	E
Rail infrastructure improvements	✓	✓	✓	✓	✓
Bus Station improvements	✓	✓	✓	✓	✓
Upgrade the A11/ Croxton Road grade-separation junction	✓	✓	✓	✓	✓
Potentially upgrade the remaining four junctions on the A11	✓	✓	✓	✓	✓
New eastern links.	✓	✓	✓	✓ (only section A – see figure 6.5)	✓
Public transport improvement for services from Key Site North towards Bury St Edmunds	✓	✓	✓	✓	✓
Public transport improvement for services from Key Site North to Brandon and Cambridge	✓	✓	✓	✓	✓
Public transport improvement for services from Key Site South East towards Bury St Edmunds, Brandon and Cambridge	✓	✓	✓	Not applicable	✓

9.2 Journeys to Work within Thetford

Improvements of pedestrian and cycling links into and within the town centre by signalisations of junctions on the desire lines, modifications of crossings to give priority to cyclists and pedestrians over other road users and an introduction of bike hire schemes at the development sites and in the town centre.

To provide a fast and reliable service to and from the town centre, the aim should be to provide bus priority measures at all major junctions on corridors from the growth areas, particularly for access to the centre of Thetford, the bus and rail stations. These may take the form of bus lanes, bus gates, selective vehicle detection at traffic signals, peak hour parking restrictions or the banning of conflicting turning movements.

Potential problem areas on the main corridors linking the potential growth areas with the town centre include:

- **Croxton Road/Norwich Road Junction** – Priority at this junction would enable buses to gain speedier access to the centre of Thetford and the bus station.

- **A1066 Hurth Way and Norwich Road** – This section of road is already extremely busy during the peak hours and any further new developments in this sector are likely to worsen this situation. There may be scope to create an inbound bus lane by realigning the verge and providing a left turn lane to Norwich Road but this would require structural work to widen the bridge over the River Thet. The junctions along Norwich Road possibly should be converted to signalisation to allow minimise delay times for buses at junctions.

Figure 9.1: Hurth Way (A1066)

- **King Street** – Allowing bus access through this pedestrian area offers a more direct route to the bus station and town centre.

Table 9.2 below provides a summary of the initial assessments of potential mitigation measures based on forecast flows in year 2031. It should be noted that further data is required to assess these measures in more detail.

Table 9.2: Summary of Proposed Mitigation Measures for Journeys to Work within Thetford

Mitigations	A	B	C	D	E
Improvements (and new) walking and cycling facilities within the development areas	✓	✓	✓	✓	✓
Bus service improvements within the development areas	✓	✓	✓	✓	✓
Introduction of public transport corridors	✓	✓	✓	✓	✓
Improvements on pedestrian and cycling links	✓	✓	✓	✓	✓

9.3 Accident reduction

Accidents may increase in Thetford as a consequence of Development areas although it is difficult to predict how many especially when examined against the continuous road safety improvement programme of the Norfolk County Council Casualty Reduction Team. Nevertheless it is important to remember that the principle objective of SafeNET, the TRL accident predictive model, is to re-allocate traffic to suitable routes. This further underpins the Department for Transport recommendation to follow the approach outlined in the IHT Urban Safety Management Guidelines which, among a list of key aims and objectives, highlights the following to be done:

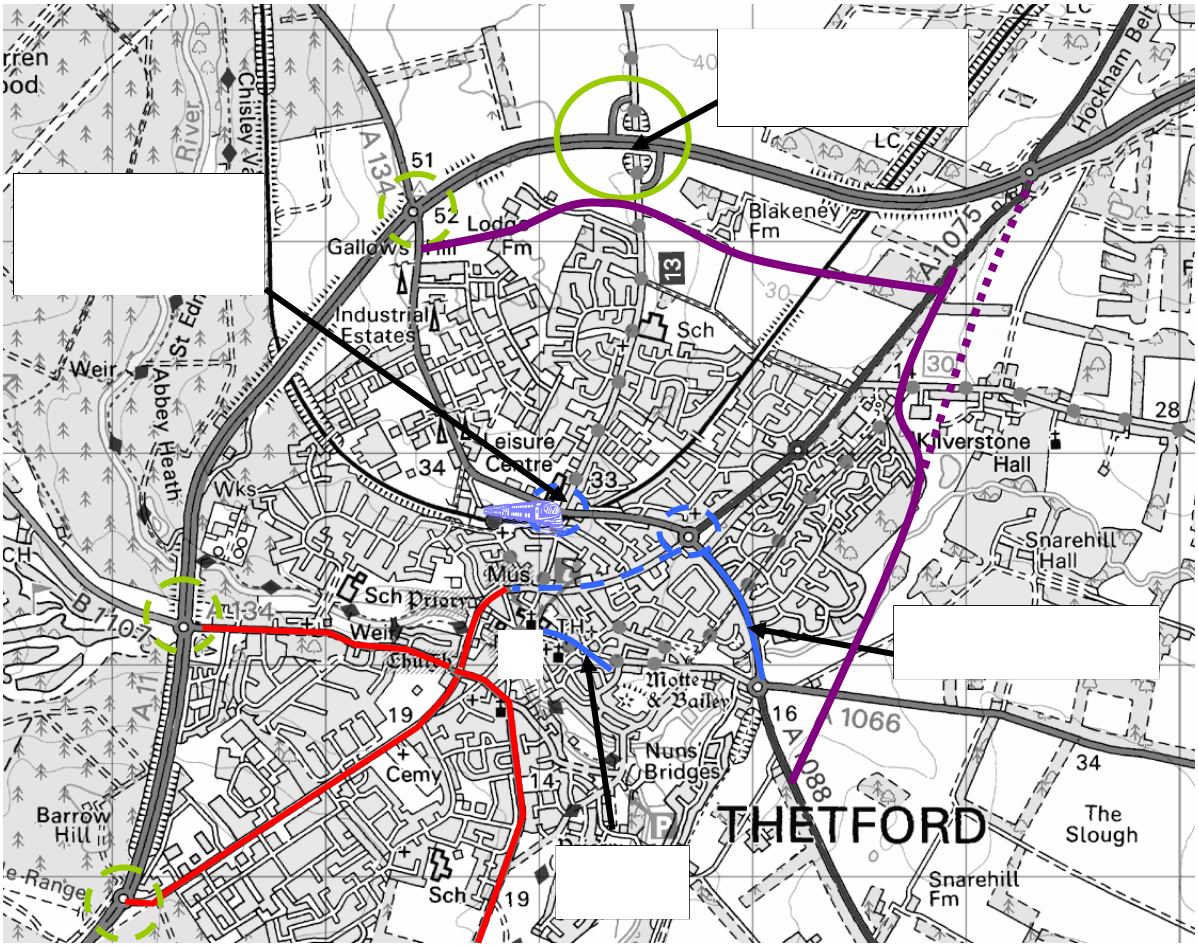
- Review the safety management strategy in view of changing conditions
- Ensure traffic moves on the right roads
- Consider the needs of all kinds of road user but especially the most vulnerable

However to mitigate the effect of Development areas on the transport infrastructure it will be necessary to review the existing Thetford safety strategy in light of the principles of Urban Safety Management.

9.4 Summary

Figure 9.1 below summarises mitigation measures that would be required to reduce the traffic impact of the development areas on the road network within and around Thetford.

Figure 9.1: Locations of Mitigation Measures



KEYS:

- Bus priority corridor
- Junction improvements for pedestrians and buses (potentially by signalisations)
- Road link improvements
- Upgrades of the A11 junction
- Potential upgrades of the A11 junctions
- Potential new eastern link roads

10 Conclusions and Recommendations

10.1 Conclusions

Public transport improvements for both railways and particularly buses are essential as the current road network within Thetford would not cope with the increase of the traffic from the development areas, which is nearly double the existing journeys to work within and outside Thetford.

The A11 links around Thetford are predicted to be able to cope with the additional traffic from the development areas, assuming the A11 Fiveways dualling scheme progresses. All of the junctions on the A11 potentially need to be upgraded. The A11/Croxton Road grade-separated junction requires to be upgraded with or without the development areas.

All five scenarios require mitigation measures to the highway links and junctions within Thetford.

Development scenario D would have the least impact on the highway links and junctions on the current road network around and within Thetford as it does not develop Key Site South East, and therefore is the preferred scenario to minimise transport infrastructure investment. However, it is understood that for other land use reasons, there could be an aspiration to develop Key Site South East.

Out of the remaining scenarios up to 2021 scenario A would balance the traffic impact from the development areas and therefore have less impact, based upon the data available and assumptions made during the highway assessments. It is stressed that further data and discussions with the Highways Agency and the local highways authority are required to agree key assumptions before committing to mitigation measures.

If Key Site South East is developed, a new bridge over the Thet is required to accommodate the new eastern links (as shown in figure 6.5). Widening the existing bridge on the A1066 Hurth Way is also required to create a quality public transport corridor along this road. The London Road is a critical link for traffic within Thetford and for journeys to work towards Bury St Edmunds, Brandon and Cambridge from Key Site South East. An option of creating a southern bypass has not been considered for environmental reasons, as the result it is essential to improve public transport services to serve the areas along the routes to Bury St Edmunds, Brandon and Cambridge to relieve traffic from the London Road. If Key Site South East is nit developed then a new bridge over the Thet would not be required.

10.2 Recommendations for Future Study/Next Steps

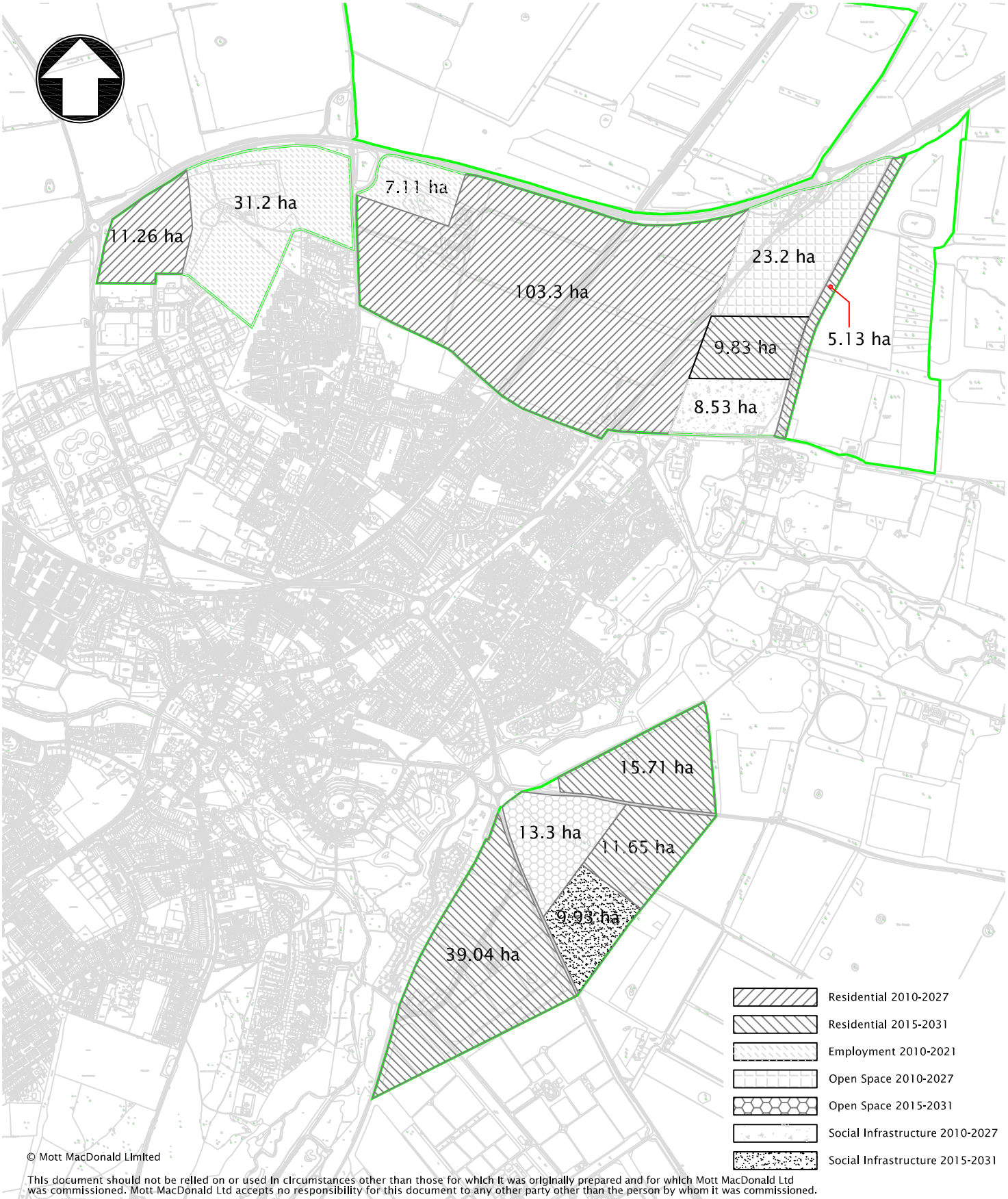
It is recommended that the following tasks be undertaken to allow further works on the Thetford Master Plan:

- Arrange a meeting with the Highways Agency and Norfolk County Council to agree traffic generation and other key assumptions made in this study as soon as possible. This also an opportunity to discuss with the Highways Agency whether rationalising the number of junctions with the A11 could be a better solution as opposed to upgrading all the five junctions.
- Organise junction surveys based on the results from the above meeting.

- Undertake junction modelling to assess current junction capacities and potential improvements.
- Undertake mitigation optioneering.

Appendix A Land Allocation

5 pages A4



Title

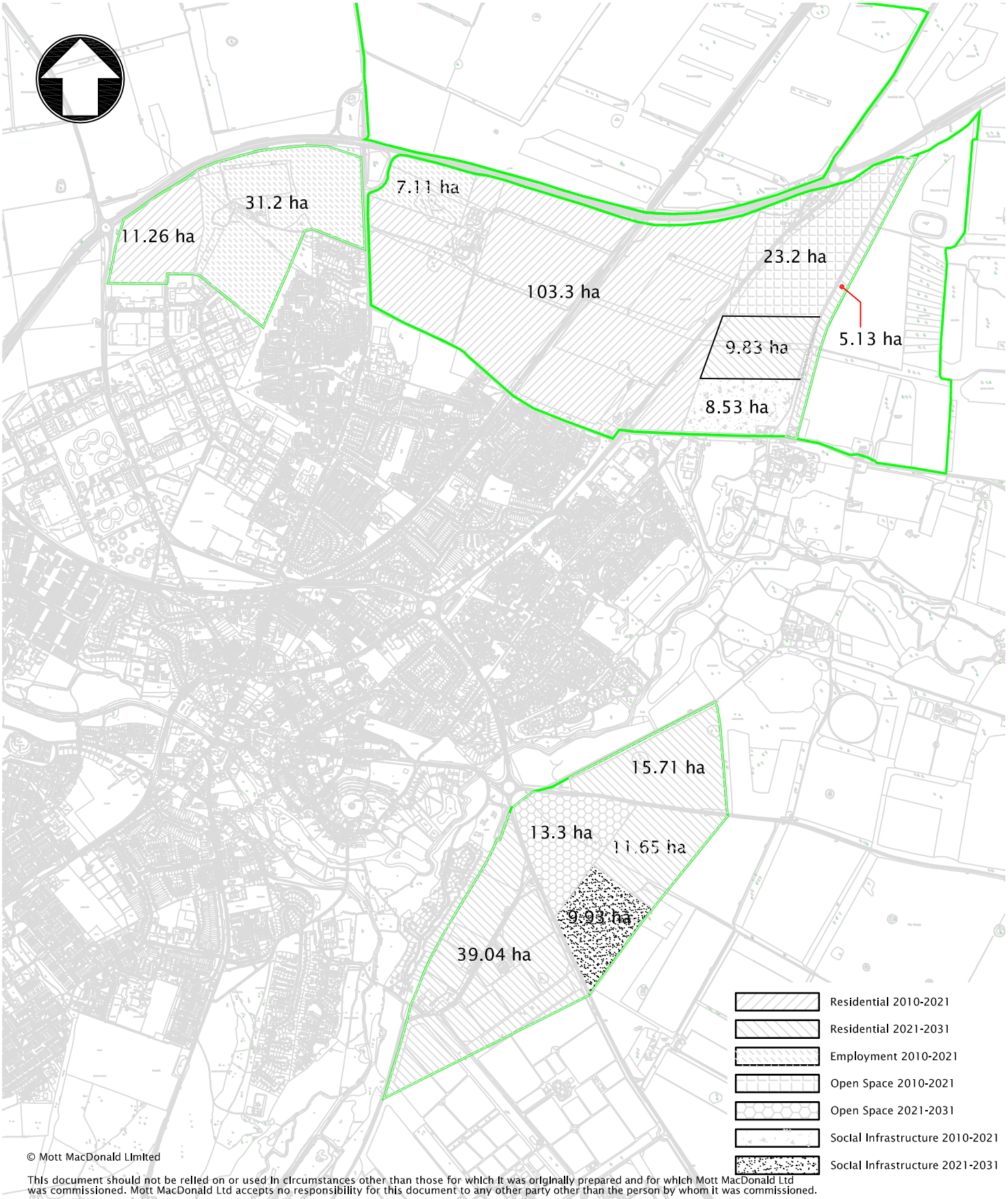
Thetford Transport Study
Land Allocations
Development Scenario A

Mott MacDonald

St Anne House
Wellesley Road
Croydon CR9 2UL
United Kingdom

Tel +44 (0)20 8774 2000
Fax +44 (0)20 8681 5706
Web www.mottmac.com

Date	Drawn	Checked	Approved	Scale at A4	Drawing No.	Rev	Status
15.07.08	SW	GS	CNJ	1:20000	233902AY01/001	P1	PRE



Title

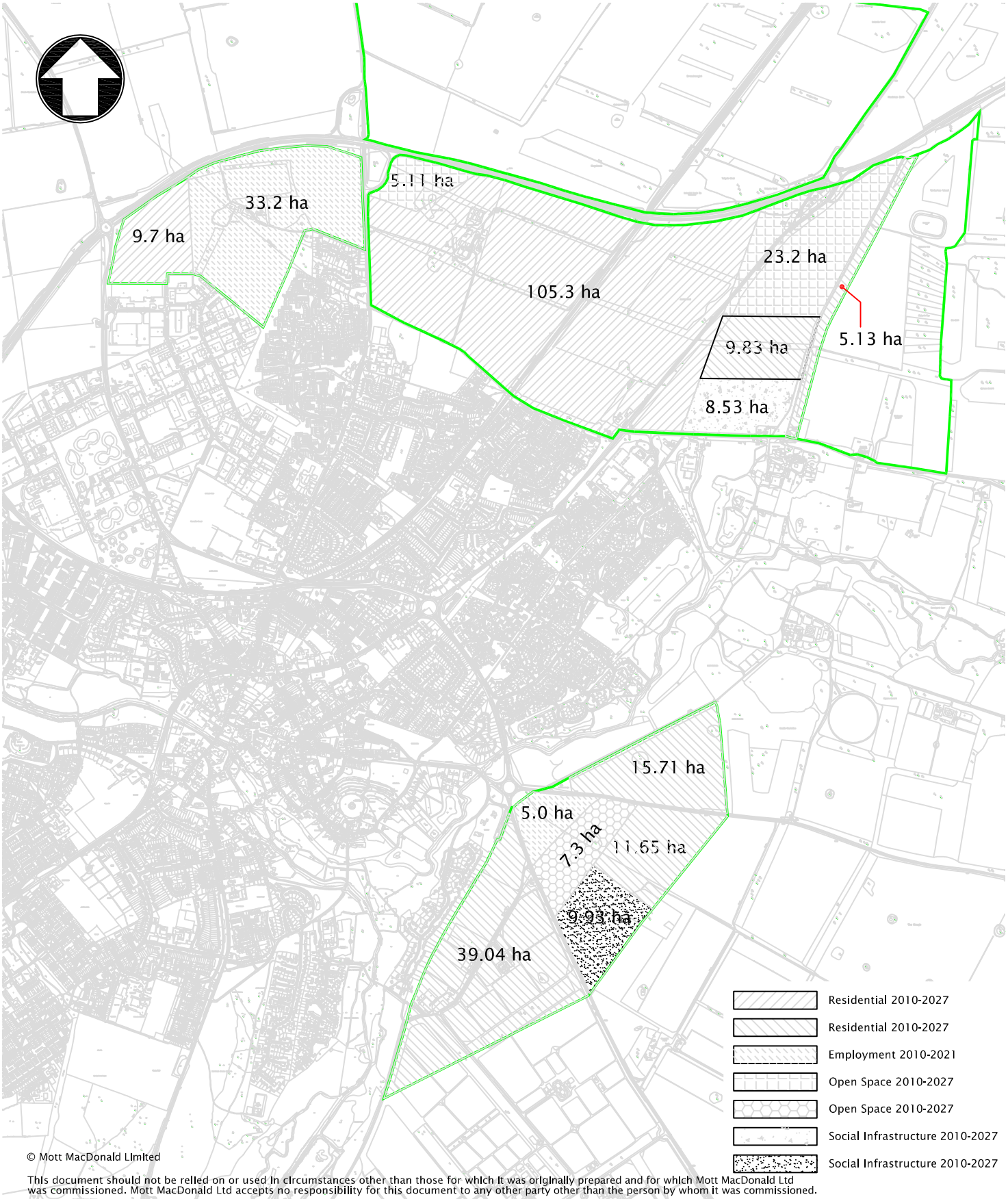
Thetford Transport Study
Land Allocations
Development Scenario B

Mott MacDonald

St Anne House
Wellesley Road
Croydon CR9 2UL
United Kingdom

Tel +44 (0)20 8774 2000
Fax +44 (0)20 8681 5706
Web www.mottmac.com

Date	Drawn	Checked	Approved	Scale at A4	Drawing No.	Rev	Status
15.07.08	SW	GS	CNJ	1:20000	233902AY01/002	P1	PRE



Title

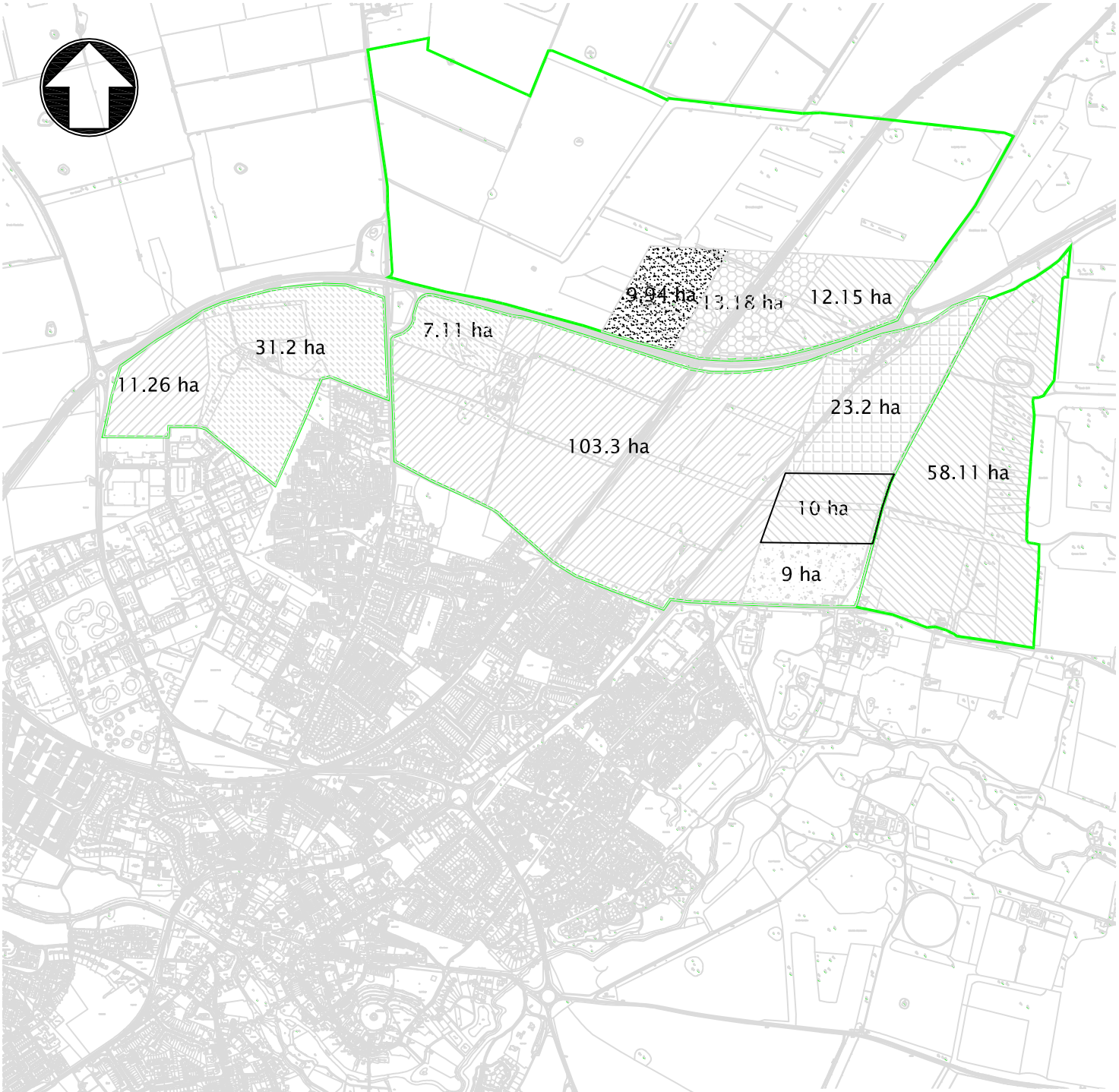
Thetford Transport Study
Land Allocations
Development Scenario C

Mott MacDonald

St Anne House
Wellesley Road
Croydon CR9 2UL
United Kingdom

Tel +44 (0)20 8774 2000
Fax +44 (0)20 8681 5706
Web www.mottmac.com

Date	Drawn	Checked	Approved	Scale at A4	Drawing No.	Rev	Status
15.07.08	SW	GS	CNJ	1:20000	233902AY01/003	P1	PRE



Title

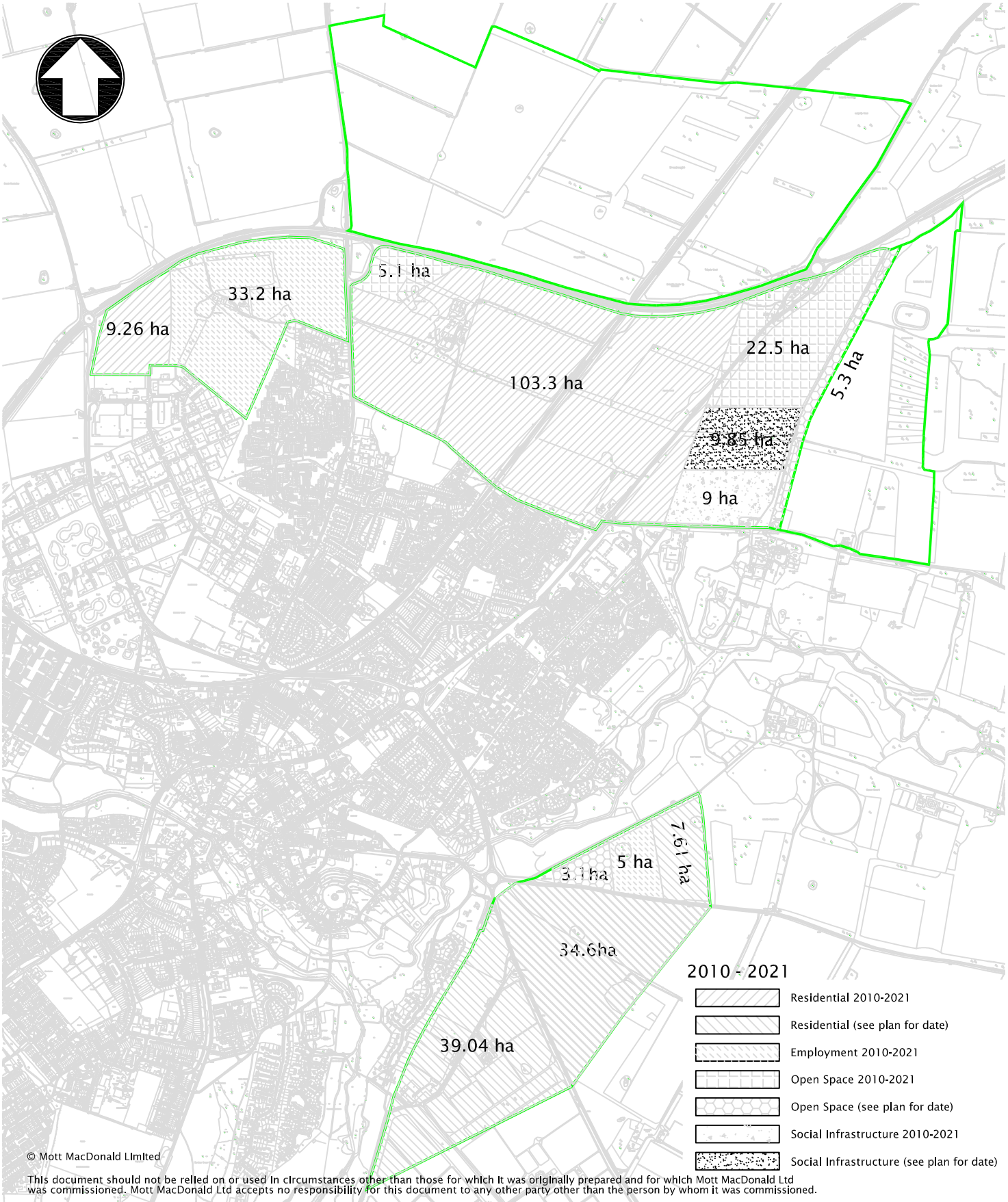
Thetford Transport Study
Land Allocations
Development Scenario D

Mott MacDonald

St Anne House
Wellesley Road
Croydon CR9 2UL
United Kingdom

Tel +44 (0)20 8774 2000
Fax +44 (0)20 8681 5706
Web www.mottmac.com

Date	Drawn	Checked	Approved	Scale at A4	Drawing No.	Rev	Status
15.07.08	SW	GS	CNJ	1:20000	233902AY01/004	P1	PRE



Title

Thetford Transport Study
Land Allocations
Development Scenario E

Mott MacDonald

Tel +44 (0)20 8774 2000
Fax +44 (0)20 8681 5706
Web www.mottmac.com

St Anne House
Wellesley Road
Croydon CR9 2UL
United Kingdom

Date	Drawn	Checked	Approved	Scale at A4	Drawing No.	Rev	Status
15.07.08	SW	GS	CNJ	1:20000	233902AY01/005	P1	PRE

Appendix B Public Transport Delivery Issues

The starting point for the procurement and delivery of public transport for the major growth locations should be a long term masterplan for the phased development of the public transport network to serve the growth areas. The network must evolve to reflect the phasing of development and changing needs of residents and businesses.

Within this masterplan there should be as much clarity as possible regarding internal public transport routes within growth areas in order to support the principle of Public Transport Orientated Development.

The high degree of flexibility offered by a bus-based system makes this mode well suited to progressive route extensions to keep pace with phased development, and is a significant benefit compared to a light rail system in these circumstances.

In order to achieve the public transport mode share targets for the growth areas it will be essential to have a high quality public transport system in place prior to the occupation of the first new houses on each development.

Implementing public transport services at this stage of development will require some form of revenue subsidy at the commencement of services but will help to bring forward the point at which services can be sustained commercially.

Development of services in this way is likely to involve a mix of public and private sector funding and require a partnership approach involving developers and public transport operators.

B.1 Split of Responsibilities

We have suggested below how each of the parties involved could potentially contribute to such a partnership but, as the case study presented in section 5.5 illustrates, within this approach there are a number of alternative delivery models that may be appropriate to reflect the specific characteristics of individual developments.

B.1.1 Developer to provide:

- All public transport infrastructure within the development to common design and quality standards that have been set out in the Local Development Framework
- A contribution to bus priority measures and passenger infrastructure on corridors linking the growth areas with the city centre and strategic employment sites
- Revenue funding for the operation of an attractive level of service from the first occupation of the new development until the point at which services become commercially sustainable
- Revenue funding or a commuted sum for the maintenance of the public transport infrastructure within the development eg bus shelters, passenger information systems
- Assistance with the marketing and promotion of public transport services to residents and businesses occupying the development

B.1.2 Local Transport Authority to:

- Set design and quality standards for developer-provided internal public transport infrastructure
- Design and deliver the external public transport infrastructure on corridors linking the growth areas with the city centre and strategic employment sites to an agreed programme
- Set the specification for the new services
- Develop a performance incentive contract regime for the new services
- Consider use of the 'de-minimis' provisions of the Transport Act 1985 to negotiate incremental extension / enhancement of existing services where beneficial
- If operators are reluctant to invest in vehicles of the required standard, consider use of developer or growth infrastructure funding to purchase vehicles for lease to operators
- Adopt and maintain the public transport infrastructure within the development when developer responsibility for maintenance ceases

B.1.3 Local Planning Authority to:

- Ensure that the principle of Public Transport Orientated Development is enshrined within the Local Development Framework and adhered to at all stages of the planning process
- Negotiate planning agreements with developers to deliver the necessary internal public transport infrastructure, contribute to external infrastructure improvements and support the operation of services until an agreed level of revenue/patronage is reached

Past experience with Section 106 agreements for public transport provision to serve major developments in the Norwich area has demonstrated that such agreements need to anticipate a range of possible scenarios for the way in which operators respond to the market opportunity presented by the development and incorporate an element of flexibility in the way in which developer contributions for public transport may be spent.

Some developments have attracted commercial bus services at a much earlier stage than anticipated, but it has not been possible to divert developer funding intended for the support of services to deliver public transport infrastructure improvements within the development. In other cases the slow pace at which the early phases of development have progressed has meant that services supported by developer funding for a fixed period of five years have not achieved commercial viability within this period, leaving the local authority to support the service or allow it to cease.

We would also recommend that planning agreements with developers encourage the developer to play an active role in the development of public transport services and avoid a situation where a developer can simply hand over a financial contribution and then walk away from any further involvement.

A recent innovation in such agreements is to leave the revenue risk for the public transport service with the developer so that the financial impact on public transport patronage and revenue of delays in the construction and/or occupation of the development is not borne by the operator or local authority, and the developer has a real incentive to promote public transport use.

B.1.4 Operators to provide:

- The management and operation of services in accordance with a performance incentive contract regime
- Investment in new vehicles of the required standard subject to the existence of a robust business case
- The depot and maintenance infrastructure for the additional vehicles required to serve the growth areas

There may be issues with developing a robust business case for operators to invest in new vehicles for new services where the level of patronage is unknown and there is uncertainty regarding the timing and progress of major developments.

Early operator involvement in the planning of the public transport network to serve the growth areas will help to mitigate these issues.

Cost-based contracts providing operators with a guaranteed revenue stream can underpin an initial investment in vehicles, but do not give the operator any incentive to promote the service.

Responsibility for marketing and promotion of the services should therefore be aligned with where the revenue risk lies.

B.2 Delivery Models

The potential delivery models for the provision of high quality public transport connections for the growth areas are briefly outlined below.

B.2.1 Quality Partnership Agreements

The concept of a voluntary quality partnership as a means of delivering improvements to local bus services is well established and there are hundreds of such agreements in place across the UK. The term is normally used to cover any partnership agreement entered into voluntarily by one or more local authorities and one or more bus operators, but may also involve other relevant parties such as developers.

A voluntary quality partnership agreement may cover any matters on which the parties involved can reach agreement and have the ability to deliver. Where appropriate, such agreements may take the form of a legally binding document executed by all parties. This would be an appropriate approach where a quality partnership agreement is used as a mechanism to deliver commitments made in a planning agreement between a local authority and a developer.

B.2.2 Statutory Quality Partnership Schemes

Statutory Quality Partnership Schemes were introduced by the Transport Act 2000 as an alternative to voluntary quality partnership agreements as a delivery model for improvements to local bus services, but have not yet been widely used.

Unlike voluntary quality partnership agreements, a Quality Partnership Scheme (QPS) is 'made' by the local transport authority after consultation with operators. The essential feature of a QPS is that the local authority provides particular facilities and sets the standard of services to be provided by bus operators as a condition of using those facilities. Once set, compliance with these standards can be enforced through the Traffic Commissioner.

Amendments proposed in the Local Transport Bill will provide additional flexibility in the implementation of a QPS to allow improvements to be phased in over a period of time and will also permit the scope of a QPS to include the specification of the timing and frequency of services and maximum fares.

With the benefit of the changes included in the Local Transport Bill a QPS will offer a more practical framework for providing access to new public transport infrastructure and is therefore worth consideration as a delivery model for public transport connections for the major growth areas.

A QPS may be preferable to a voluntary agreement where there is a risk of service quality being undermined by low quality competition from an operator unwilling to participate in a voluntary agreement. A QPS could also potentially be used as a mechanism to lever a higher quality of service for the major growth areas than it would be possible to obtain through a voluntary agreement. However, there are significant risks in the adoption of such a strategy, which would be contrary to a true partnership approach and may have unintended consequences elsewhere on the public transport network.

A developer cannot be a party to a QPS, but a QPS could be made to deliver commitments made in a planning agreement between a local authority and a developer.

B.2.3 Quality Contracts Schemes

The concept of Quality Contracts Schemes was introduced by the Transport Act 2000 as a further alternative delivery model for improvements to local bus services, but no such schemes have been implemented, primarily due to the difficulty in satisfying the legal test for statutory approval of a scheme.

A Quality Contracts Scheme has the effect of suspending the deregulated market for the provision of bus services in the area concerned and enables the local transport authority to take total control of the specification of the public transport network in that area, including routes, timetables, vehicles, fares and ticketing. A QCS would therefore enable the local authority to have total control of the specification of services for the growth areas and to ensure services develop in full accordance with a long term masterplan. A QCS would also avoid the support of services through planning agreements being undermined by unexpected commercial registrations.

However, even with the changes proposed in the Local Transport Bill a QCS will not be an easy or cheap option for a local authority to take, and should generally only be considered as a fall back option in circumstances where the local authority cannot achieve its aspirations for public transport to serve the growth areas through some form of partnership approach and where there would be clear benefits to the public which would outweigh any adverse effect on operators.

A QCS for new services to a development area does at least avoid the issue of confiscation of existing business and is thus less problematic than a scheme including existing services.

As with a QPS, a developer cannot be a party to a QCS, but a QCS could be made to deliver commitments made in a planning agreement between a local authority and a developer.

B.2.4 PFI

It is conceivable that it might be possible to develop some form of PFI business model for the delivery of both public transport services for the growth areas and some of the supporting infrastructure. Some local authorities have briefly considered this approach, but none have attempted to follow it through.

B.3 Delivery Case Study – Kent Thameside Fastrack

Centred upon Dartford and Gravesend, Kent Thameside is one of the main growth areas in the Thames Gateway, with 50 000 new jobs and 30 000 new homes planned over the next 20-30 years. The area also includes the Bluewater shopping complex and the new Ebbsfleet International rail station.

The core principles of the development vision for Kent Thameside include:

- 'Public Transport Orientated Development' – encouraging higher density development along public transport corridors thus enabling more people to live close to good public transport links

- Timing of infrastructure provision – to have attractive public transport in place before development is occupied in order to increase the probability that those occupying the development will become regular public transport users.

In accordance with these principles the Fastrack BRT system has been promoted by Kent County Council and the Kent Thameside Delivery Board as the centrepiece of an integrated transport network connecting the major development sites. A high quality bus-based solution was adopted both for engineering reasons and because of the flexibility it offers to develop the network organically over an extended period.

The Fastrack network will eventually cover some 40km, with significant sections of segregated unguided busway. Plans envisage up to 50% of the network running on segregated alignments with a further 25% using conventional bus lanes.

Two Fastrack routes are now in operation, the first of which (Route B) has been wholly publicly funded, with the second (Route A) wholly funded by a developer.

Route B

Route B, opened in March 2006, operates between Dartford and Gravesend via the Bluewater shopping complex. Of the 15km route some 7.5km is on segregated alignments, including 5.5km of almost continuous busways and priority measures between Dartford and Bluewater.

Route B is operated by Arriva under an innovative 'de-minimis' contract with Kent County Council. The 14 new buses used on the route are owned by the County Council and the provision of the vehicles to Arriva forms part of the service subsidy. The operating contract also includes a series of performance indicators based on those developed by Transport for London.

The Route B vehicles are conventional Volvo/Wrightbus 12m low floor single deck buses, but with a high quality specification and distinctive branding.

Route B has been an undisputed success, with patronage in the first year of 2.75 million against a predicted level of 1.1 million, and solid evidence of modal shift.

Route A

Route A, launched in June 2007, operates between Dartford Station and Bluewater via a major new

residential and commercial development immediately to the west of the Dartford Crossing known as 'The Bridge', Crossways Business Park and Greenhithe.

The section of route within The Bridge development is a dedicated busway, accessed at the western end via a new private bridge over the M25 motorway.

In contrast to Route B, Route A is wholly funded by the developer of The Bridge, Prologis. A Section 106 planning agreement requires Prologis to provide both infrastructure and revenue funding for a Fastrack service for a period of 17 years. Operation of Route A is contracted by Prologis to Arriva, using 12 low floor single deck buses with a similar specification to that for Route B. Under this contract the revenue risk lies with Prologis.

The busway through The Bridge is of conventional highway construction, but is a private road owned and maintained by Prologis, with access physically restricted by barrier controls at each end of the busway. The barriers are activated by tags or transponders fitted to the Fastrack fleet.

The masterplan for delivery of the full Fastrack network called for a phased approach, with the project kick started with public sector funding, but future phases wholly funded by the private sector.

The intention is therefore to follow the 'Route A' model for the delivery of the planned future expansion of the Fastrack network. Current plans include a further section of gated private busway through the Eastern Quarry development adjacent to Bluewater.

In the longer term it is envisaged that a franchise will be awarded to a private sector operator for the operation and maintenance of the entire Fastrack network once this is nearing completion and

patronage levels have been demonstrated. This would involve an application for a statutory Quality Contracts Scheme or the use of alternative regulatory powers that may become available once the current Local Transport Bill is enacted.

Appendix C Samples of Base Flows

3 pages A4

Key

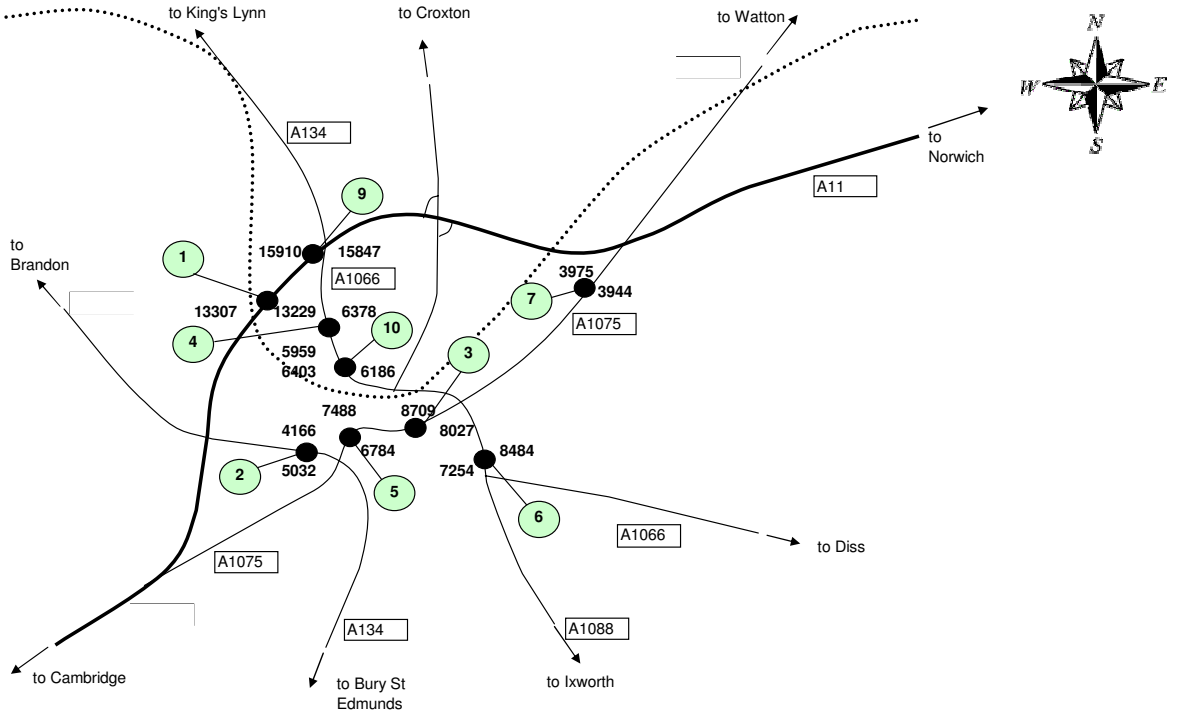
Number	Description	Year	Month	SI	E	M
1	A11 Thetford Bypass from A134 Mundford Road to B1107 Brandon Road	2006	May	1.10	1.15	352
2	A134 Brandon Road from U31214 Canons Close to C587 London Road	2006	October	1.00	1.15	358
3	C587 Norwich Road from U30451 Croxton Road to U30433 Earls Street	2006	June	1.00	1.15	351
4	A1066 Mundford Road from U30211 Telford Way to U30210 Station Lane	2006	July	1.00	1.15	349
5	C587 London Road from Bury Road to U30202 Minstergate Street	2006	July	1.00	1.15	349
6	A1066 Hurth Way from U31344 Rosecroft Way to A1088 Thetford Way	2006	July	1.00	1.15	349
7	A1075 Norwich Road from A11 Thetford Bypass to C148 Kilverstone Road	2006	July	1.00	1.15	349
8	A11 Thetford Bypass	2006	***	***	***	***
9	A11 Thetford	2006	***	***	***	***
10	A1066 Mundford Road Thetford	2006	***	***	***	***
11	*A1066 Mundford Road / C107 Croxton Road junction*	*2007*	February	1.00	1.15	366
12	*C587 Norwich Road from U30451 Croxton Road to U30433 Earls Street*	*2007*	June	1.00	1.15	351

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

1	Northbound	11999	1.15	352	554	13307
	Southbound	11928	1.15	352	551	13229
2	Eastbound	3693	1.15	358	174	4166
	Westbound	4461	1.15	358	210	5032
3	Eastbound	7875	1.15	351	363	8709
	Westbound	7258	1.15	351	334	8027
4	Northbound	5419	1.15	349	248	5959
	Southbound	5800	1.15	349	266	6378
5	Northbound	6810	1.15	349	312	7488
	Southbound	6170	1.15	349	283	6784
6	Northbound	6597	1.15	349	302	7254
	Southbound	7716	1.15	349	354	8484
7	Northbound	3615	1.15	349	166	3975
	Southbound	3587	1.15	349	164	3944
8	Northbound					12417
	Southbound					12313
9	Northbound					*15910*
	Southbound					*15847*
10	Eastbound					*6186*
	Westbound					*6403*

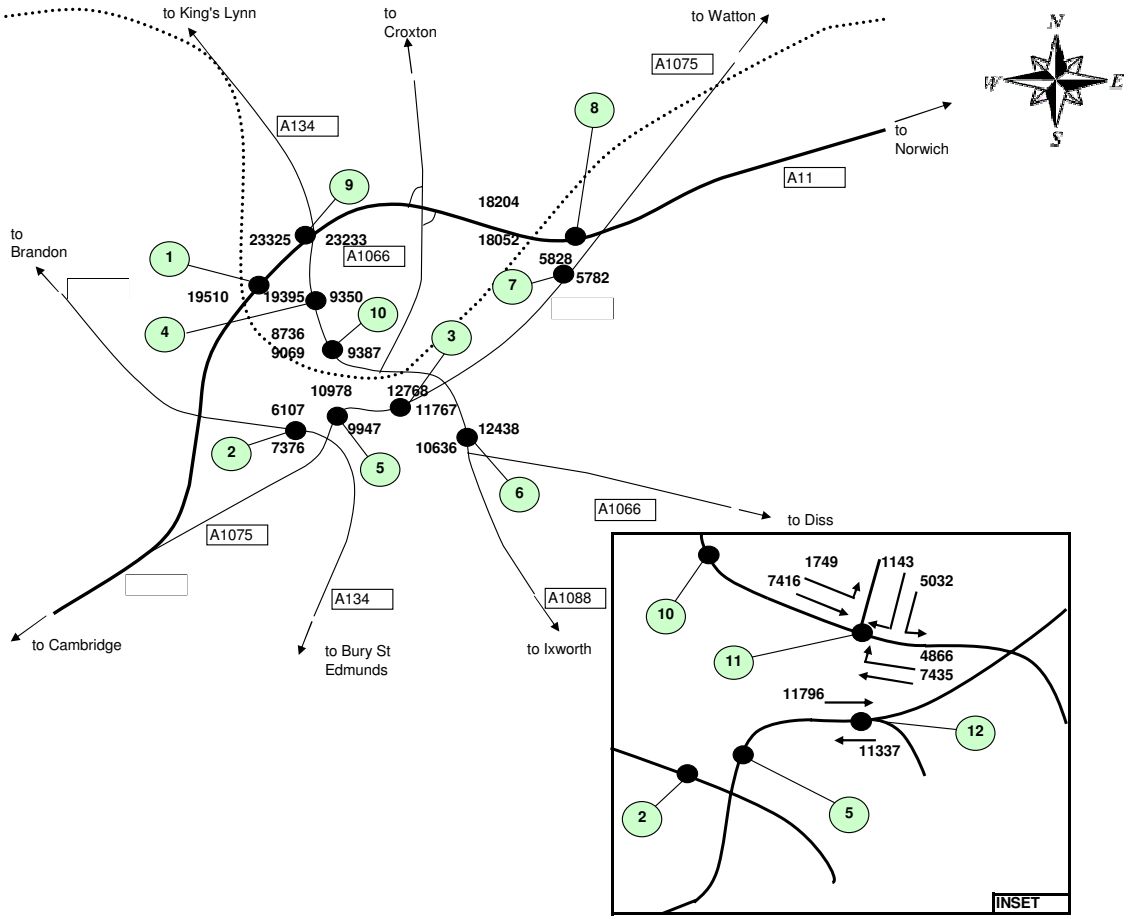
E = 1.15
M = 352 May
358 October
351 June
349 July
366 February

** Average of March, June, September and December 2006*



		2007 AADT	High Factor	2021 AADT High
1	Northbound	13520	1.443	19510
	Southbound	13440	1.443	19395
2	Eastbound	4232	1.443	6107
	Westbound	5112	1.443	7376
3	Eastbound	8848	1.443	12768
	Westbound	8155	1.443	11767
4	Northbound	6054	1.443	8736
	Southbound	6480	1.443	9350
5	Northbound	7608	1.443	10978
	Southbound	6893	1.443	9947
6	Northbound	7371	1.443	10636
	Southbound	8620	1.443	12438
7	Northbound	4039	1.443	5828
	Southbound	4007	1.443	5782
8	Northbound	12616	1.443	18204
	Southbound	12510	1.443	18052
9	Northbound	16165	1.443	23325
	Southbound	16101	1.443	23233
10	Eastbound	6285	1.443	9069
	Westbound	6505	1.443	9387
11	South- to Westbound	792	1.443	1143
	South- to Eastbound	3487	1.443	5032
	West- to Northbound	3372	1.443	4866
	Westbound	5152	1.443	7435
	Eastbound	5140	1.443	7416
	East- to Northbound	1212	1.443	1749
12	Eastbound	8175	1.443	11796
	Westbound	7856	1.443	11337

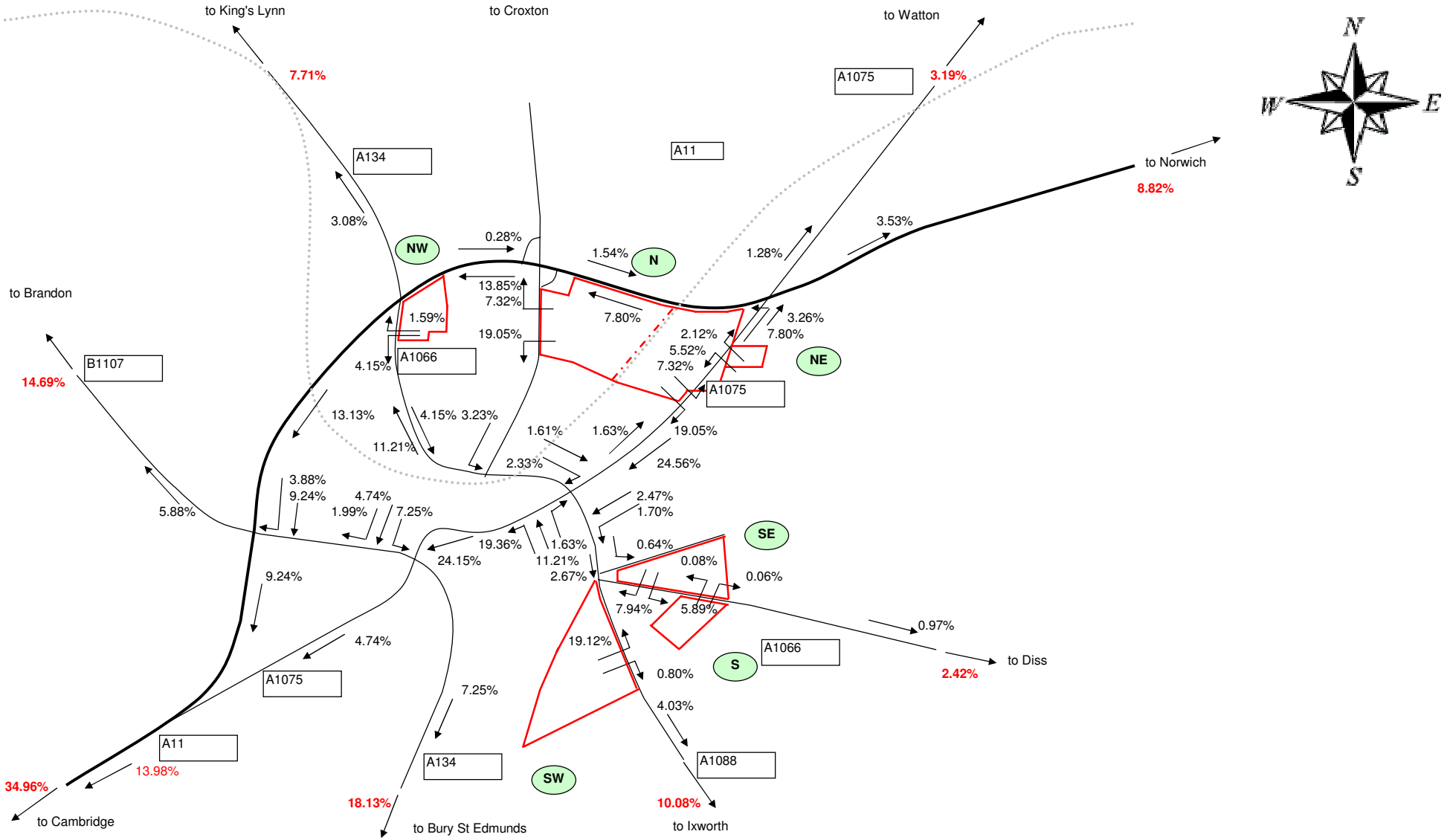
2007-2031 High Growth Factor 1.443



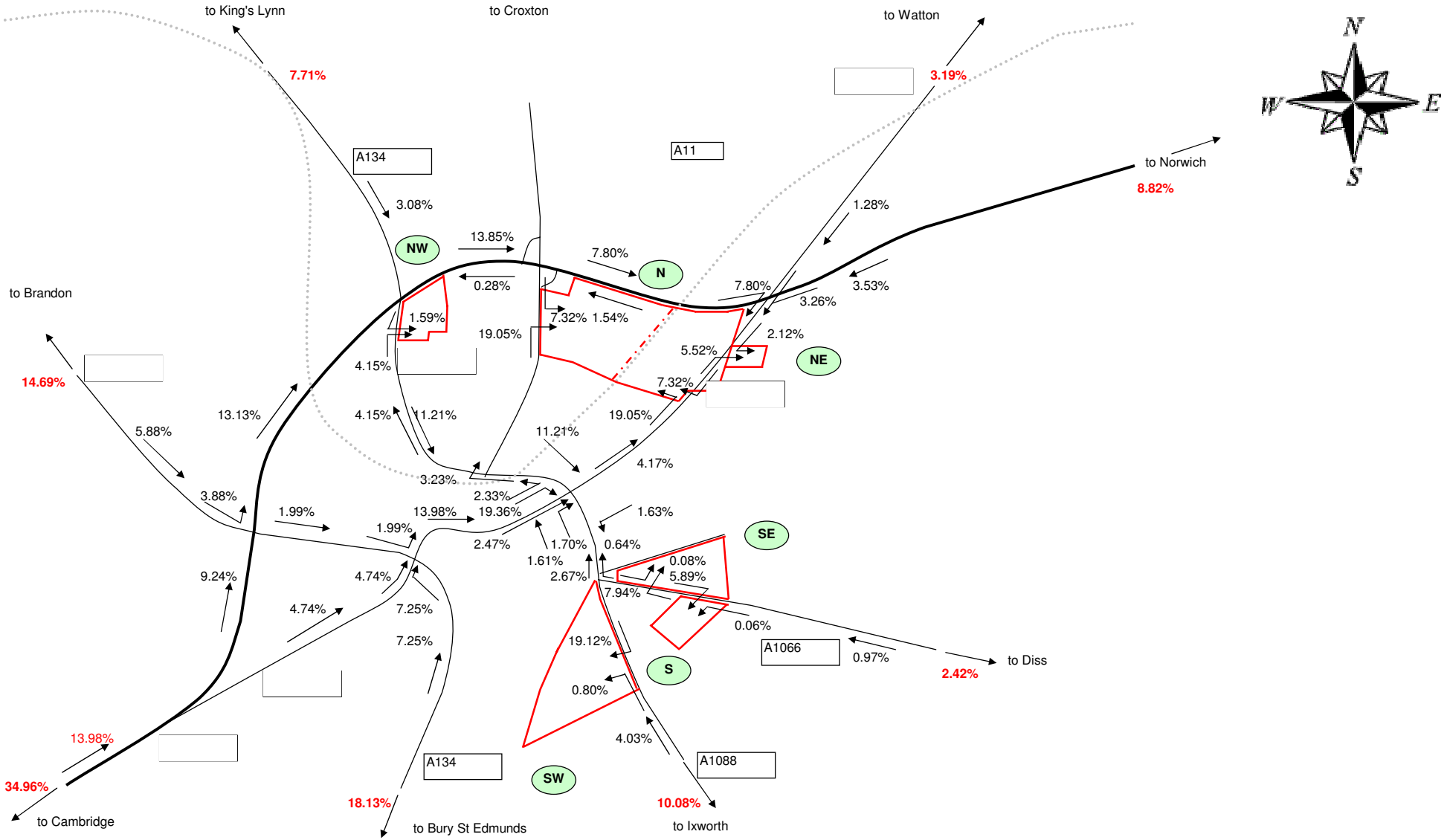
Appendix D Samples of Residential Generation Flows

3 pages A4

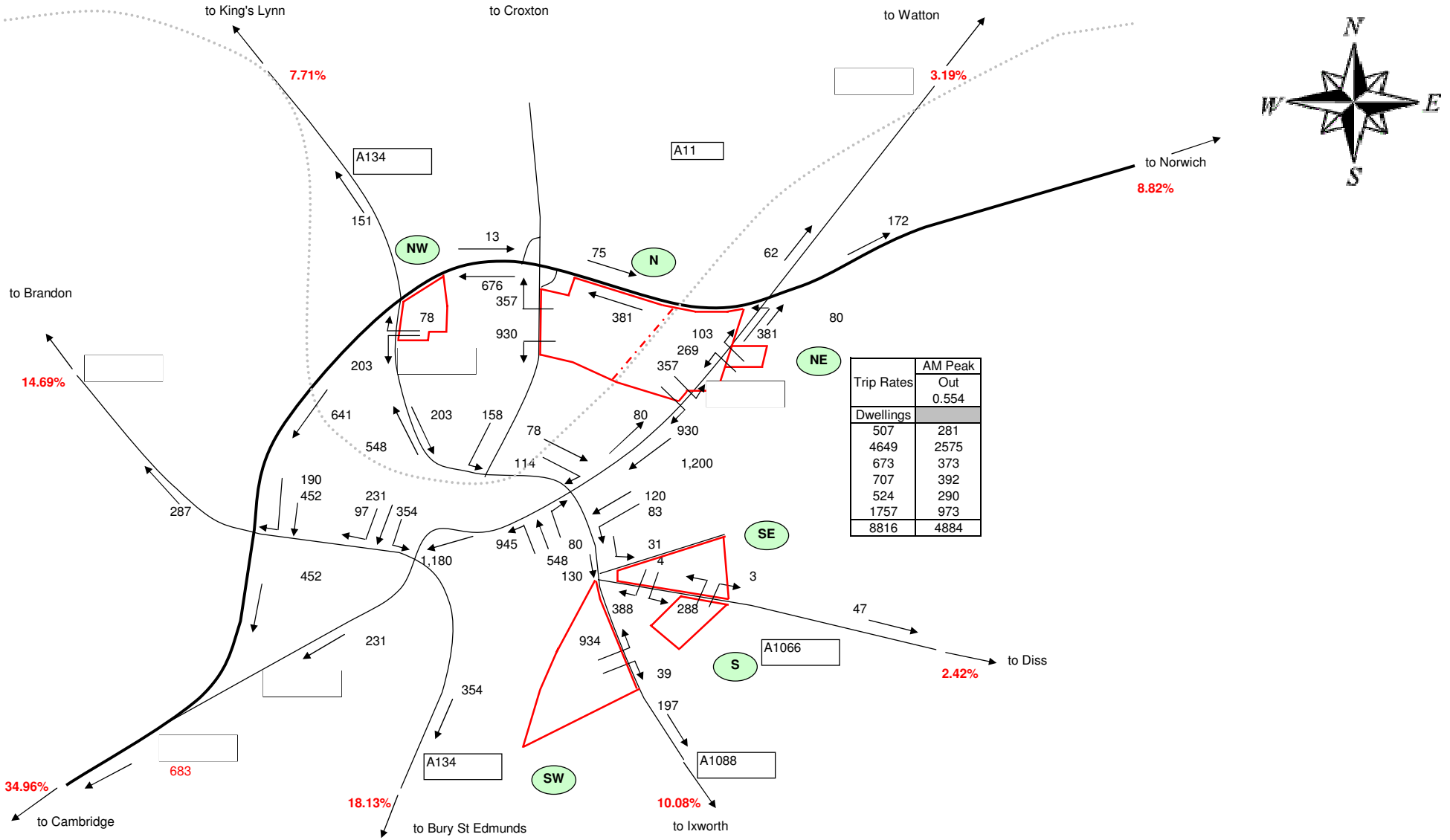
Trip Distribution ALL 2031 Out



Trip Distribution ALL 2031 In



Trip Gen AM Peak 2031 Out

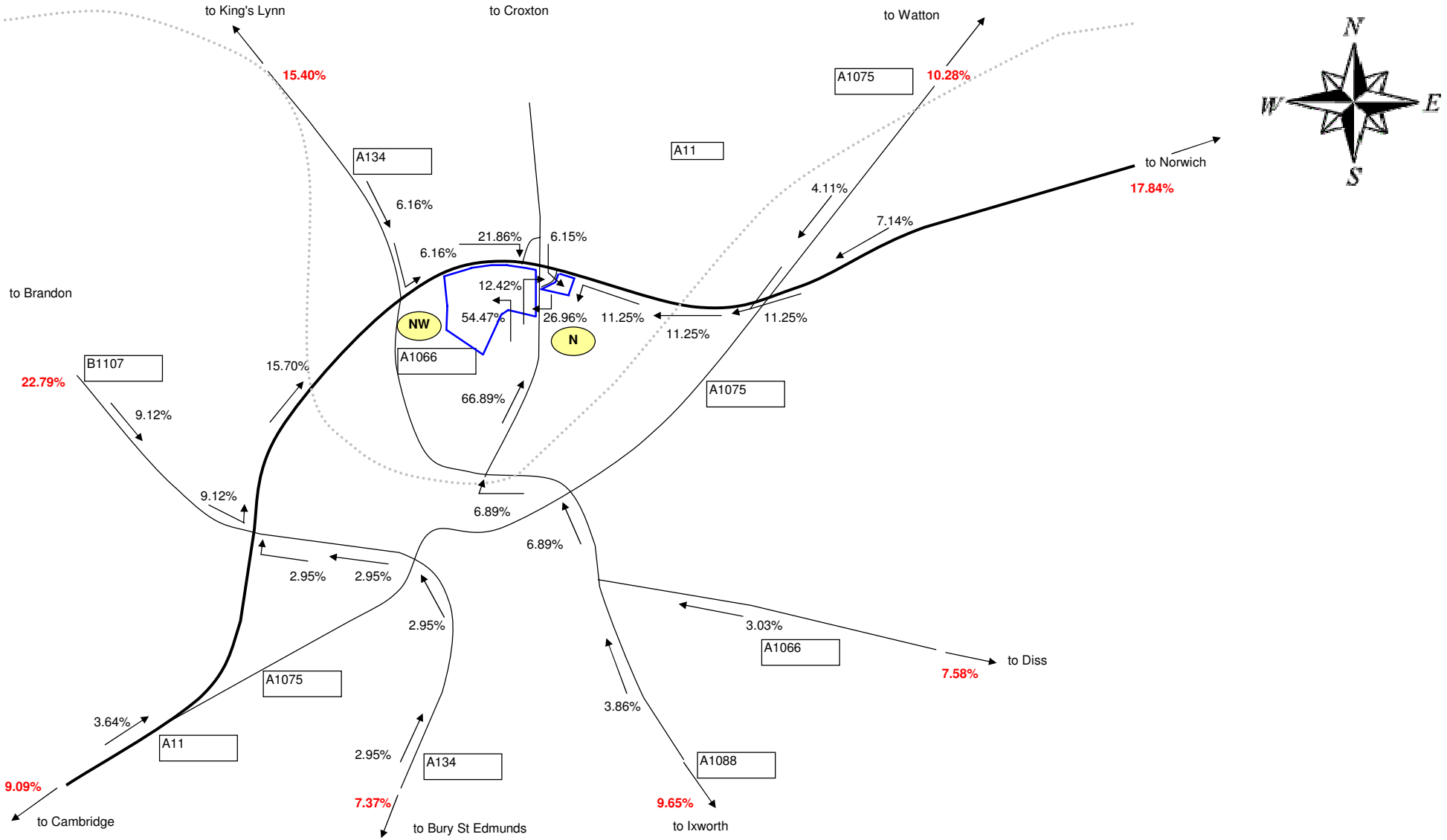


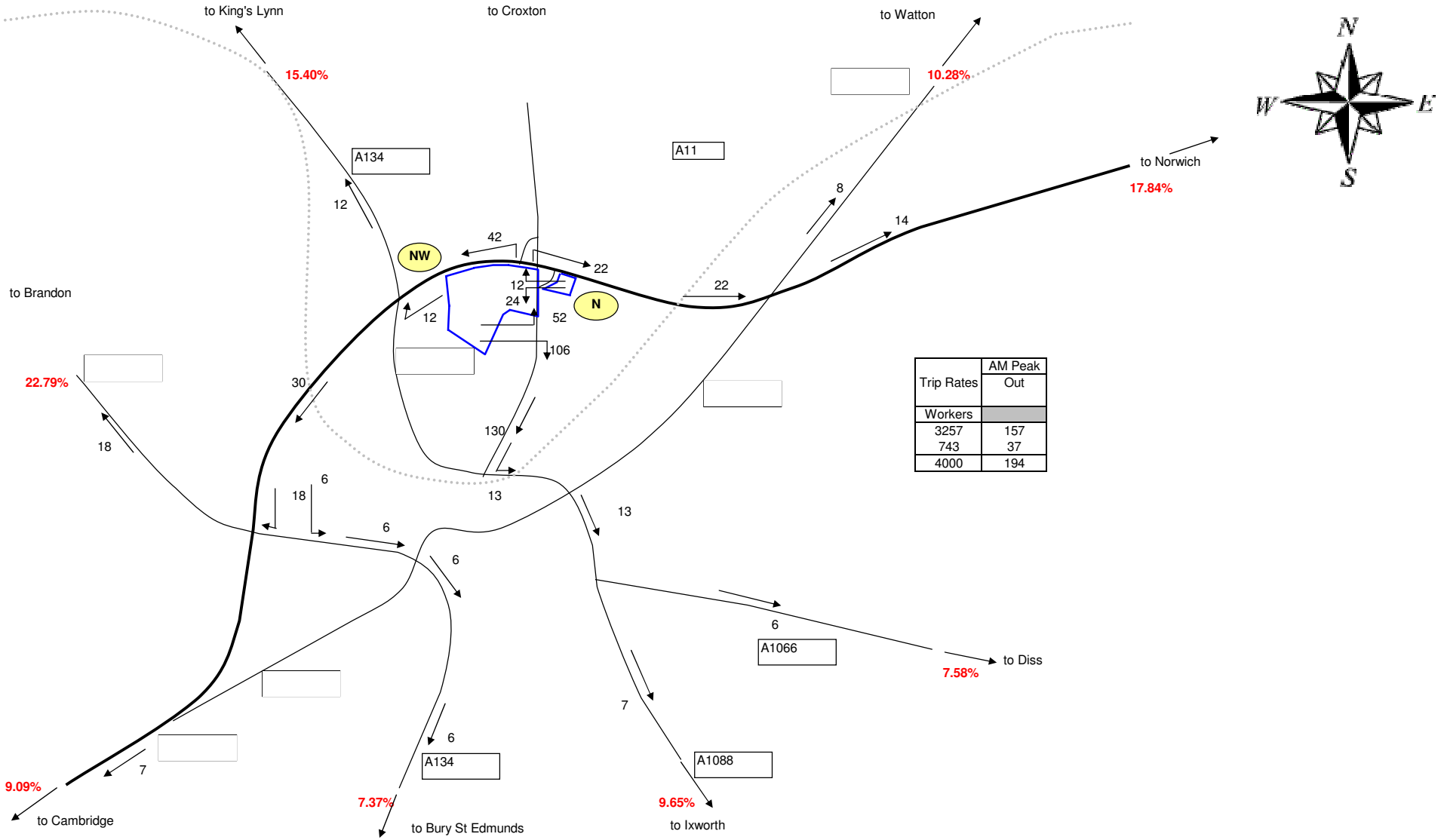
Trip Rates	AM Peak Out 0.554
Dwellings	
507	281
4649	2575
673	373
707	392
524	290
1757	973
8816	4884

Appendix E Samples of Employment Generation Flows

3 pages A4

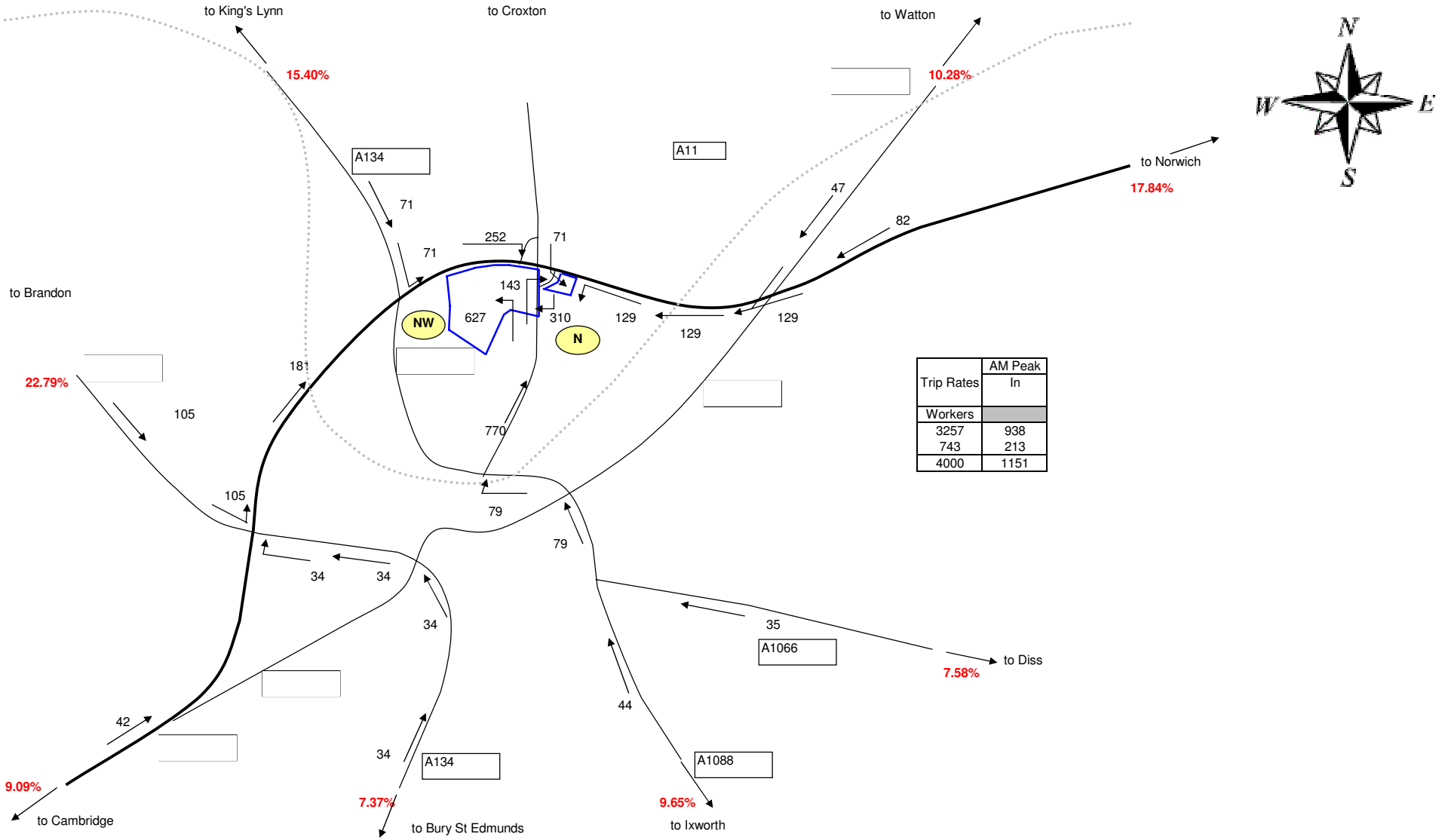
Trip Distribution ALL 2021





Trip Rates	AM Peak Out
Workers	
3257	157
743	37
4000	194

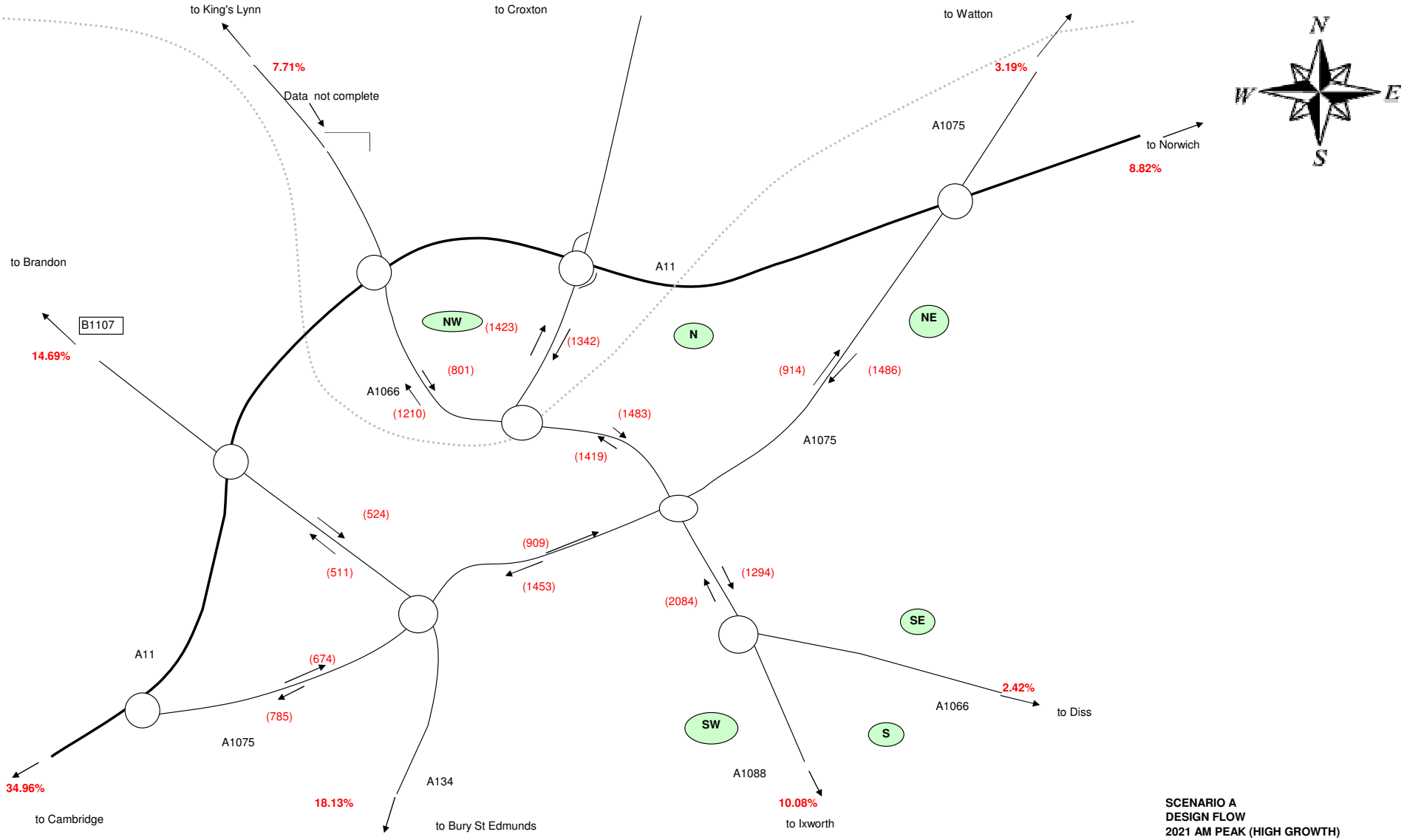
Trip Gen AM Peak 2021 In

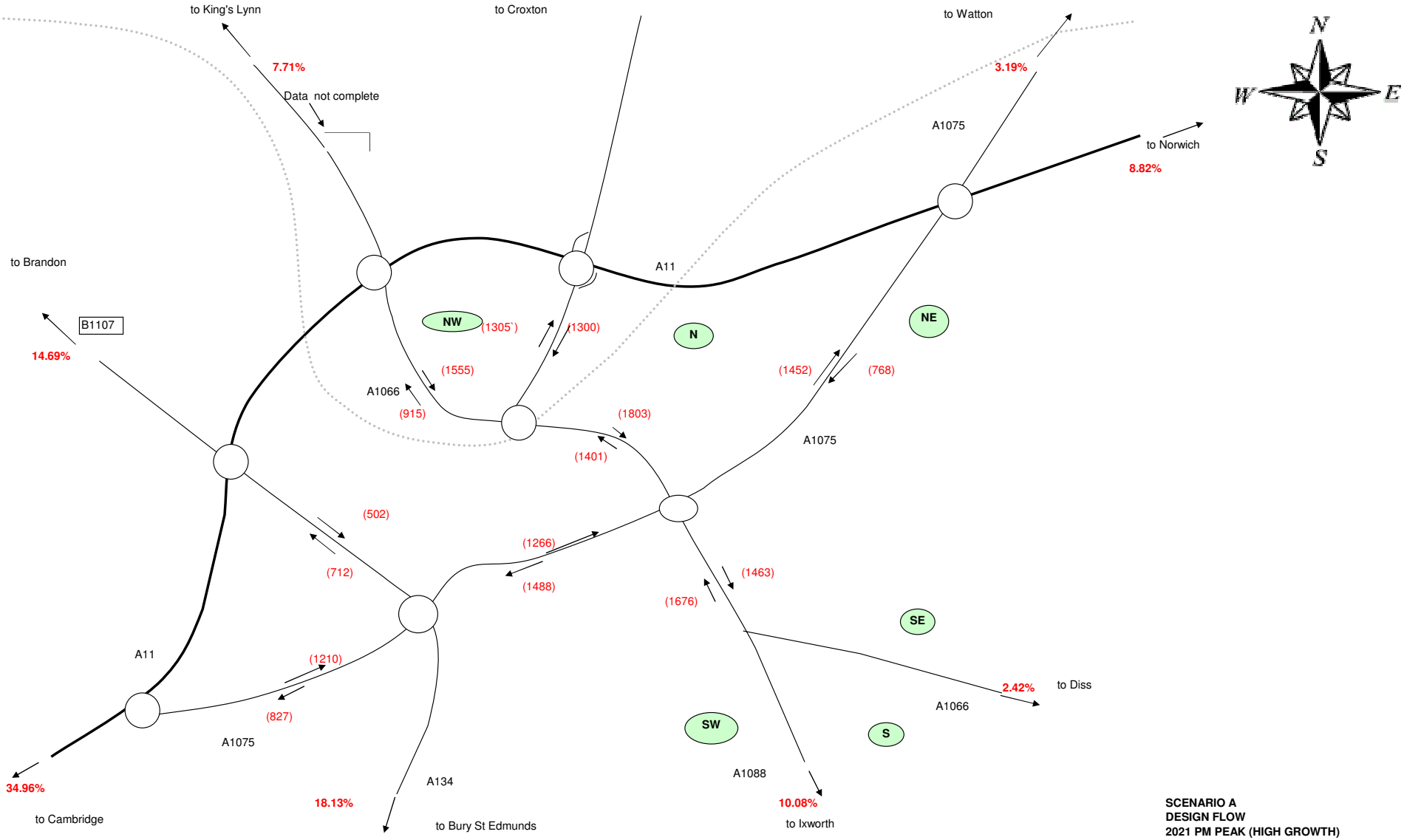


Trip Rates	AM Peak
	In
Workers	
3257	938
743	213
4000	1151

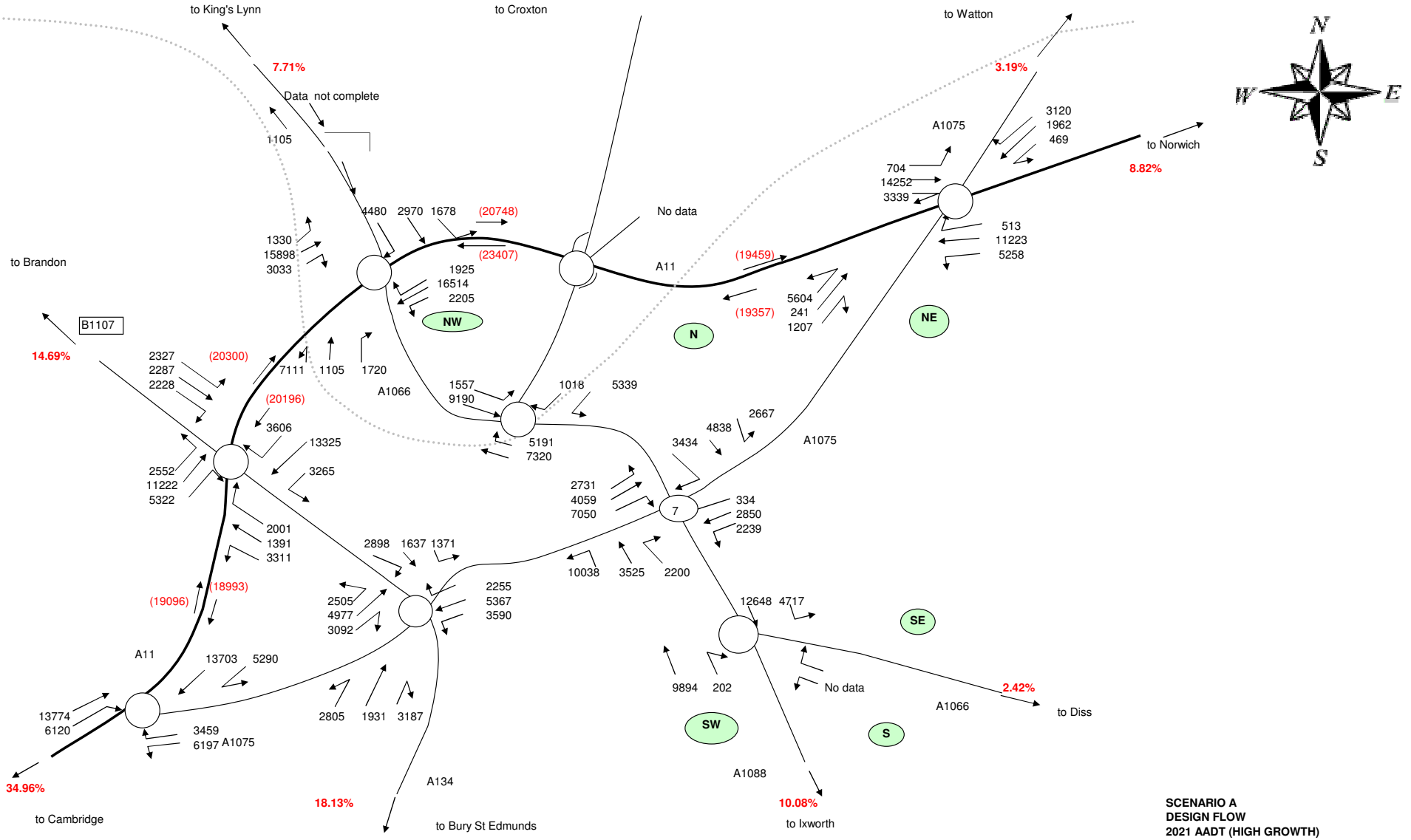
Appendix F Samples of Design Flow

3 pages A4


to King's Lynn
7.71%
Data not complete
to Croxton
to Watton
3.19%
A1075
to Norwich
8.82%
N
W
E
S
to Brandon
B1107
14.69%
A11
NW
(1423)
(1342)
N
NE
(801)
A1066
(1210)
(914)
(1486)
(1483)
(1419)
A1075
(524)
(511)
(909)
(1453)
(1294)
(2084)
SE
A11
(674)
(785)
A1075
2.42%
A1066
to Diss
SW
S
A1088
34.96%
to Cambridge
18.13%
A134
to Bury St Edmunds
10.08%
to Ixworth
SCENARIO A
DESIGN FLOW
2021 AM PEAK (HIGH GROWTH)



SCENARIO A
DESIGN FLOW
2021 PM PEAK (HIGH GROWTH)



SCENARIO A
DESIGN FLOW
2021 AADT (HIGH GROWTH)