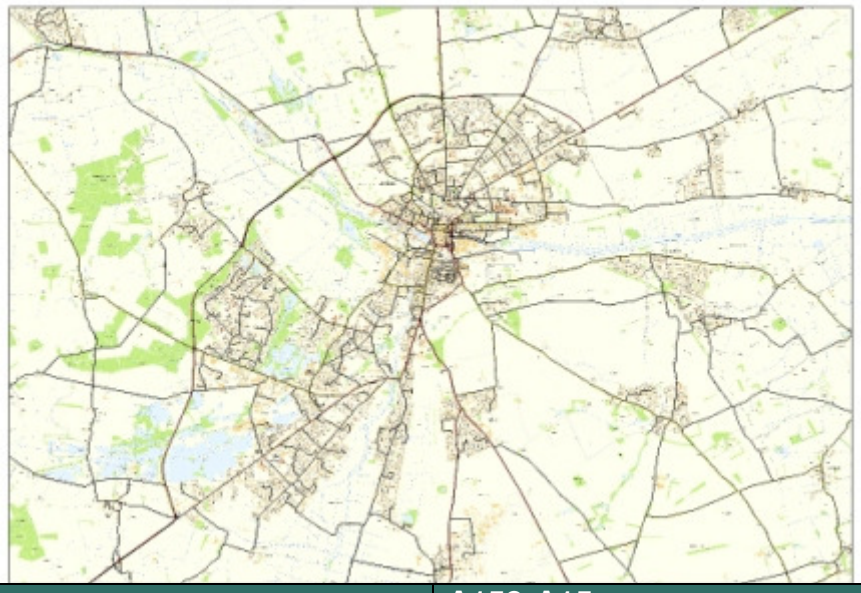
Appendix J – Routing Plots

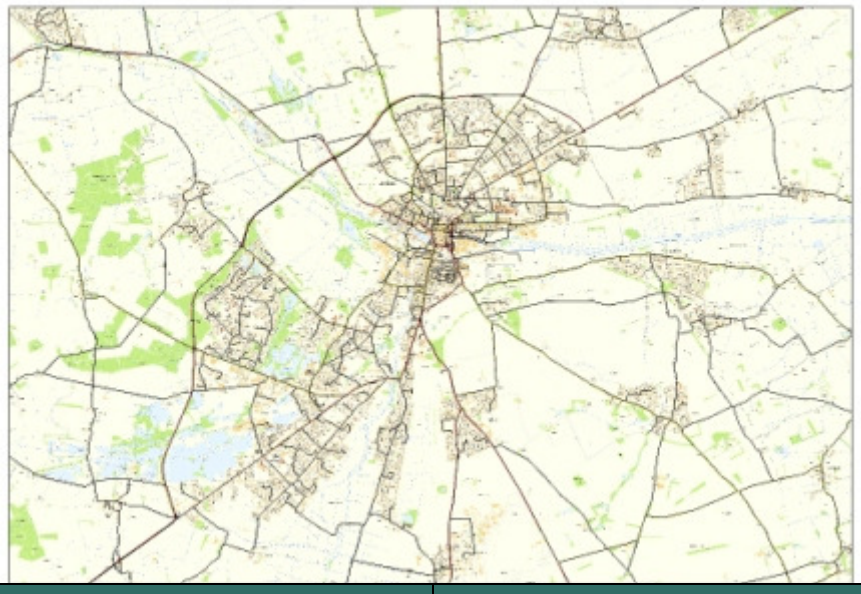
Appendix I – Routing Plots

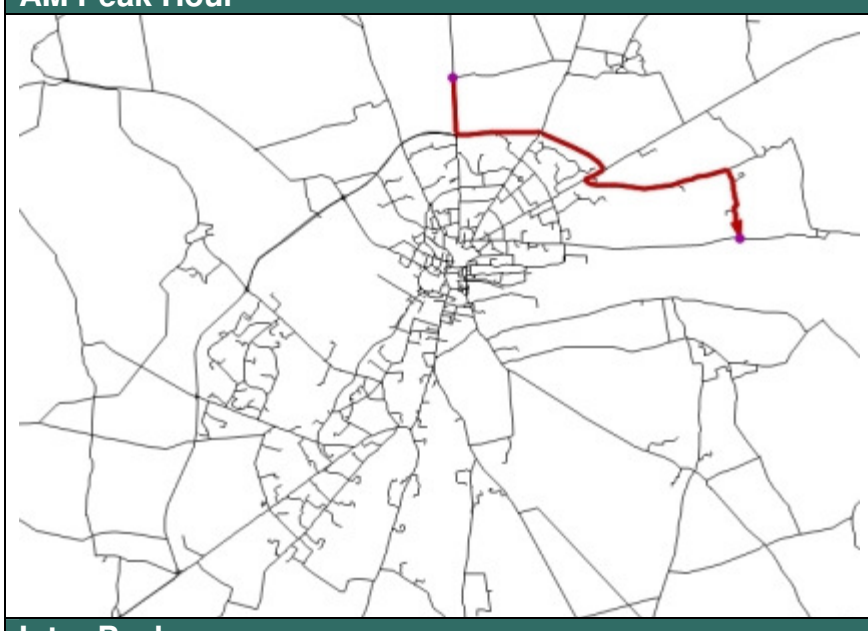
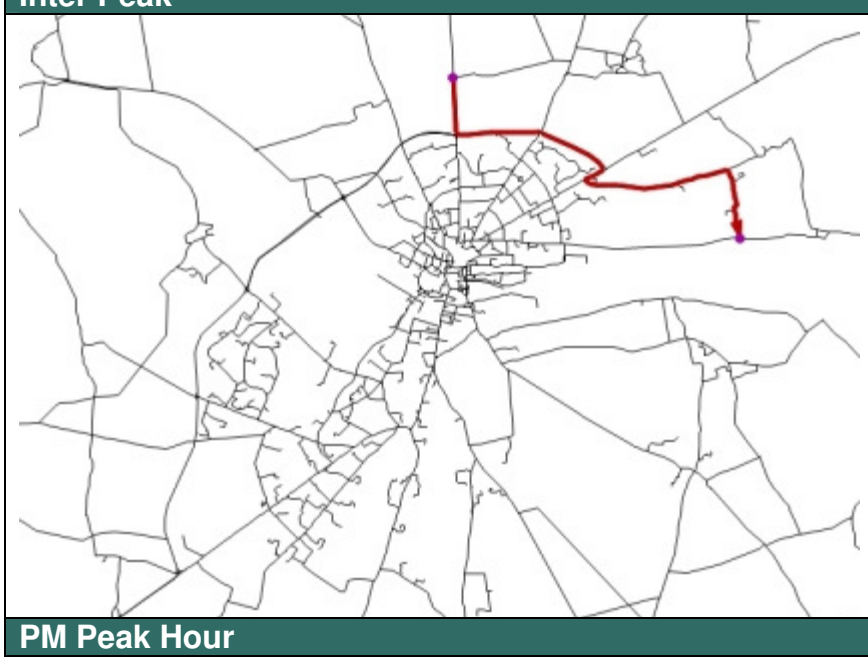
1 - LEB Model Routing Plots Between A15 and A158



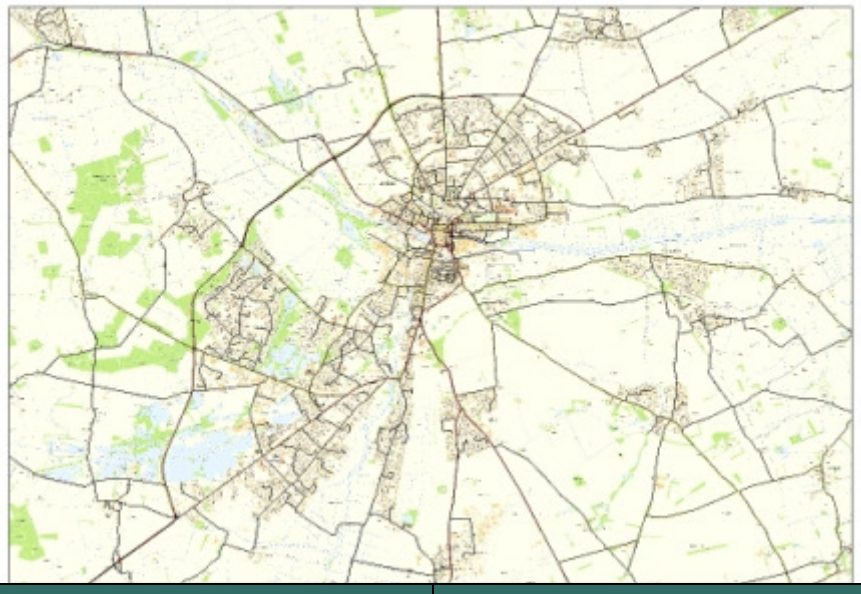
A15-A158	A158-A15
AM Peak Hour	
Inter Peak	
PM Peak Hour	

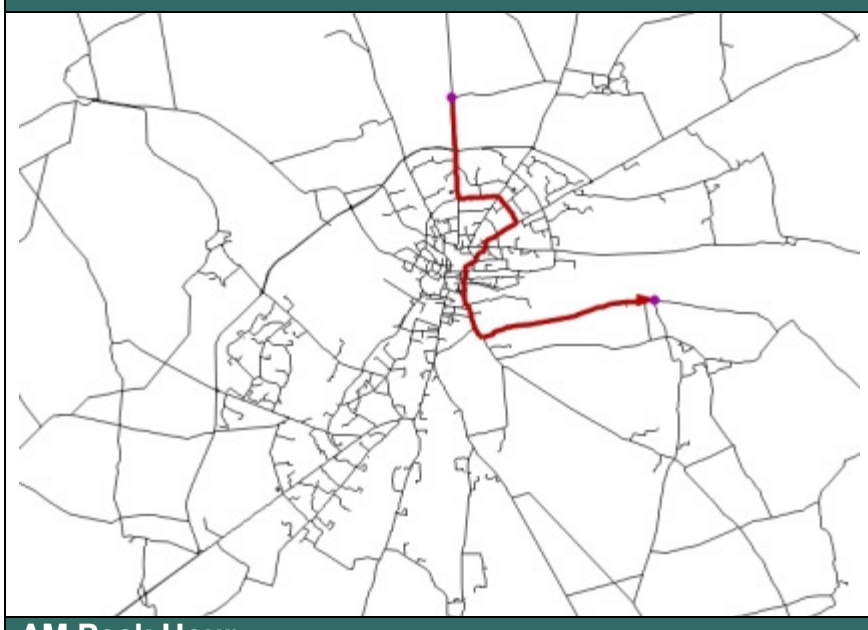
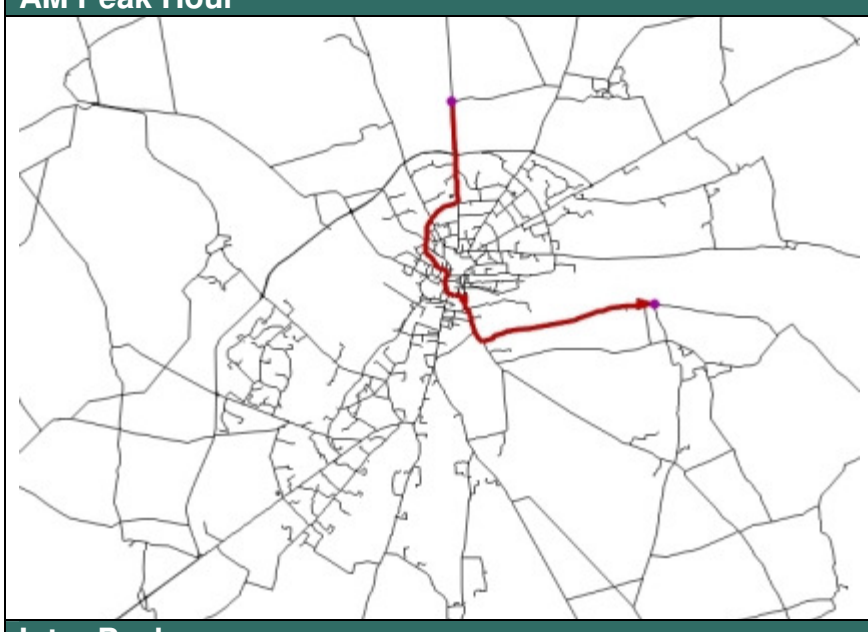
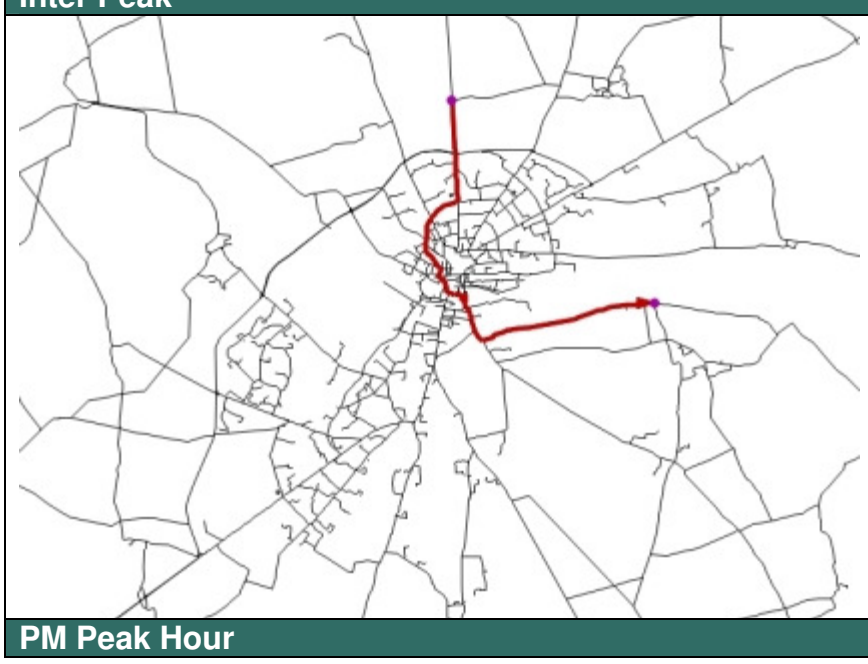
2 - LEB Model Routing Plots Between A15 and Greetwell



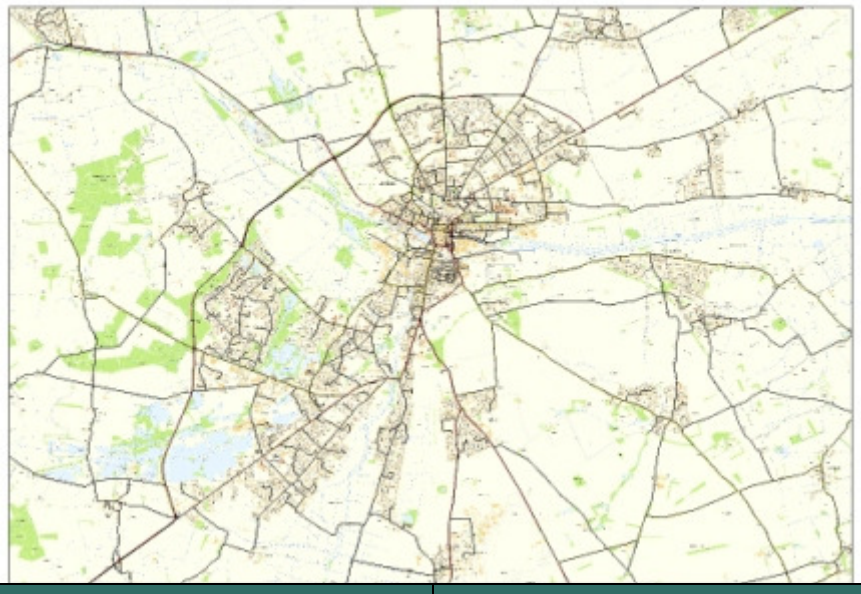
	
AM Peak Hour	
	
Inter Peak	
	
PM Peak Hour	

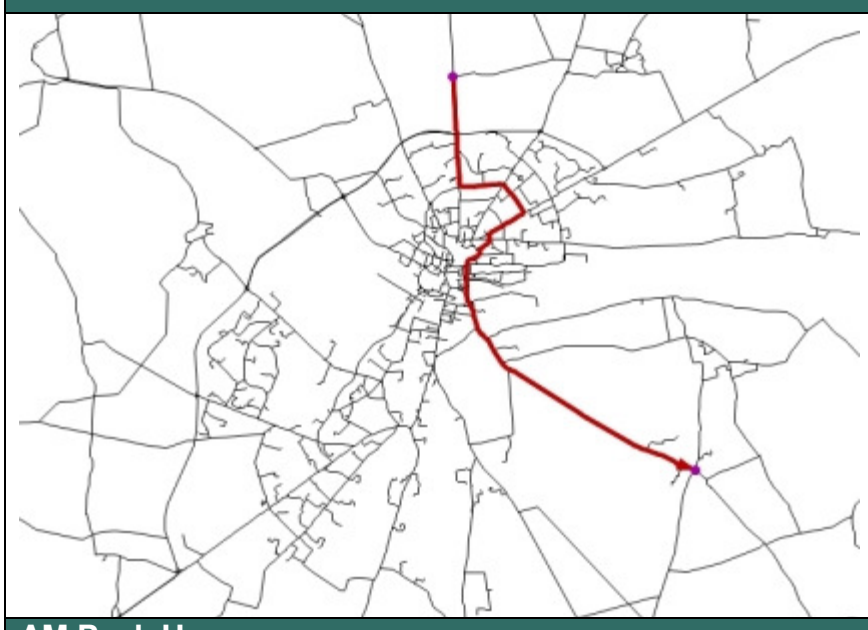
3 - LEB Model Routing Plots Between A15 and Main



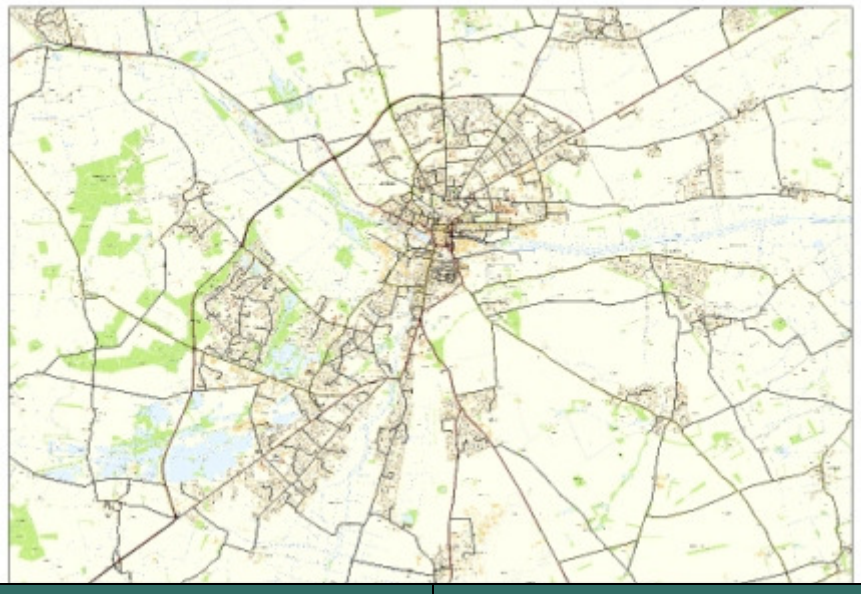
	
AM Peak Hour	
	
Inter Peak	
	
PM Peak Hour	

4 - LEB Model Routing Plots Between A15 and Lincoln



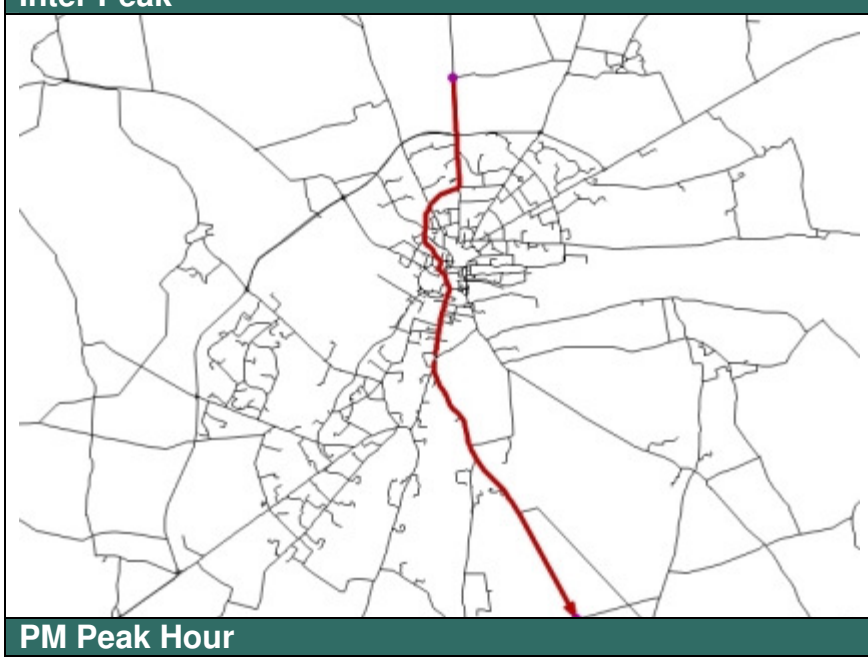
	
AM Peak Hour	
	
Inter Peak	
	
PM Peak Hour	

5 - LEB Model Routing Plots Between A15 and Sleaford



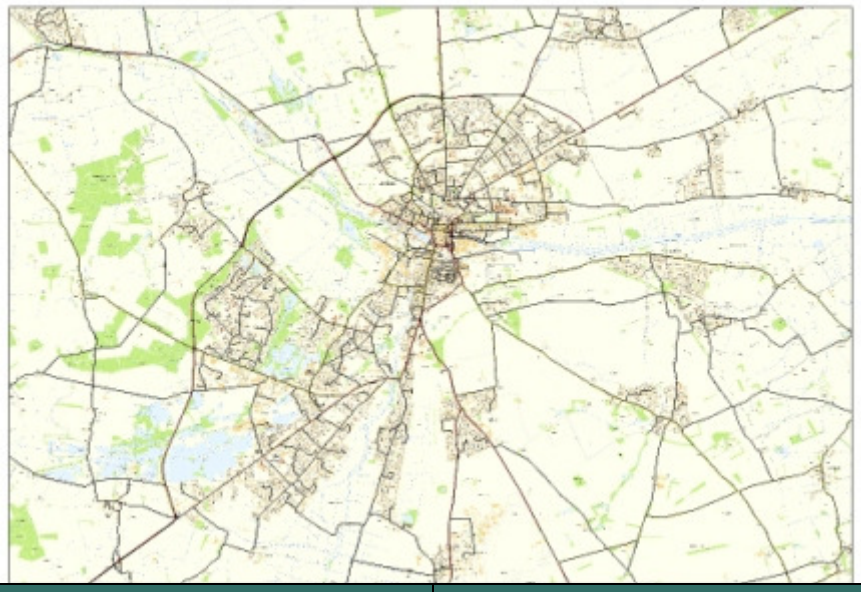
AM Peak Hour

Inter Peak

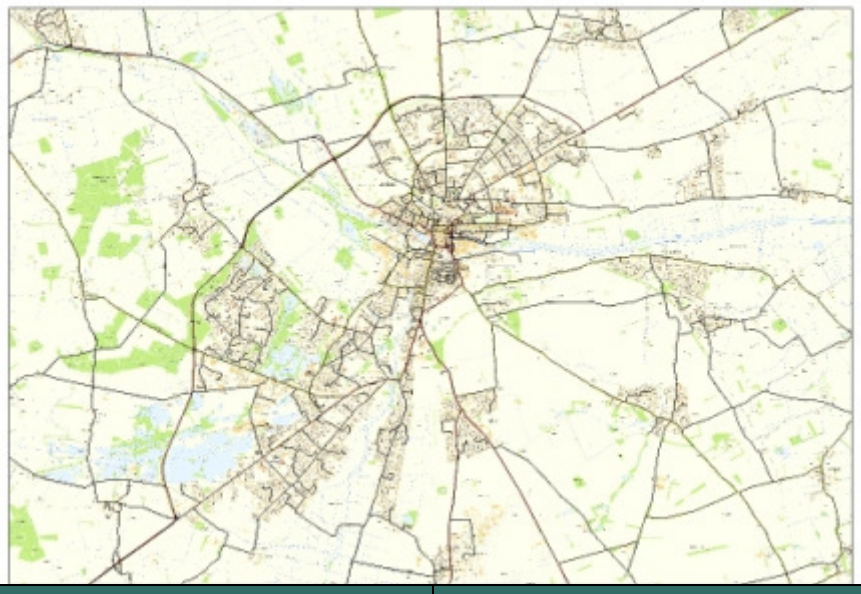


PM Peak Hour

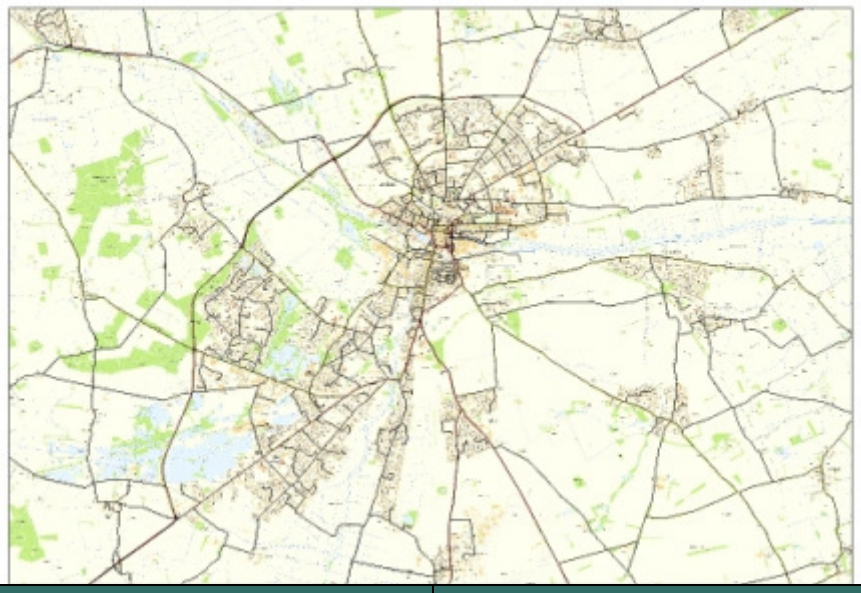
6 - LEB Model Routing Plots Between A15 and A607



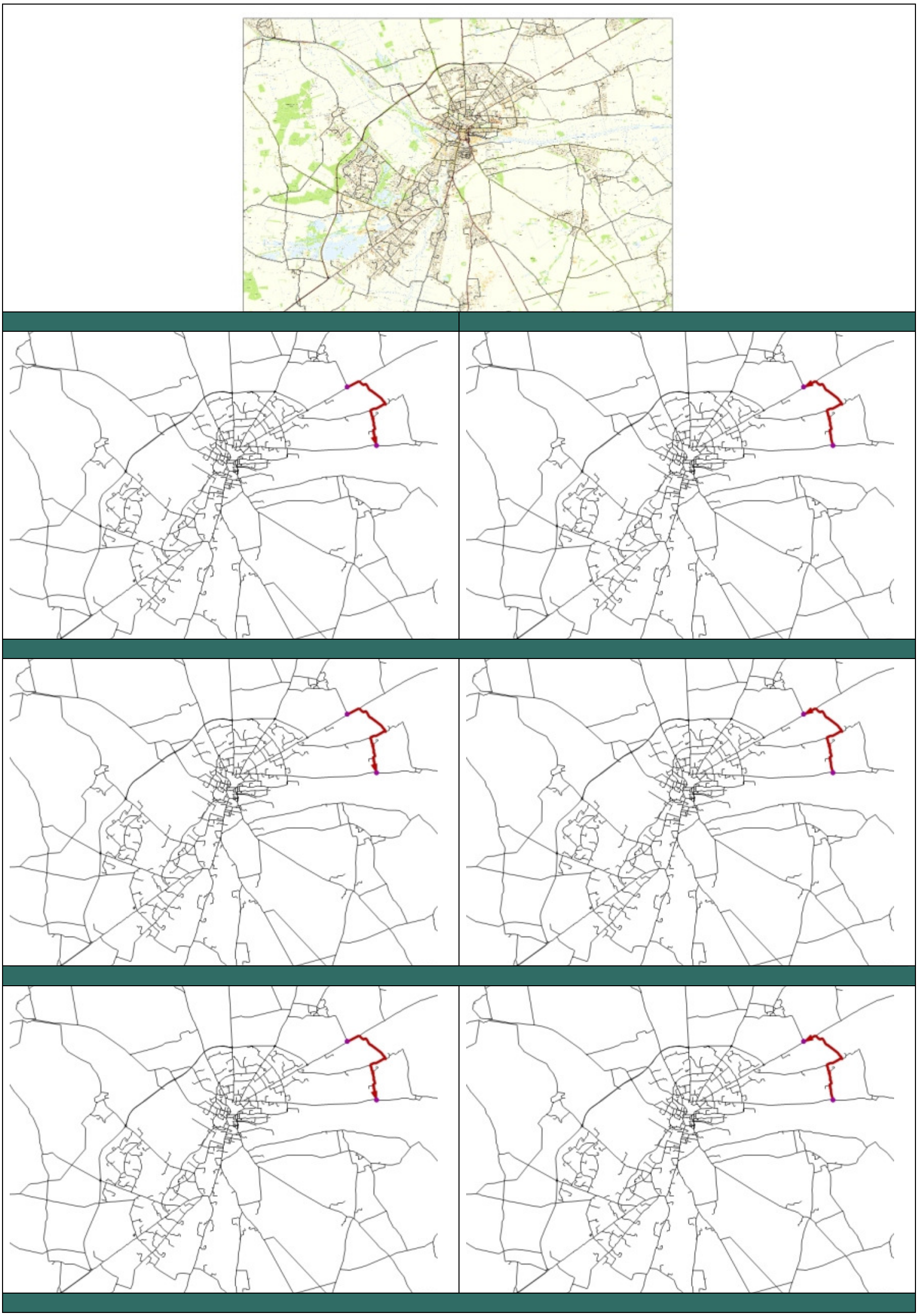
7 - LEB Model Routing Plots Between A15 and A46



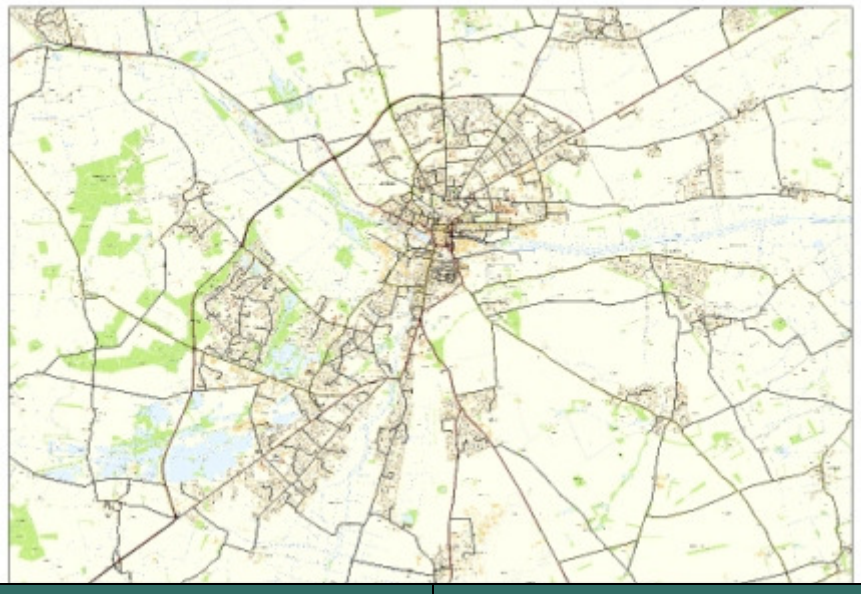
8 - LEB Model Routing Plots Between A15 and A57



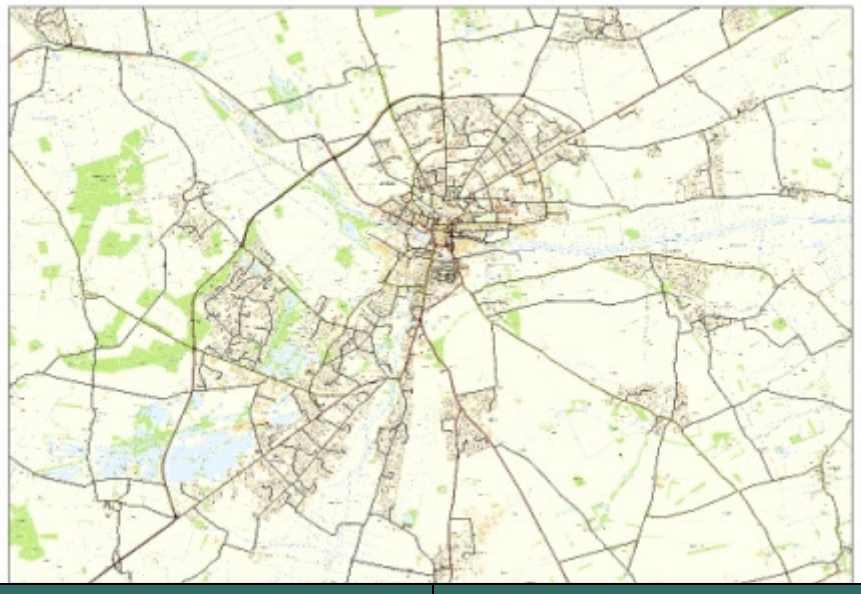
9 - LEB Model Routing Plots Between A158 and Greetwell



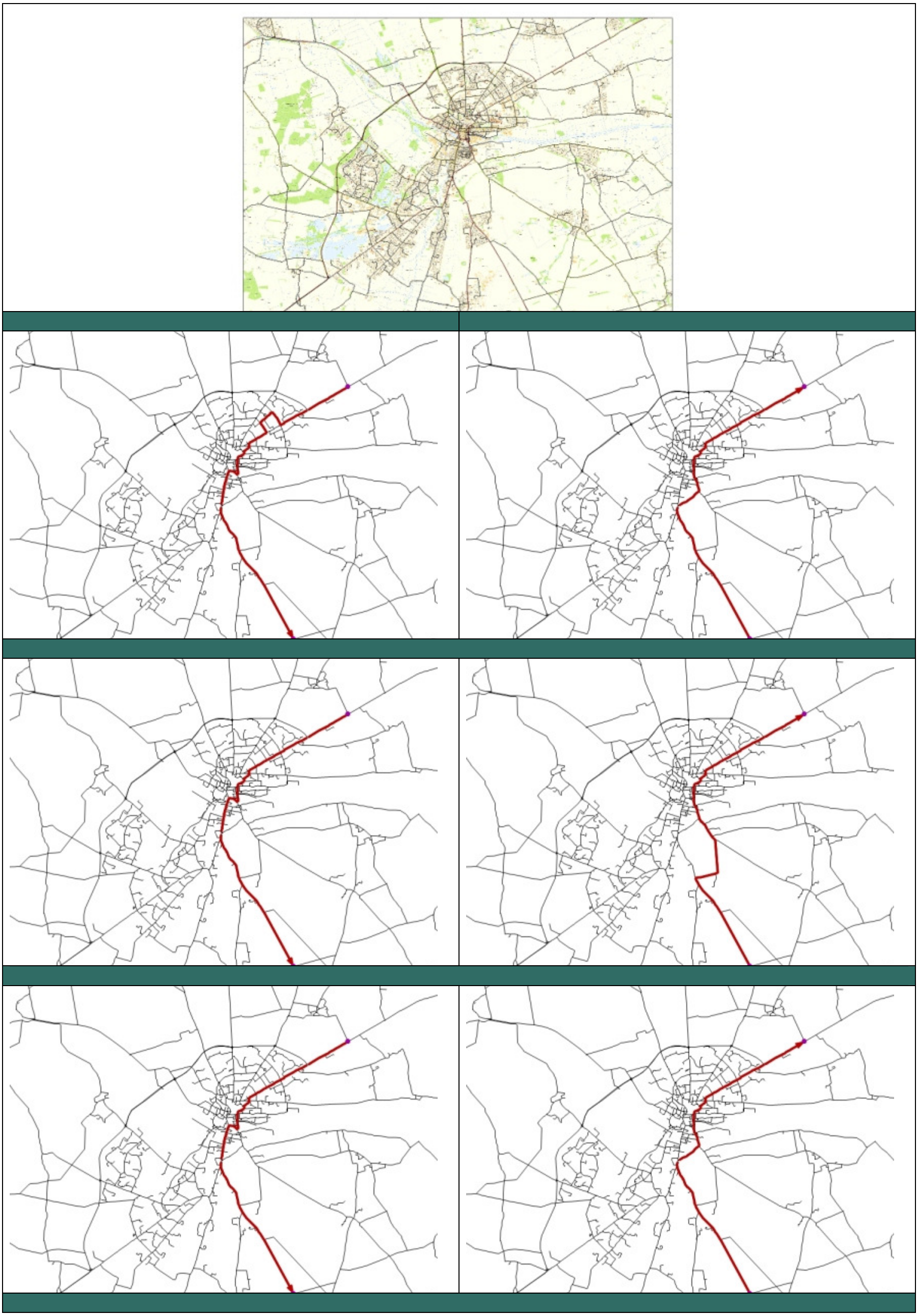
10 - LEB Model Routing Plots Between A158 and Main



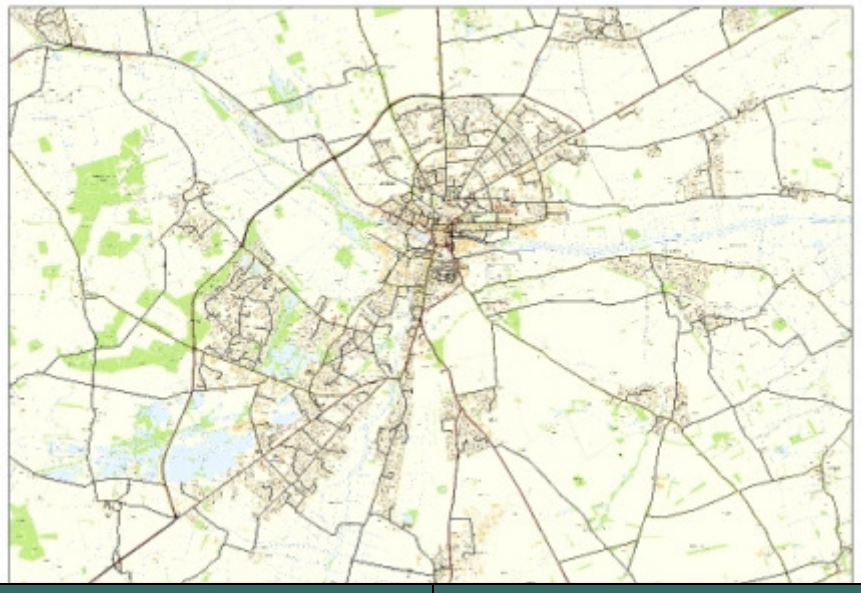
11 - LEB Model Routing Plots Between A158 and Lincoln



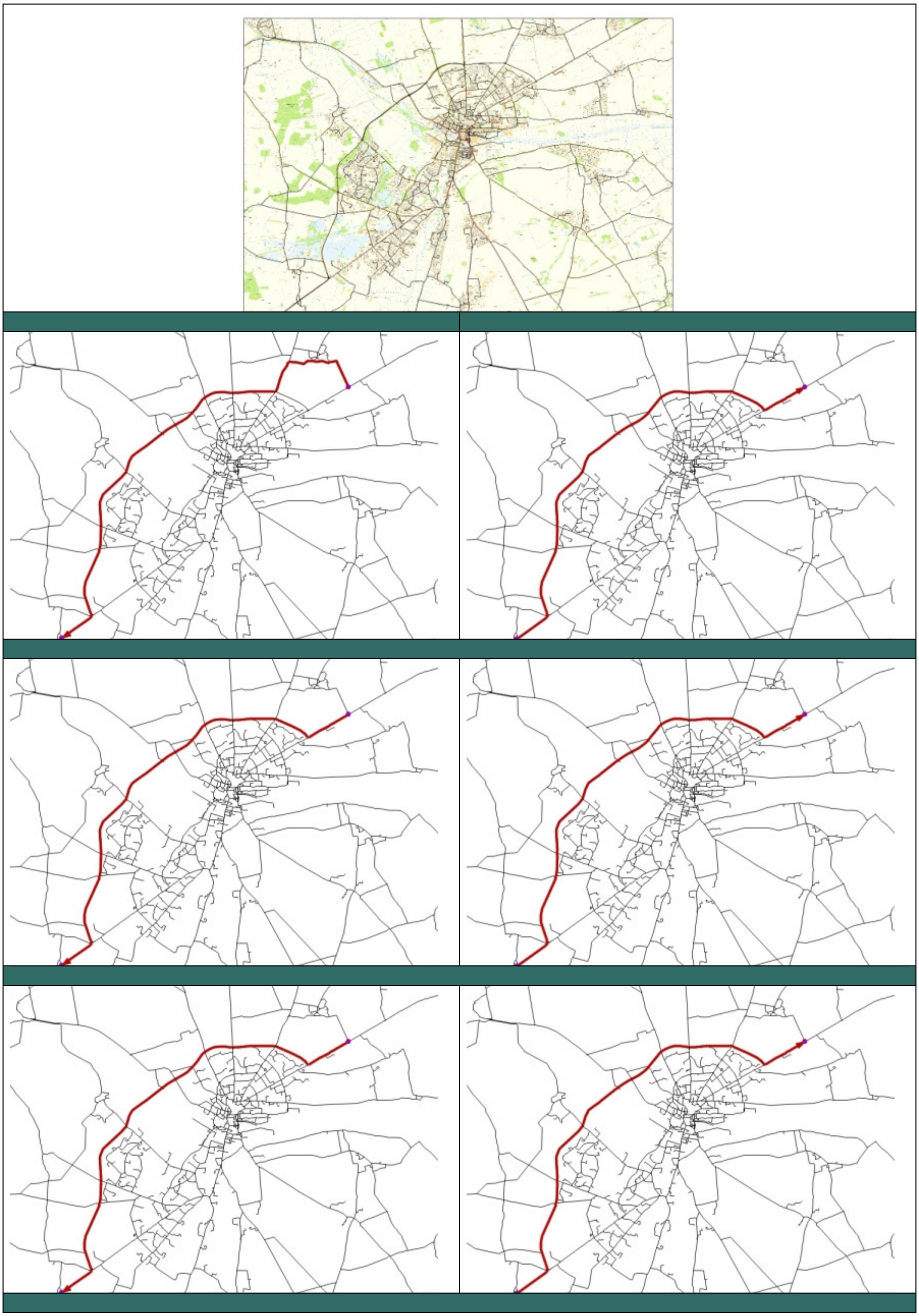
12 - LEB Model Routing Plots Between A158 and Sleaford



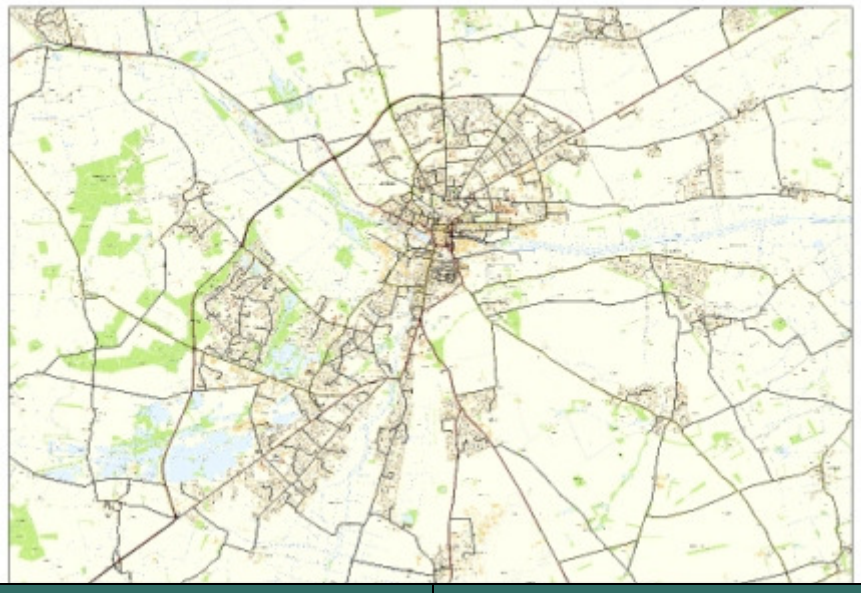
13 - LEB Model Routing Plots Between A158 and A607



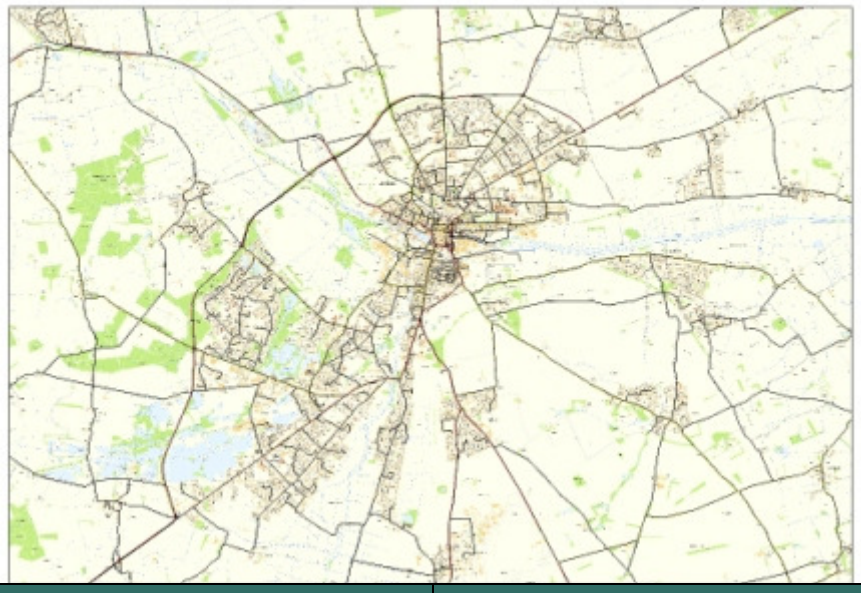
14 - LEB Model Routing Plots Between A158 and A46



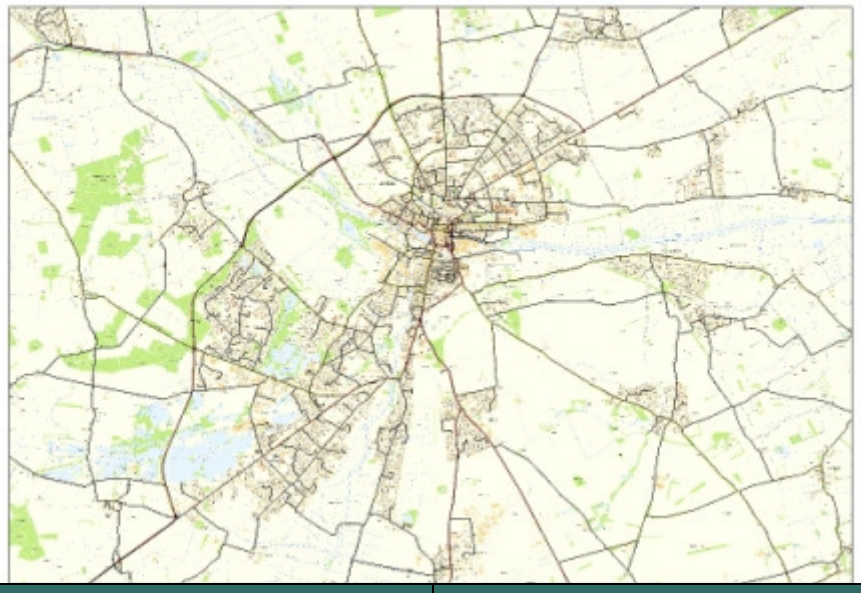
15 - LEB Model Routing Plots Between A158 and A57



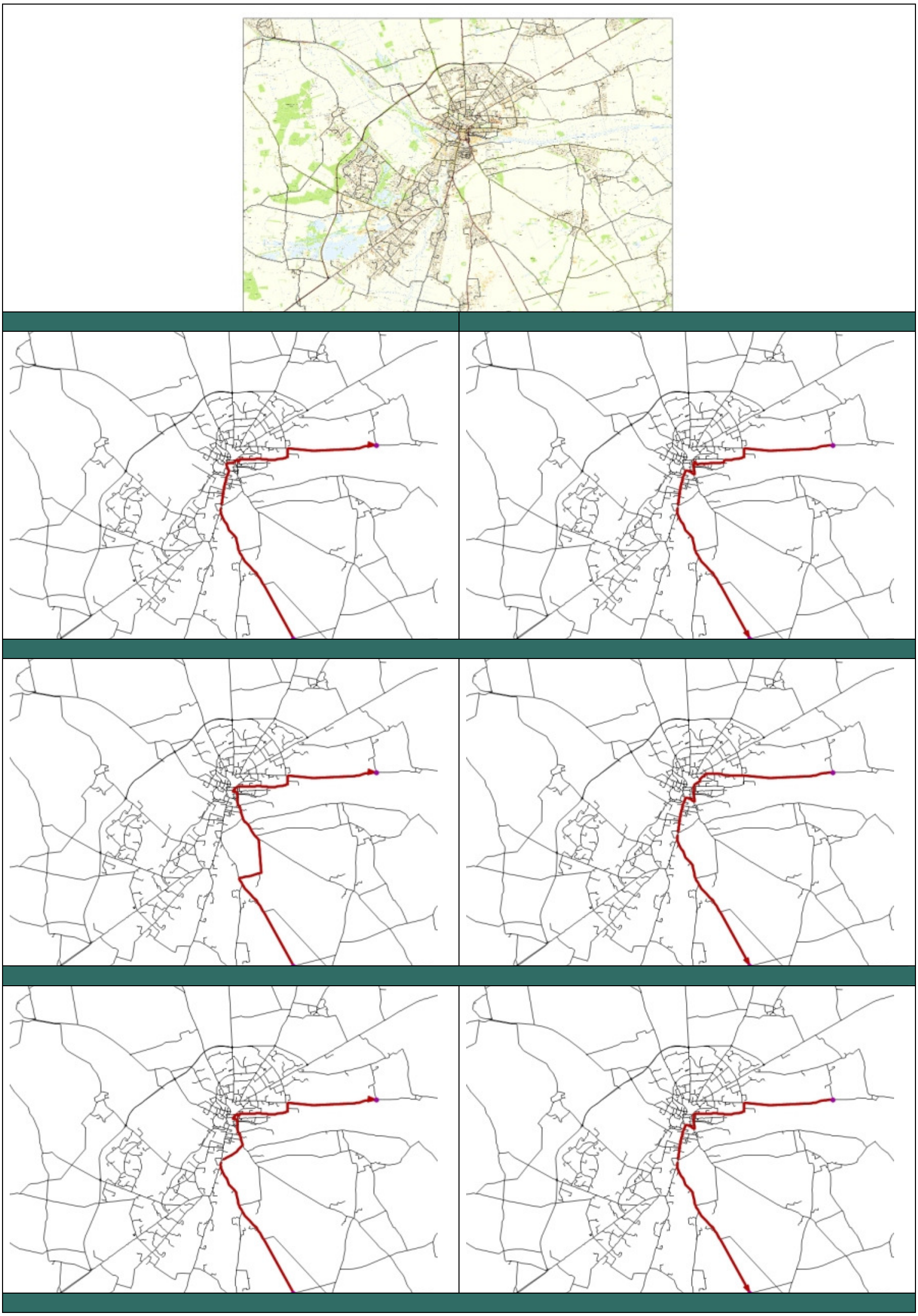
16 - LEB Model Routing Plots Between Greetwell and Main



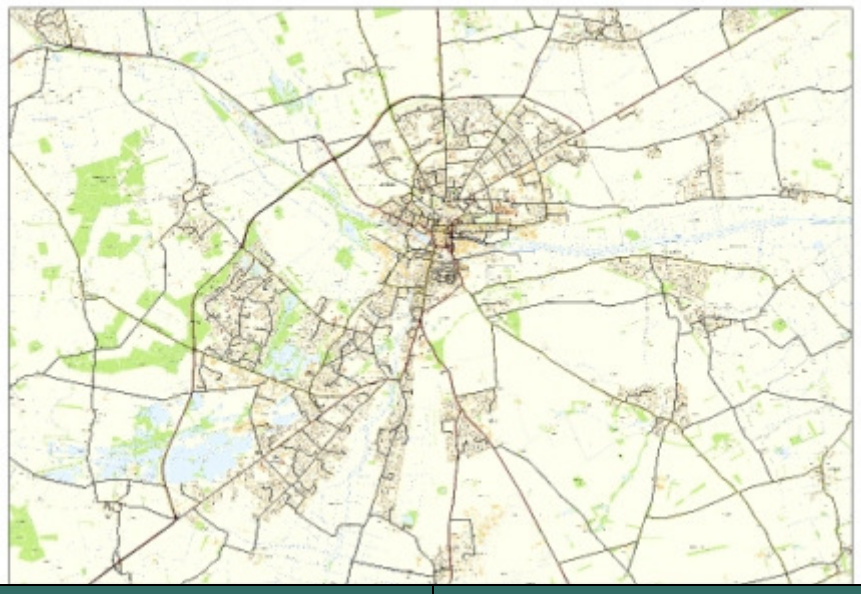
17 - LEB Model Routing Plots Between Greetwell and Lincoln



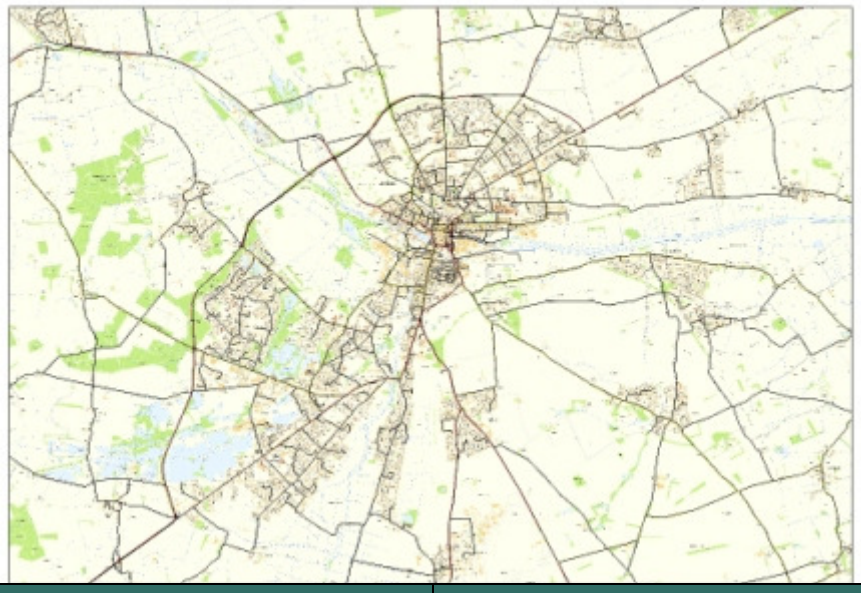
18 - LEB Model Routing Plots Between Sleaford and Greetwell



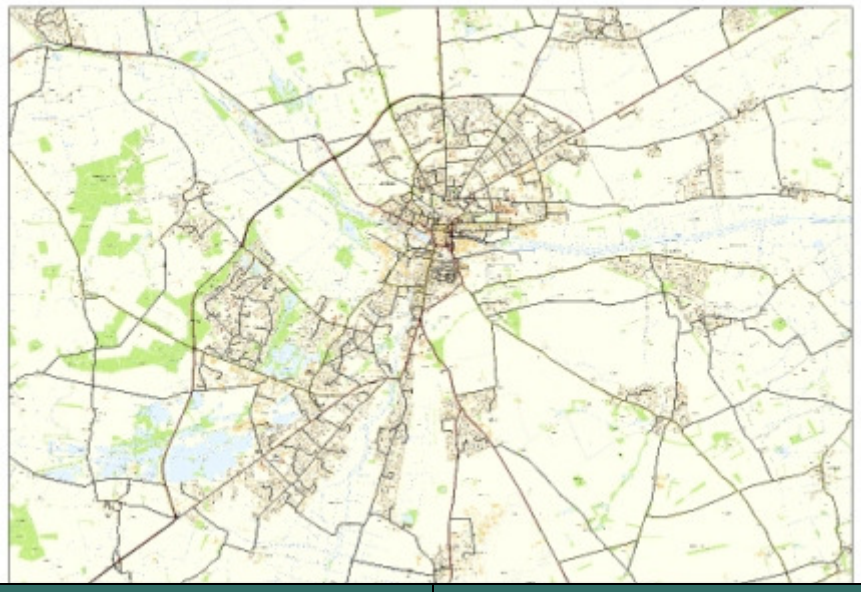
19 - LEB Model Routing Plots Between A607 and Greetwell



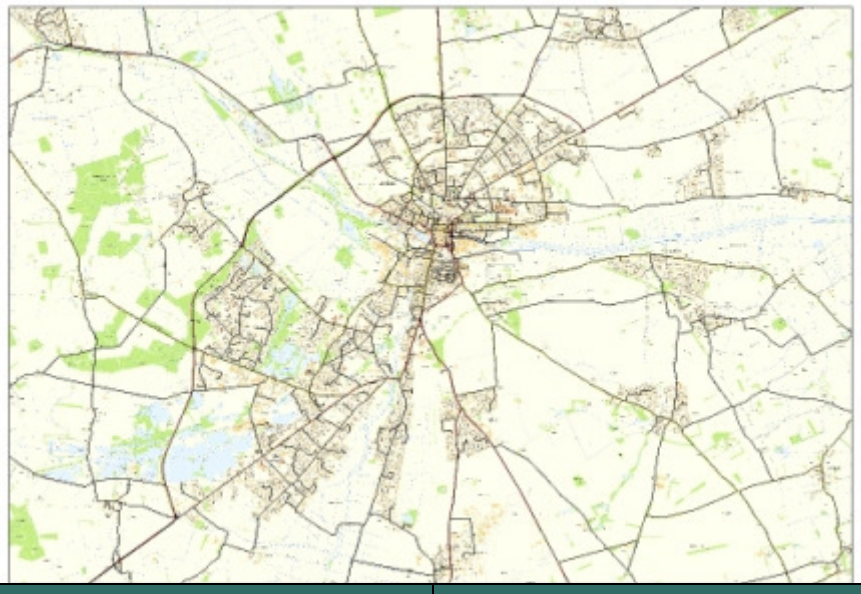
20 - LEB Model Routing Plots Between A46 and Greetwell



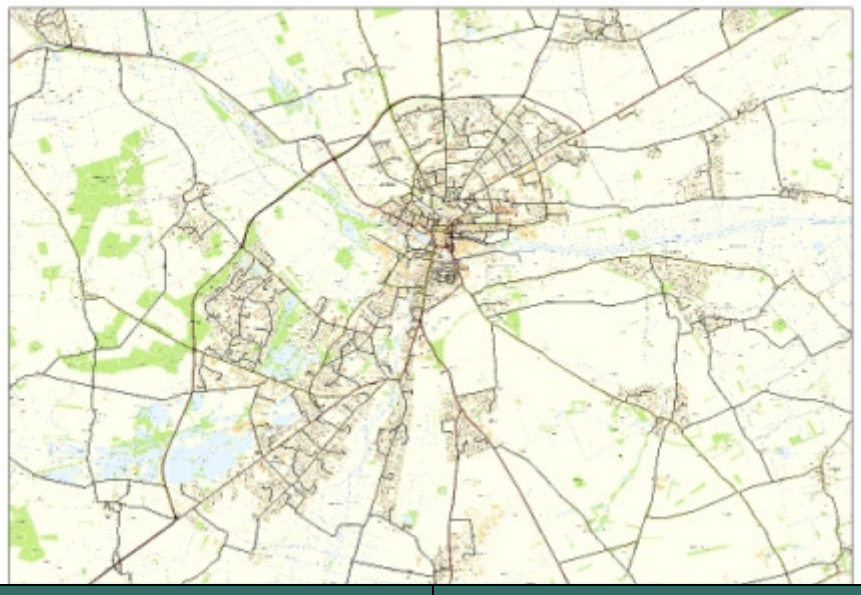
21 - LEB Model Routing Plots Between A57 and Greetwell



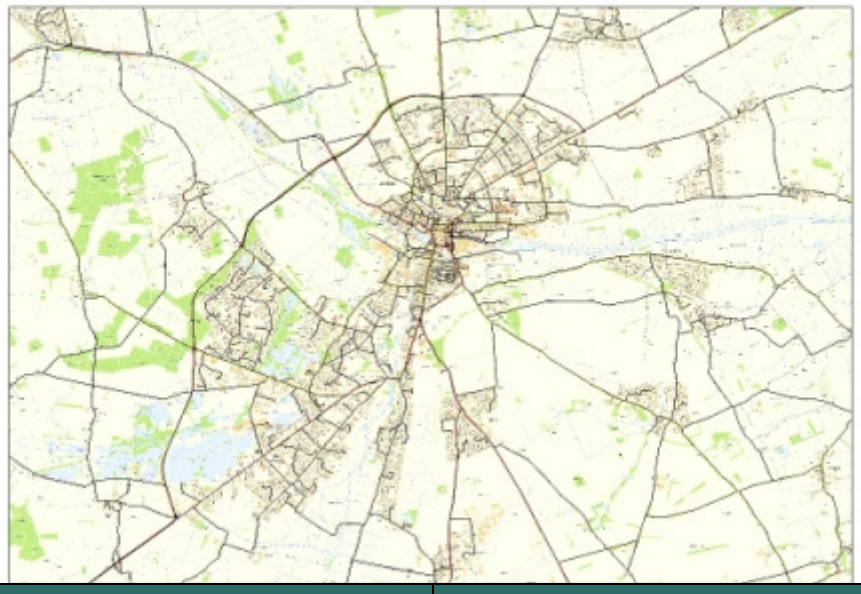
22 - LEB Model Routing Plots Between Main and Lincoln



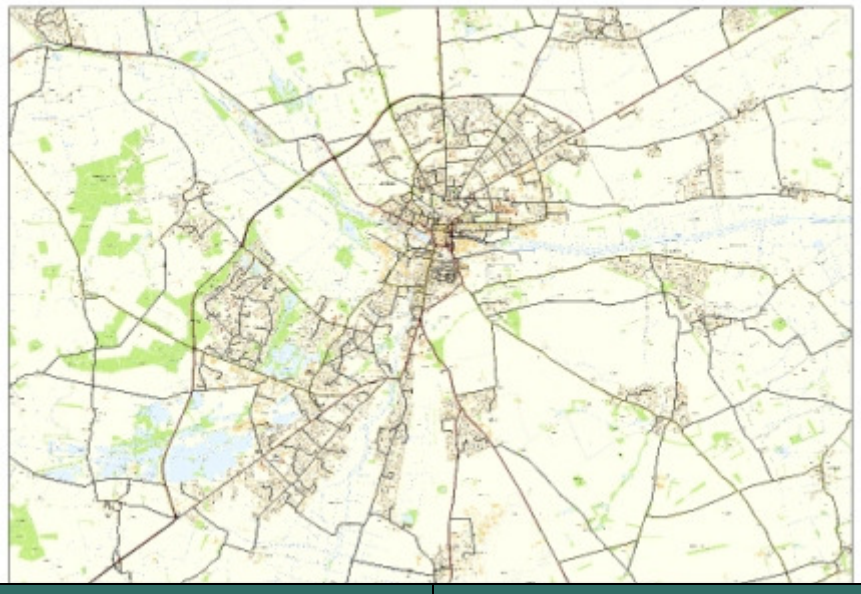
23 - LEB Model Routing Plots Between Main and Sleaford



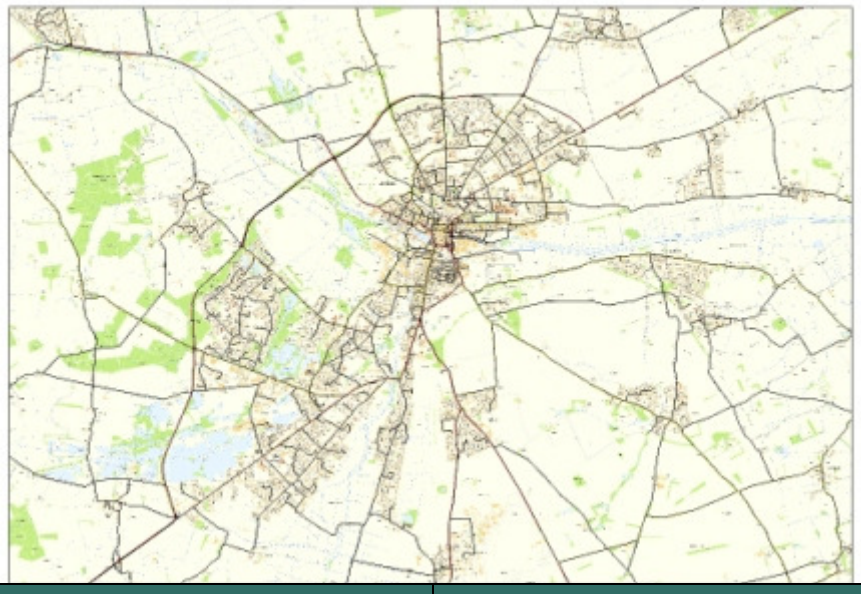
24 - LEB Model Routing Plots Between A607 and Main



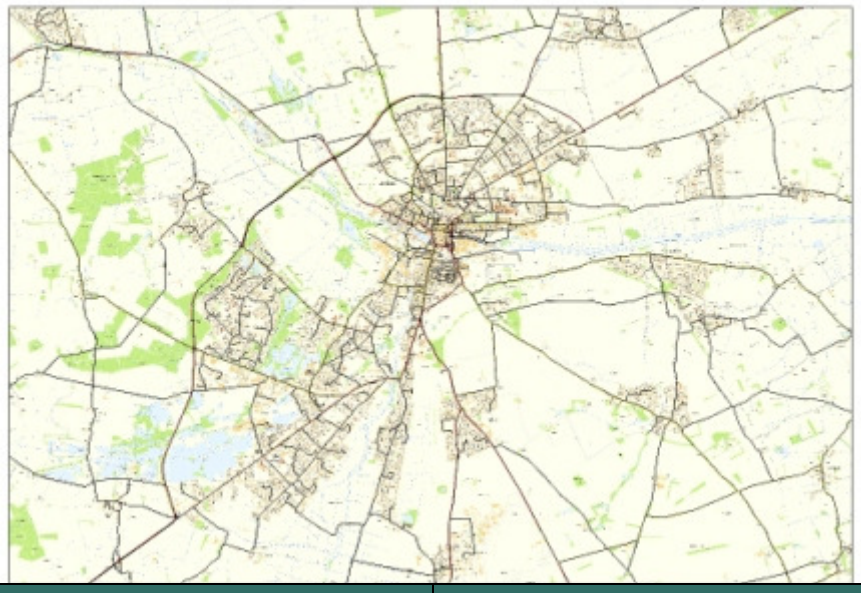
25 - LEB Model Routing Plots Between A46 and Main



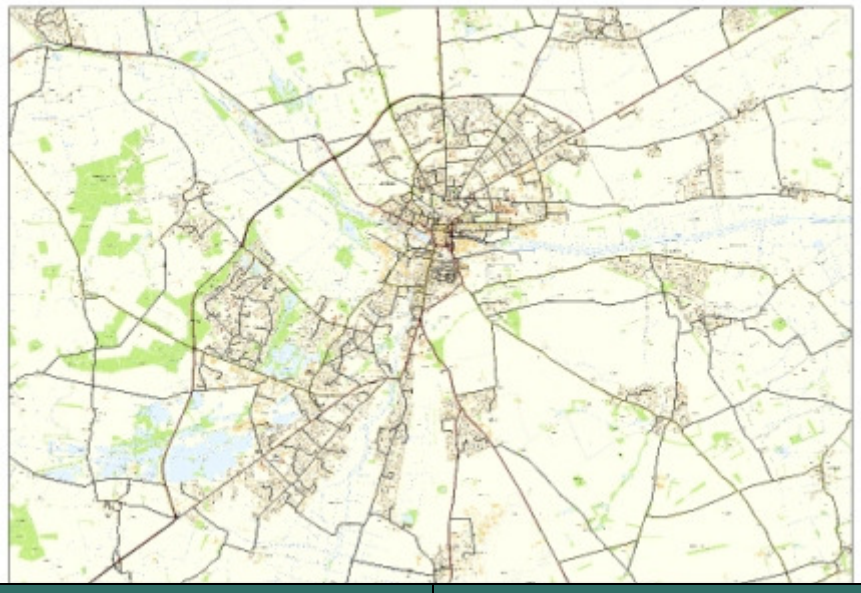
26 - LEB Model Routing Plots Between A57 and Main



27 - LEB Model Routing Plots Between Lincoln and Sleaford

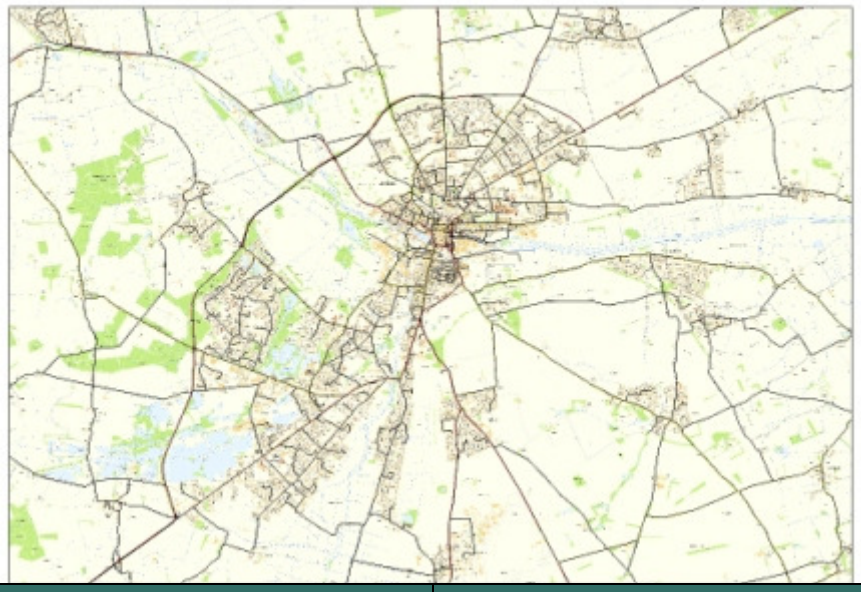


28 - LEB Model Routing Plots Between A607 and Lincoln

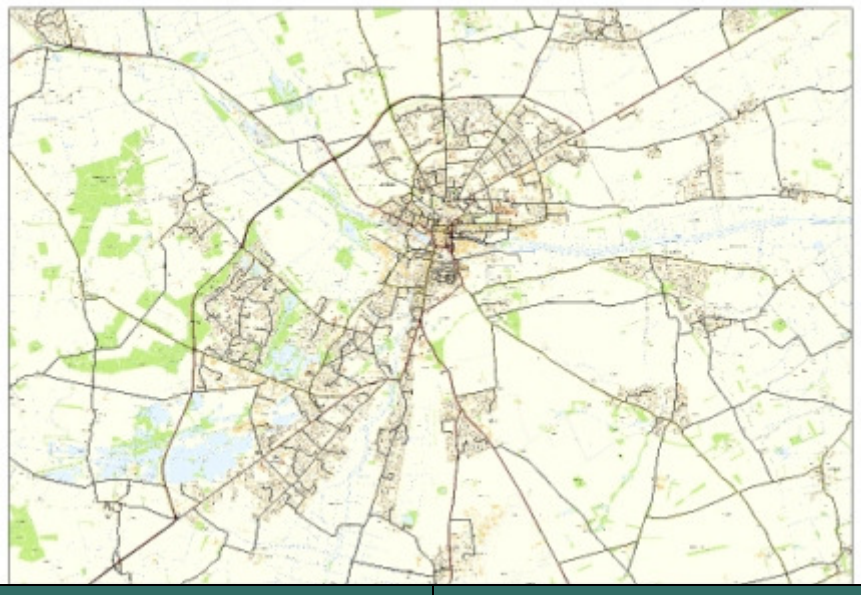


29 - LEB Model Routing Plots Between A46 and Lincoln

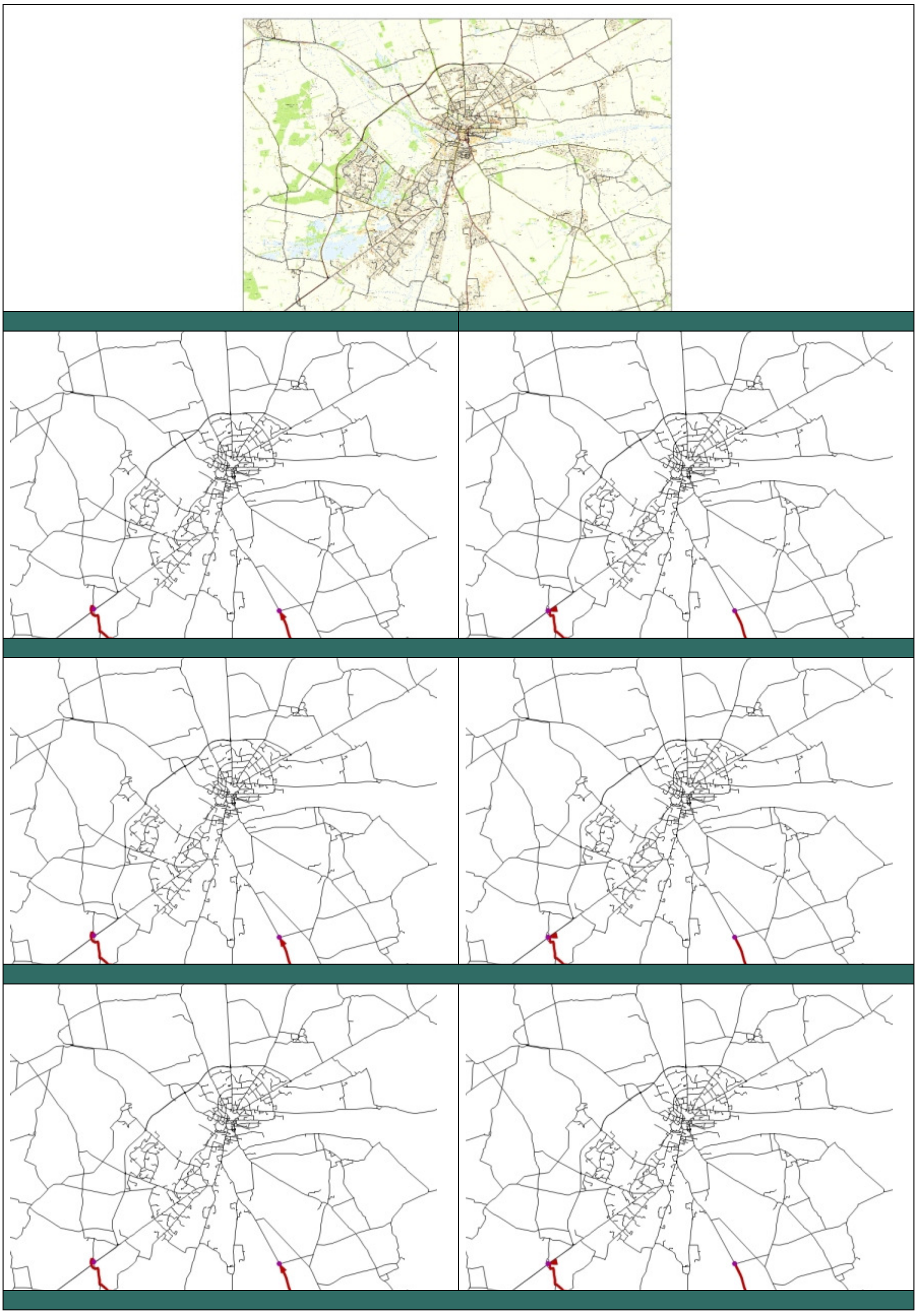
30 - LEB Model Routing Plots Between A57 and Lincoln



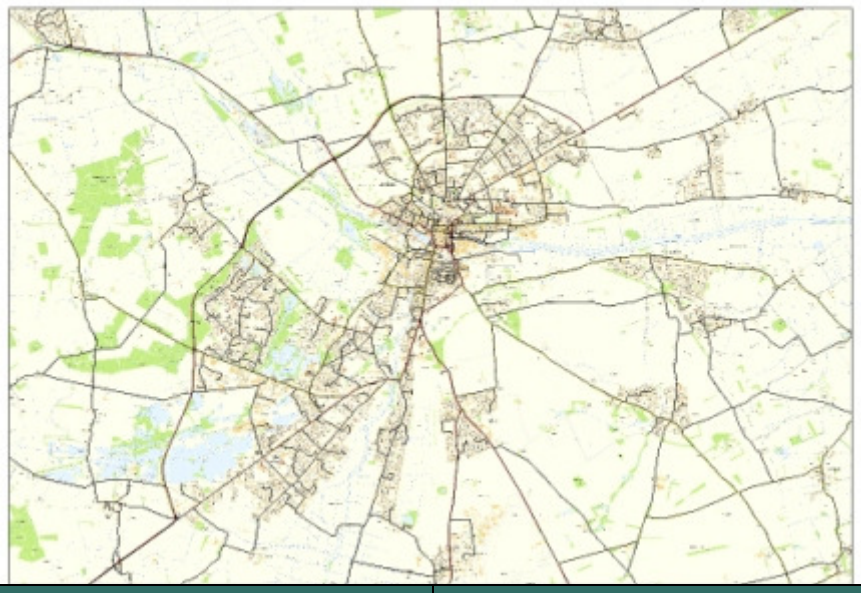
31 - LEB Model Routing Plots Between A607 and Sleaford



32 - LEB Model Routing Plots Between A46 and Sleaford

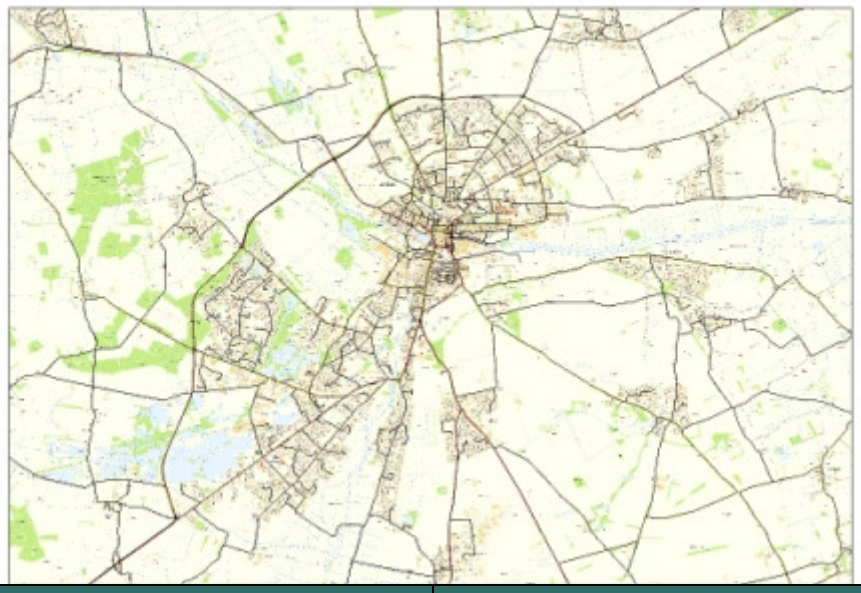


33 - LEB Model Routing Plots Between A57 and Sleaford

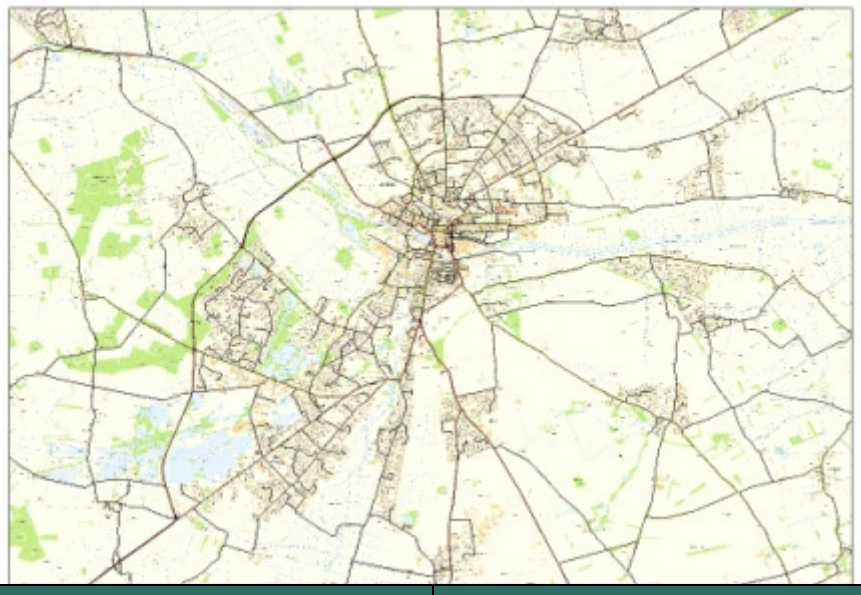


34 - LEB Model Routing Plots Between A46 and A607

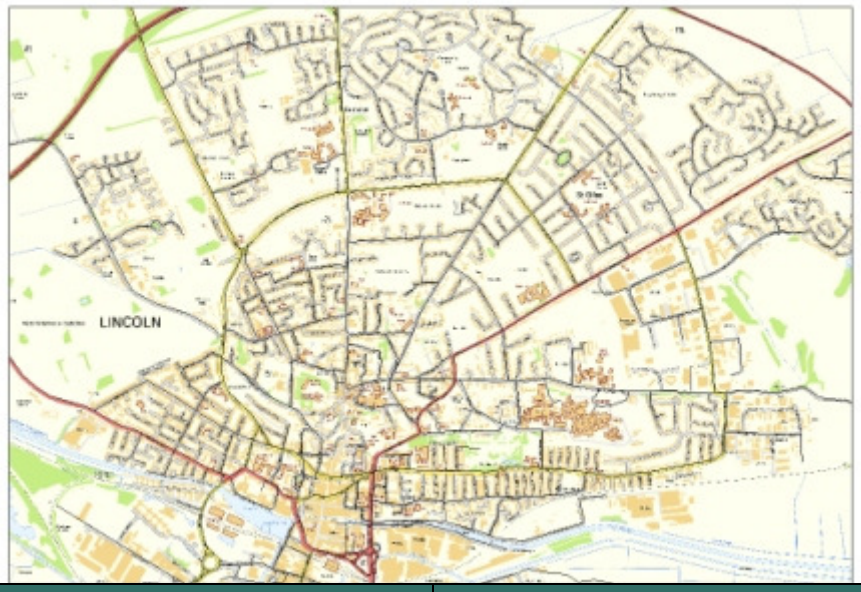
35 - LEB Model Routing Plots Between A57 and A607

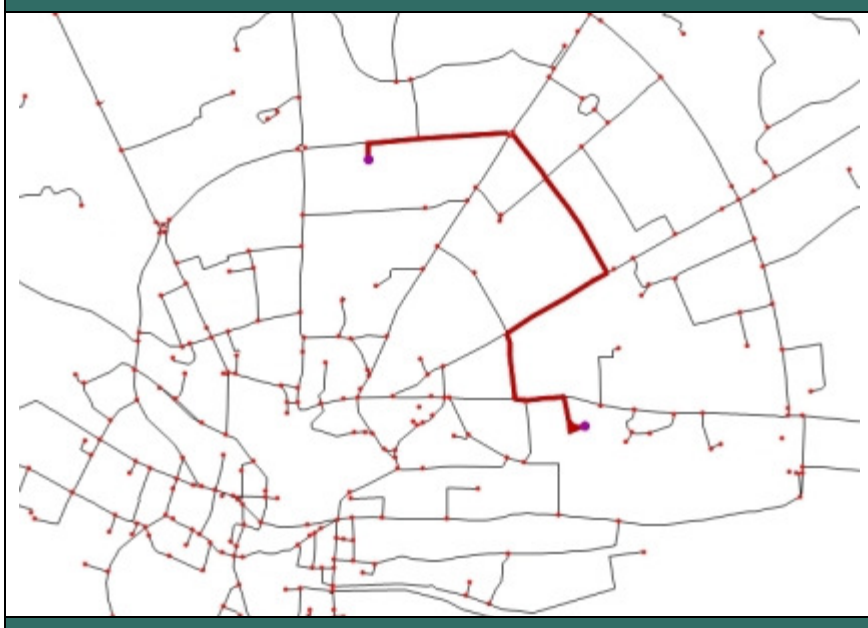


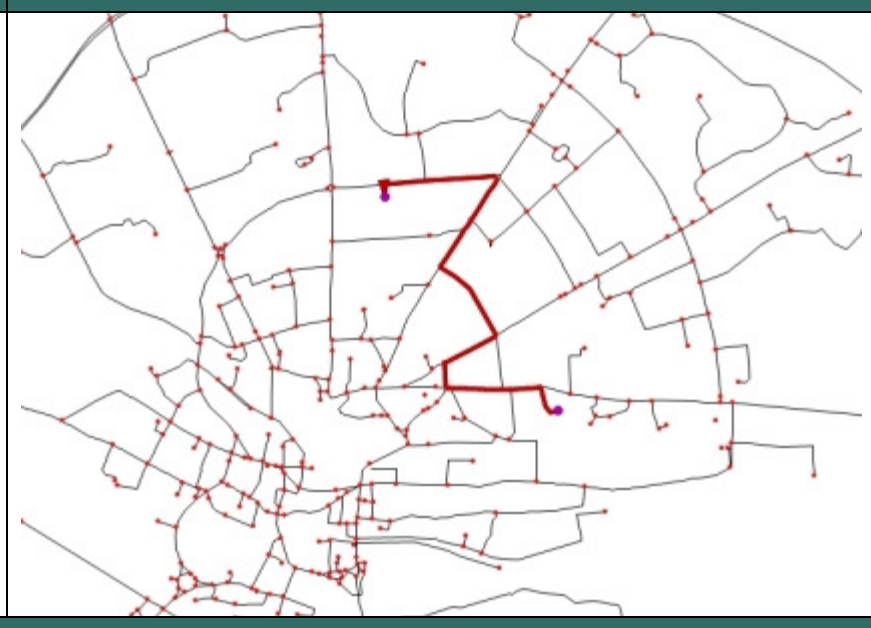
36 - LEB Model Routing Plots Between A46 and A57

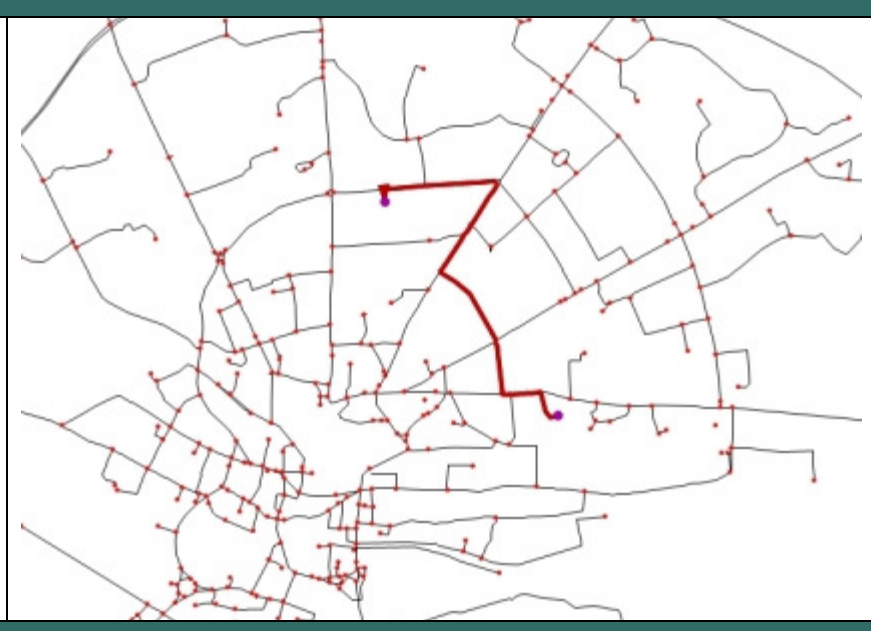


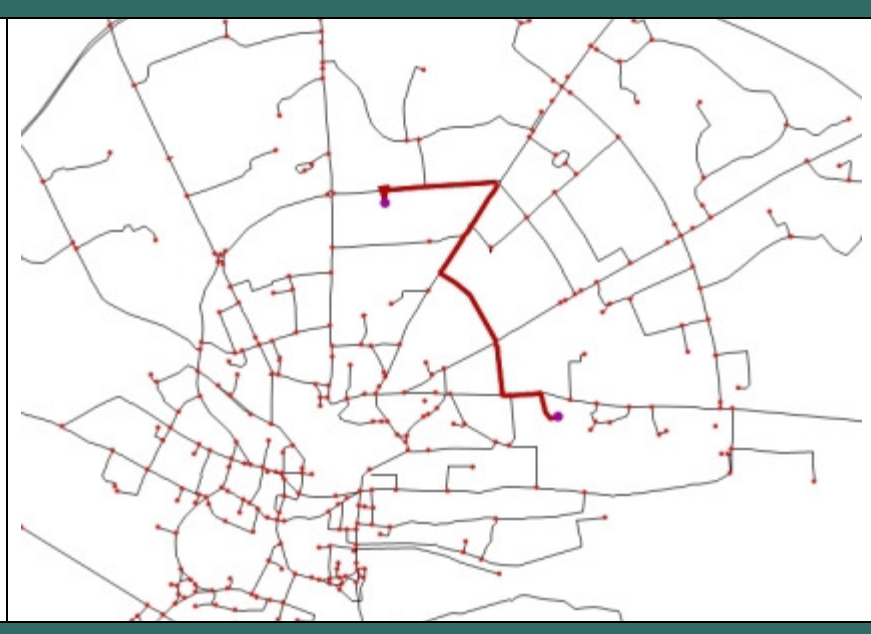
37 - LEB Model Routing Plots Between BishG and Hospital



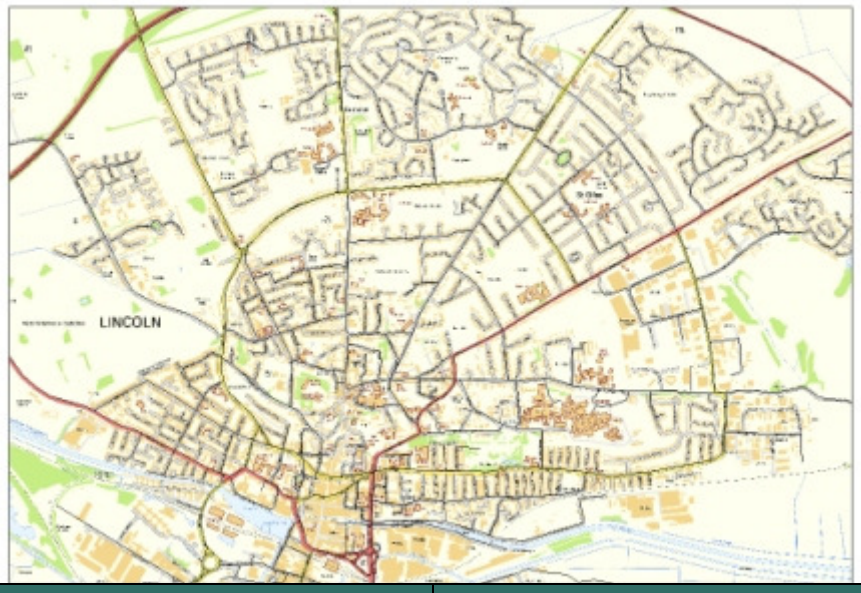


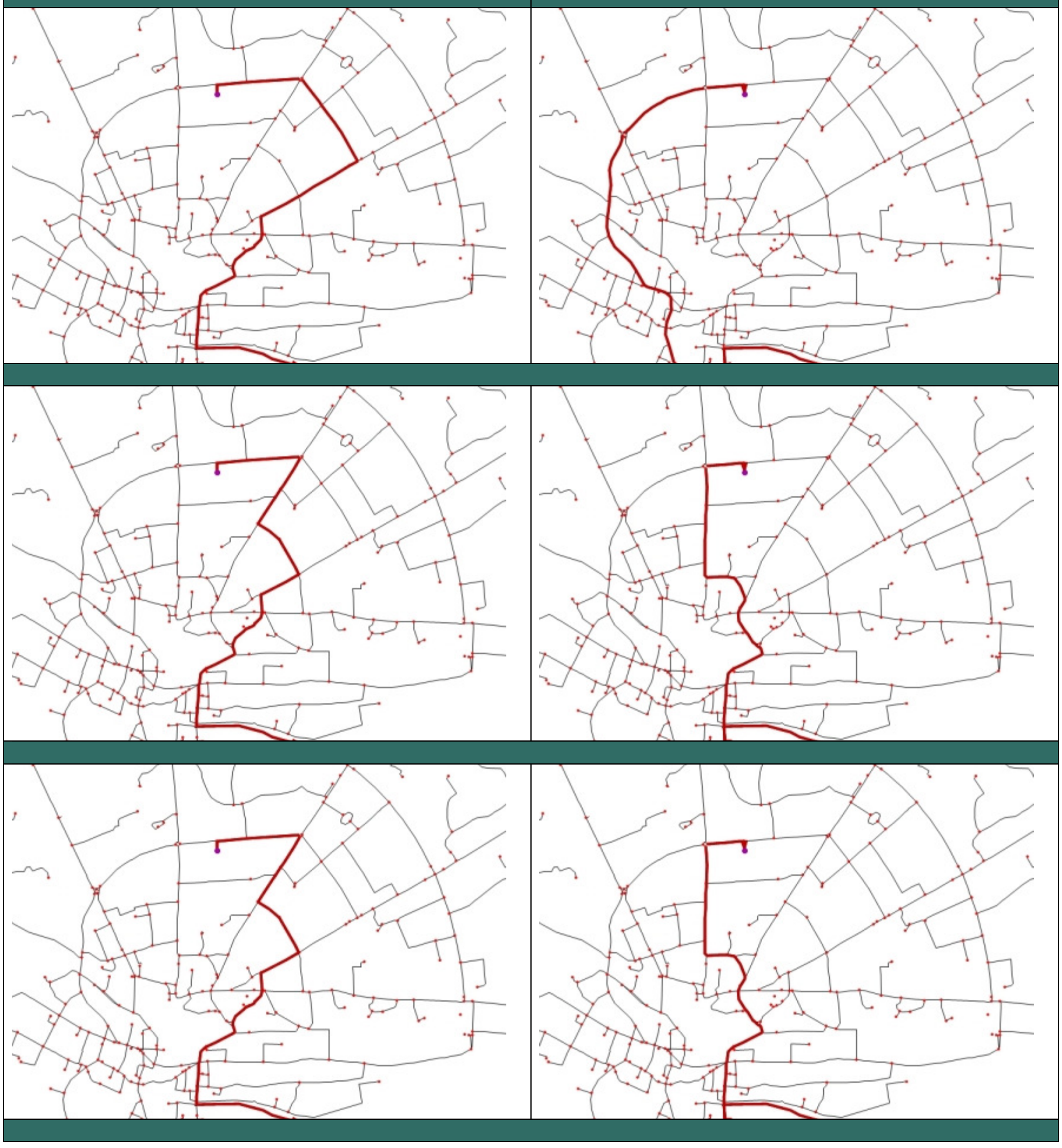




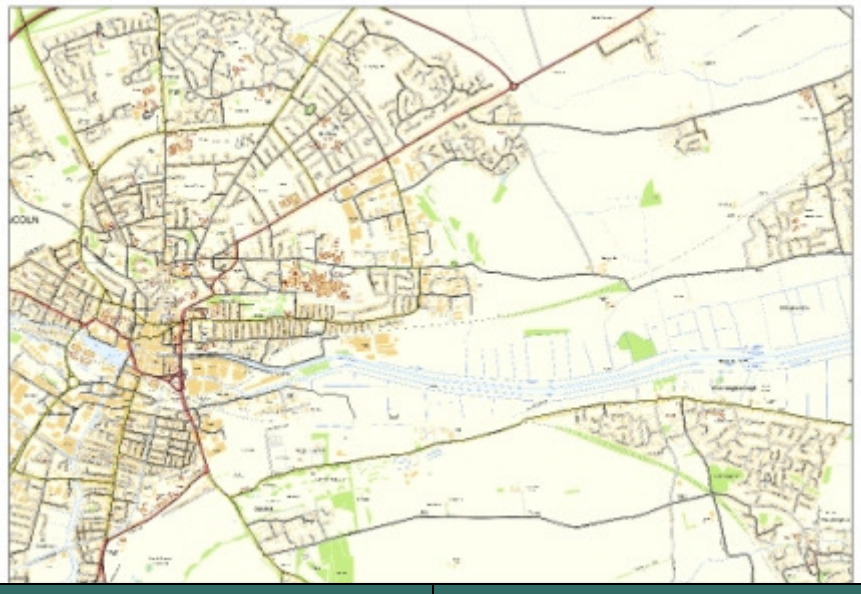


38 - LEB Model Routing Plots Between BishG and Enterprise

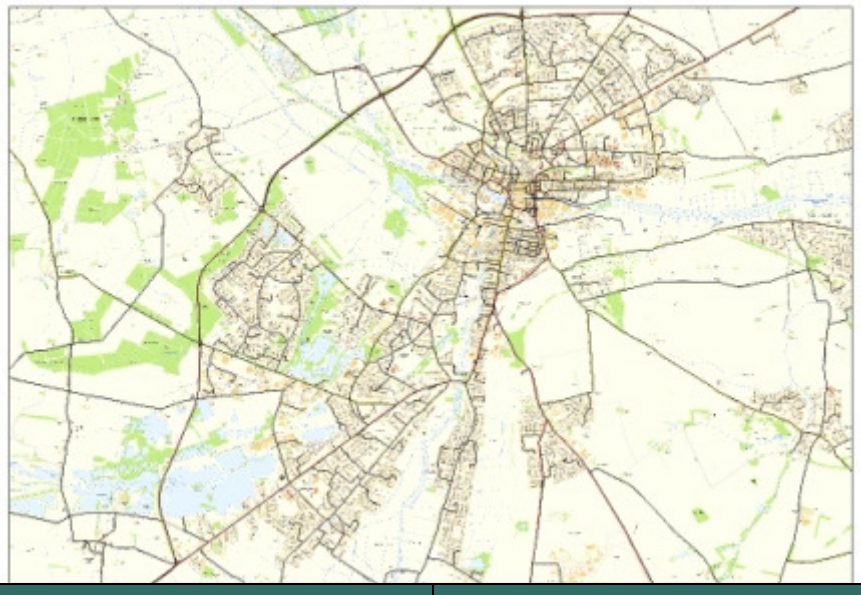


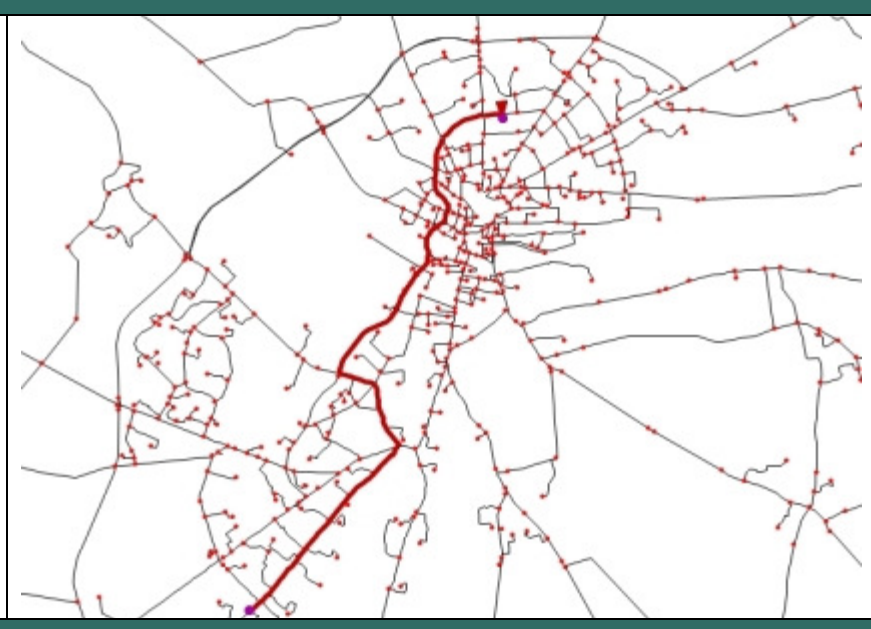


39 - LEB Model Routing Plots Between BishG and Washingb

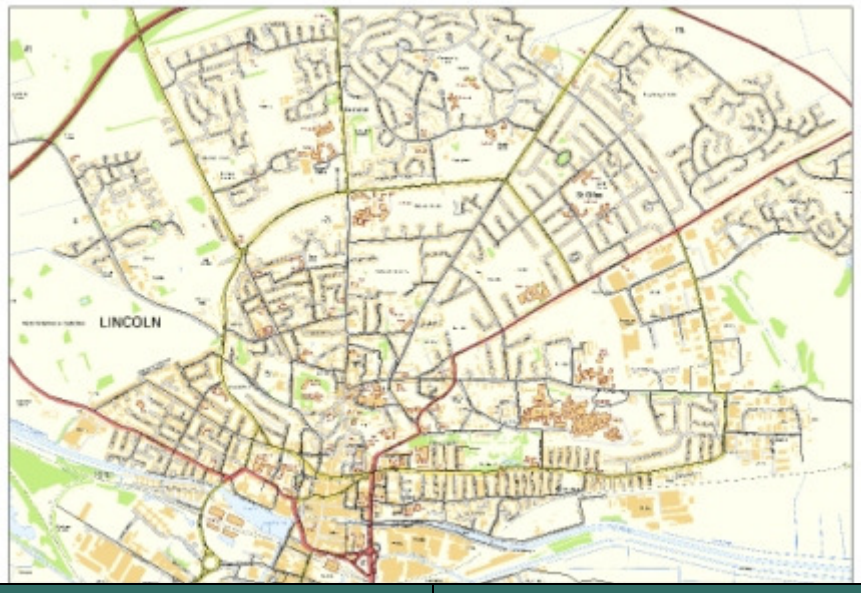


40 - LEB Model Routing Plots Between BishG and NHyke

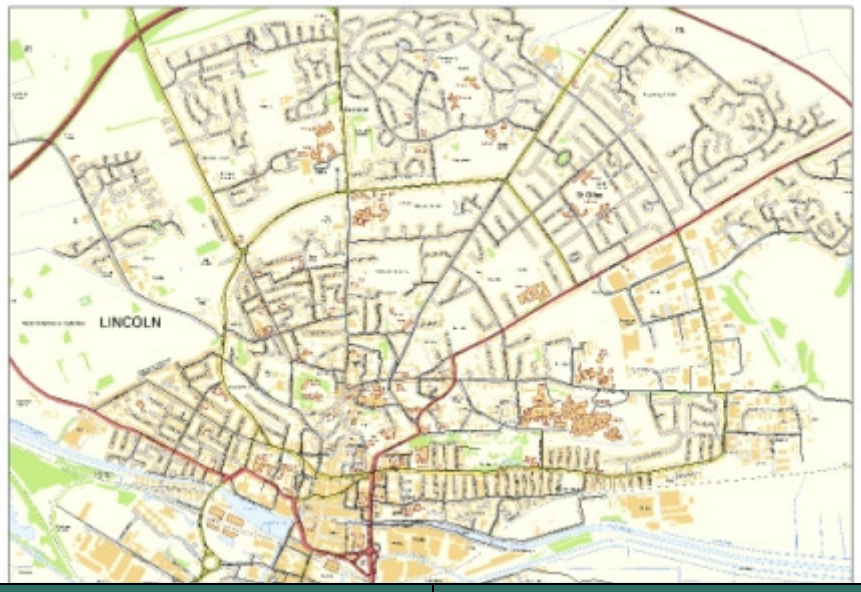


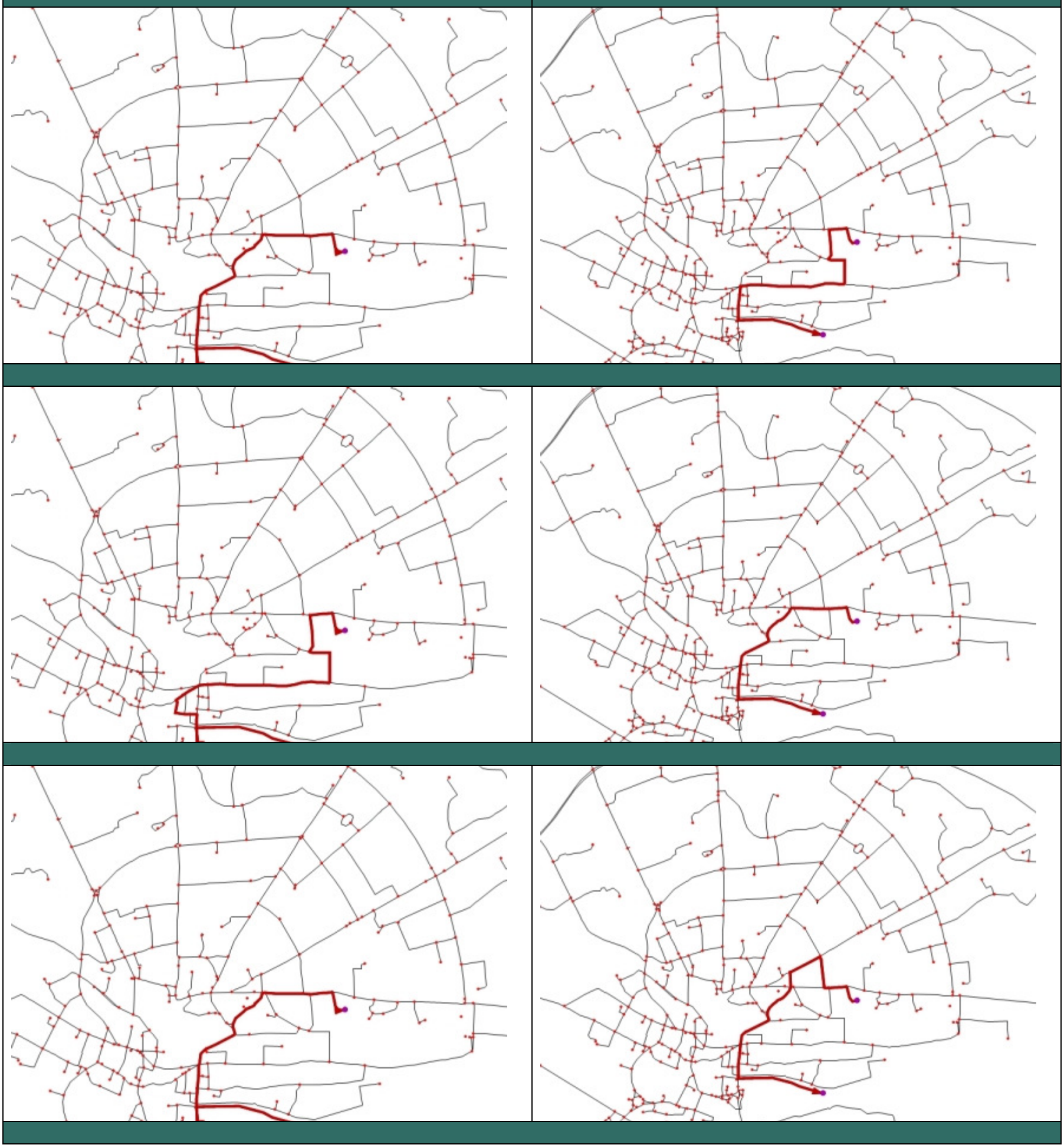


41 - LEB Model Routing Plots Between BishG and UniLincoln

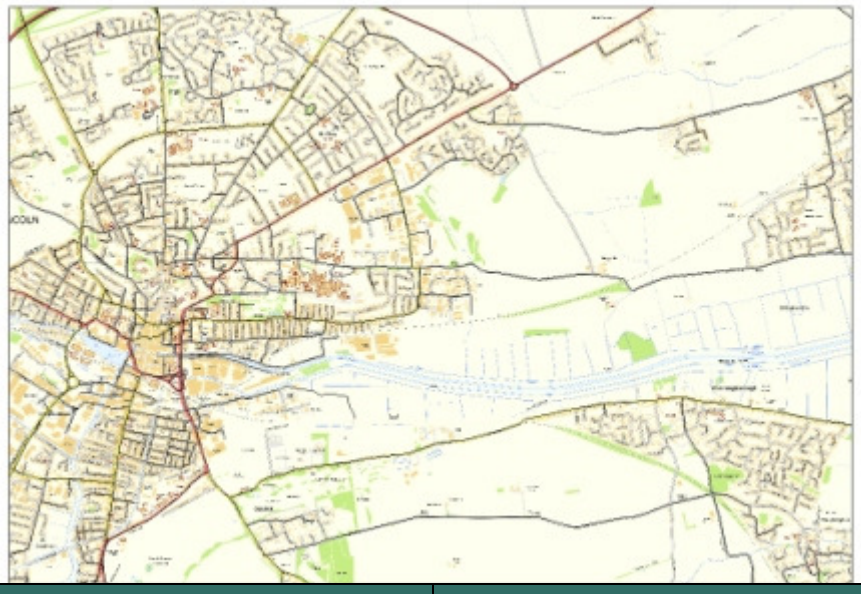


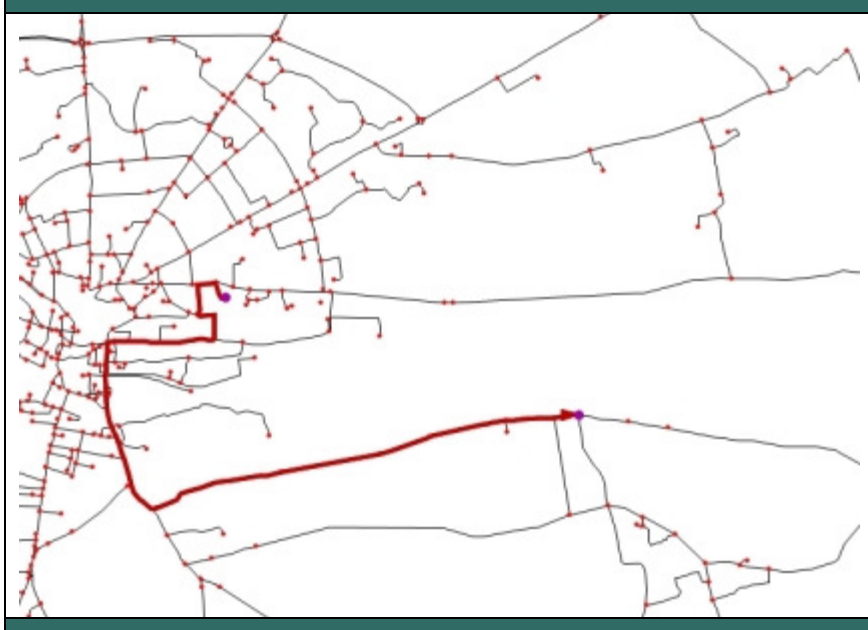
42 - LEB Model Routing Plots Between Enterprise and Hospital

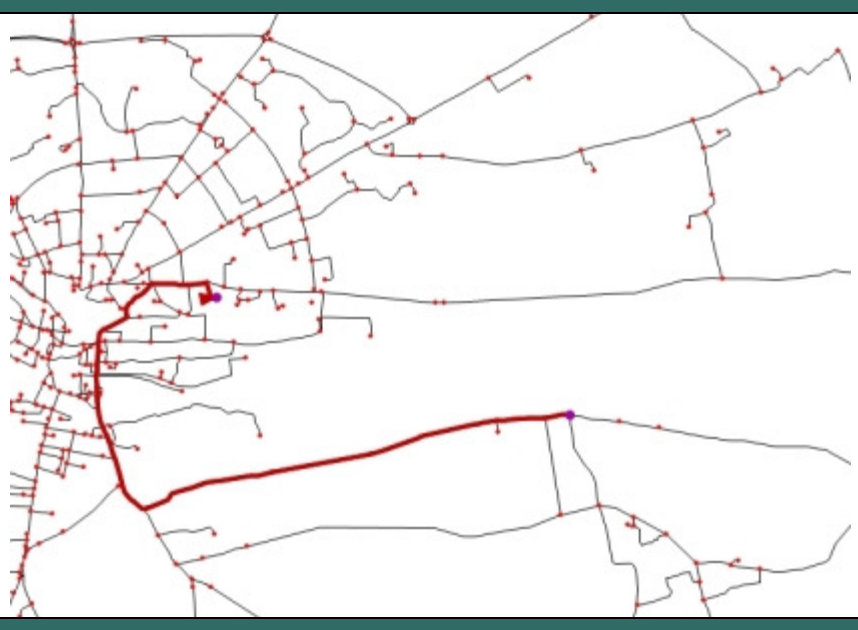


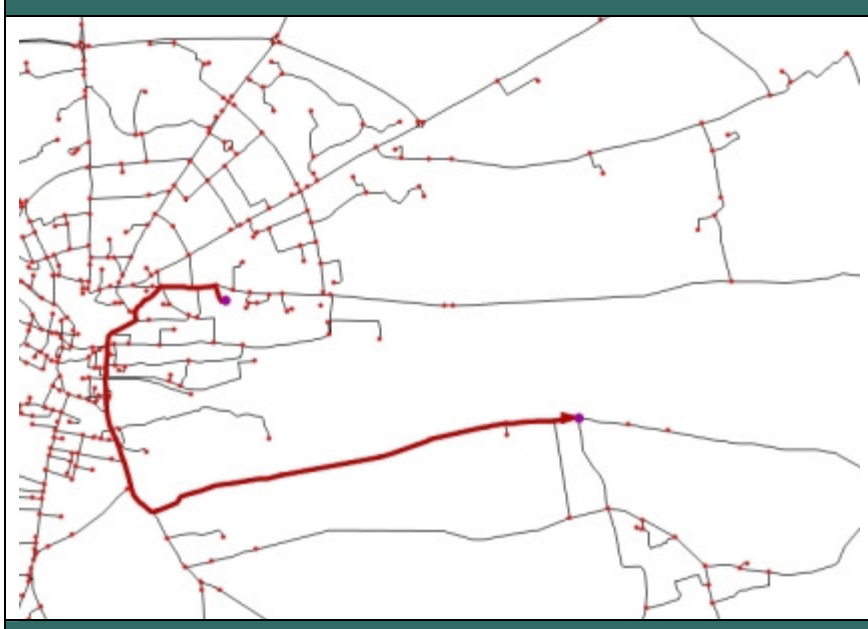


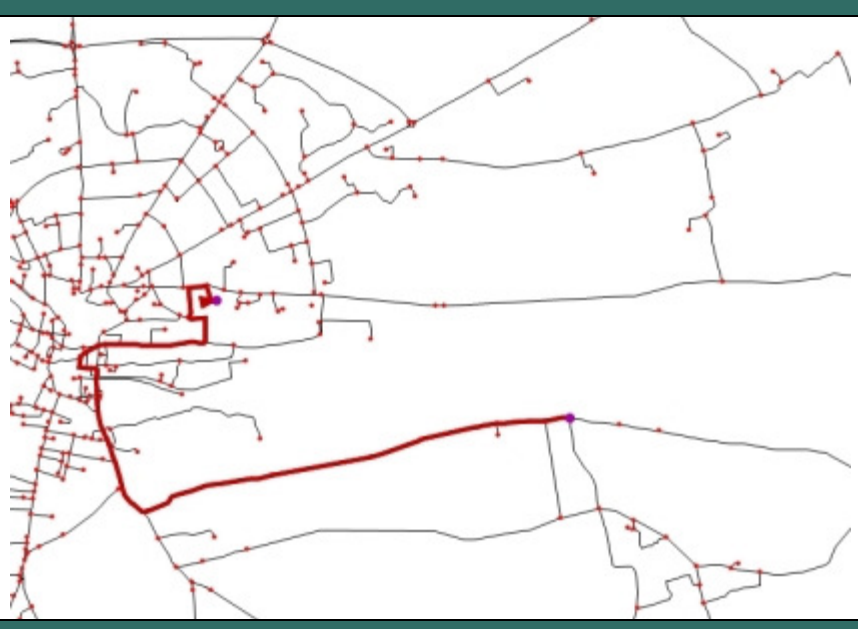
43 - LEB Model Routing Plots Between Hospital and Washingb



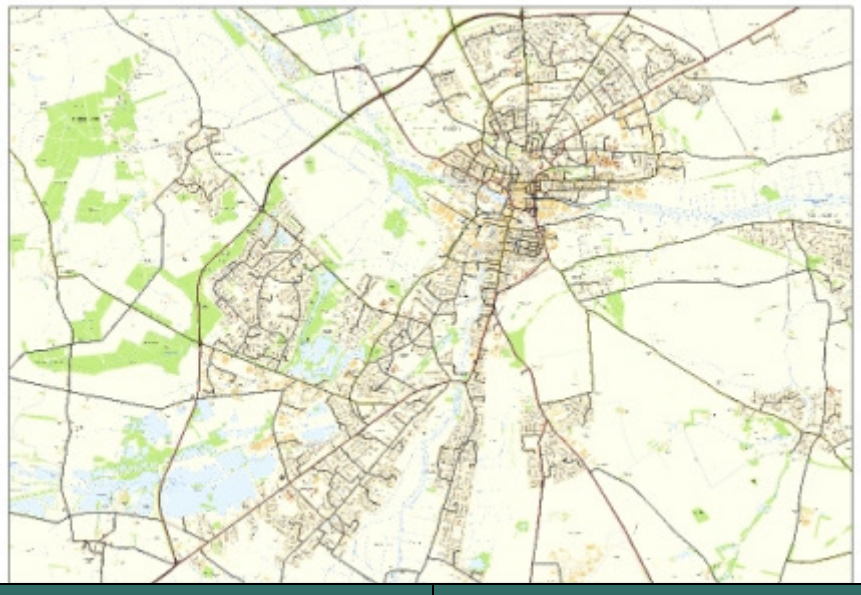




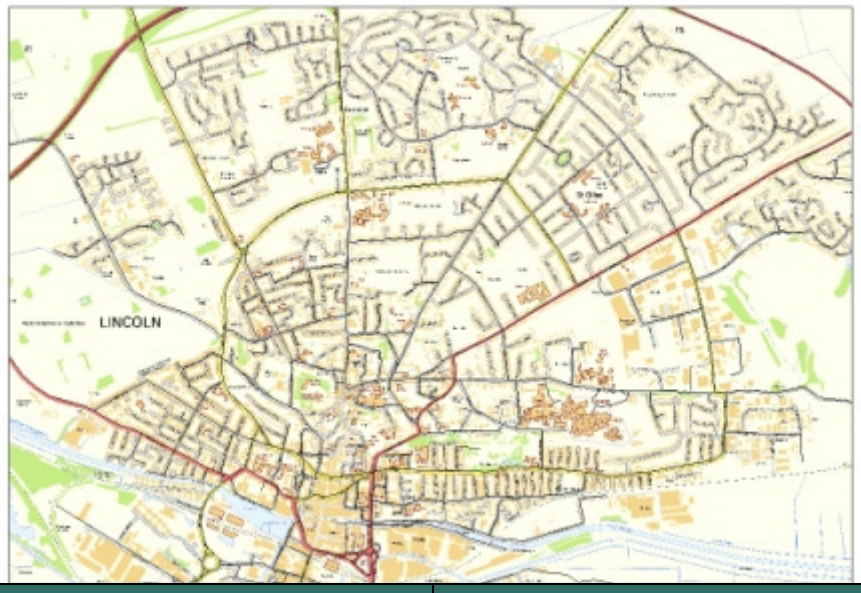


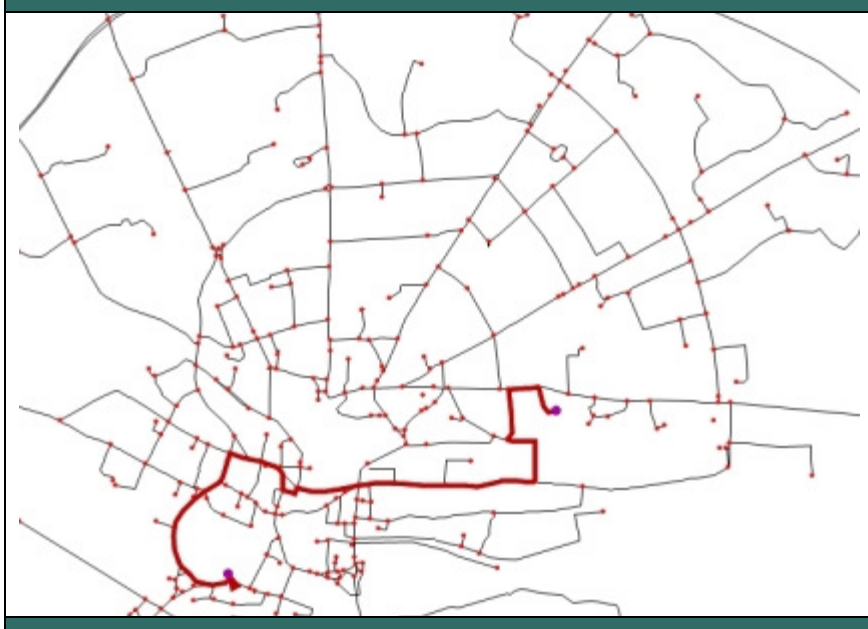


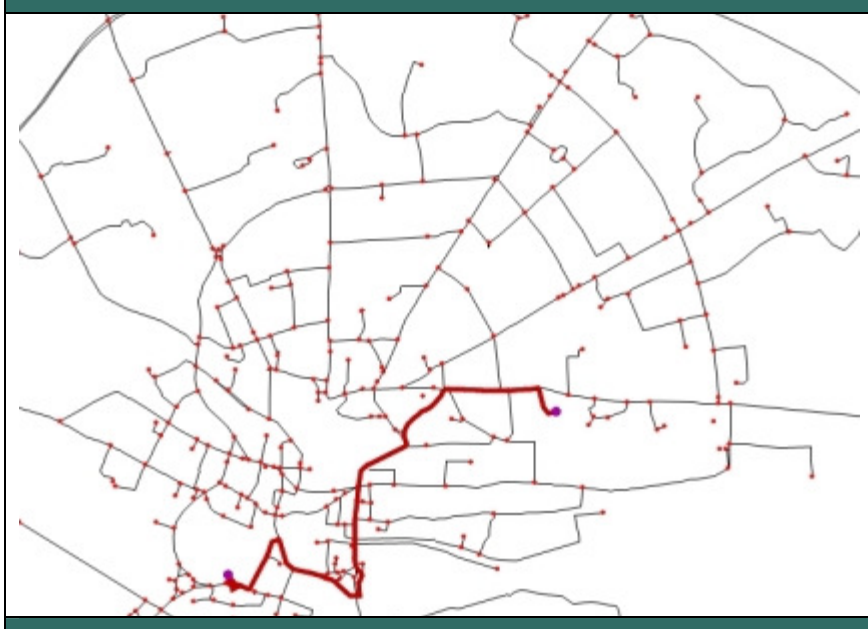
44 - LEB Model Routing Plots Between Hospital and NHyke

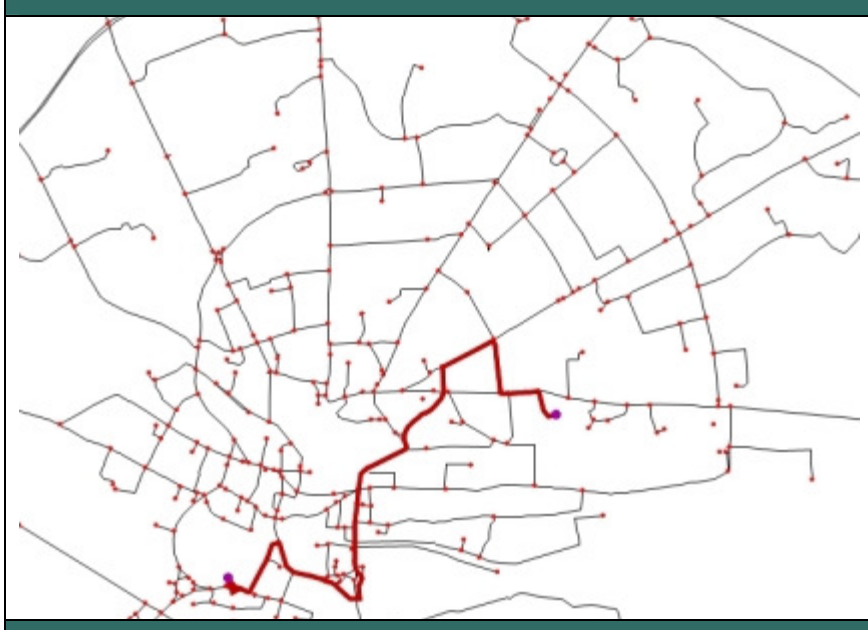


45 - LEB Model Routing Plots Between Hospital and UniLincoln

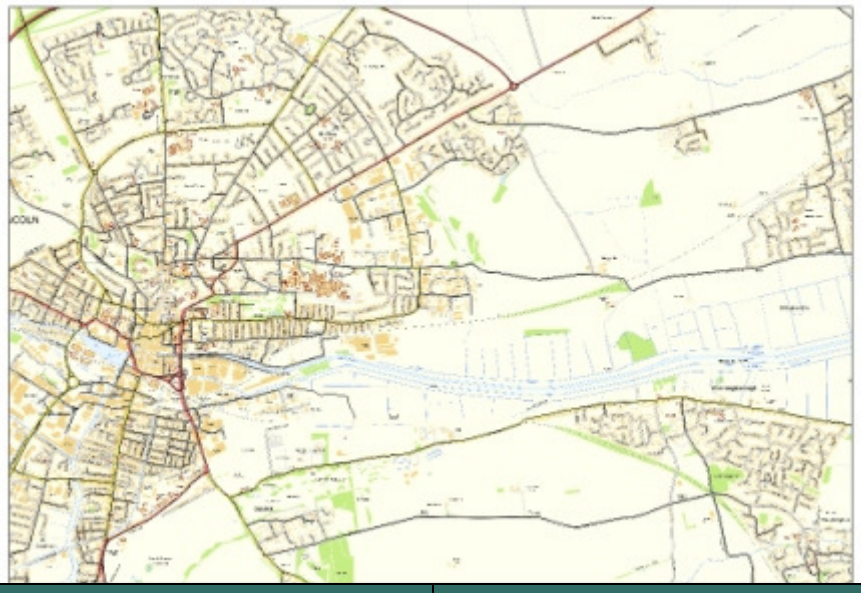


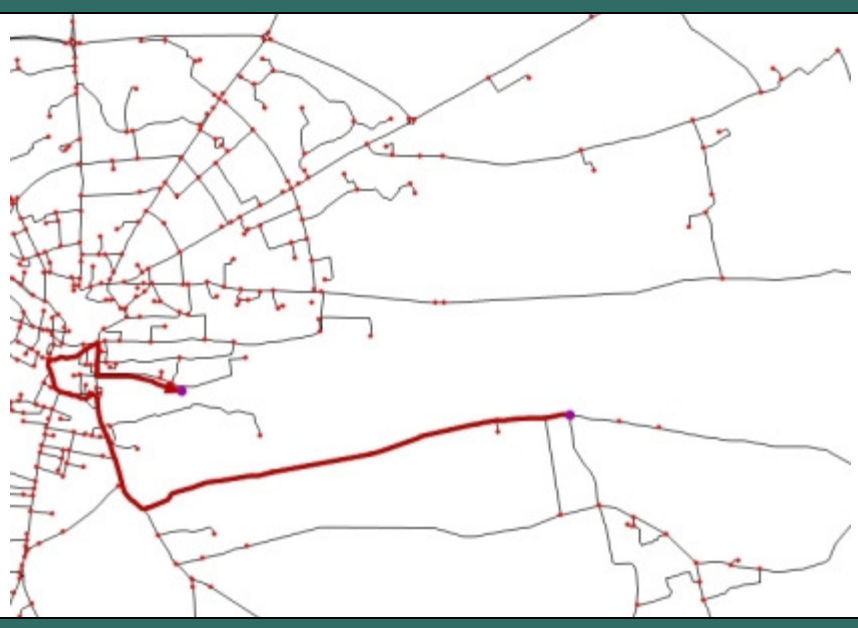




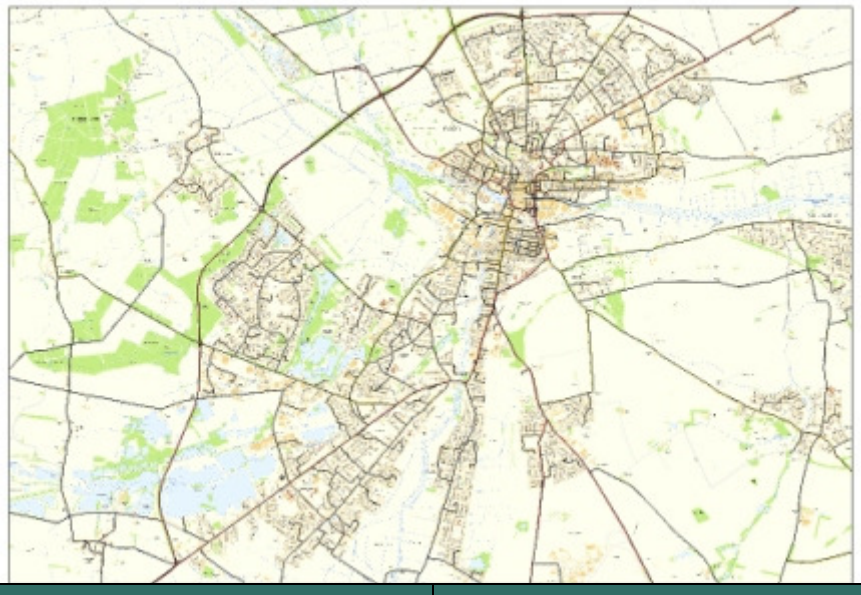


46 - LEB Model Routing Plots Between Enterprise and WashingB

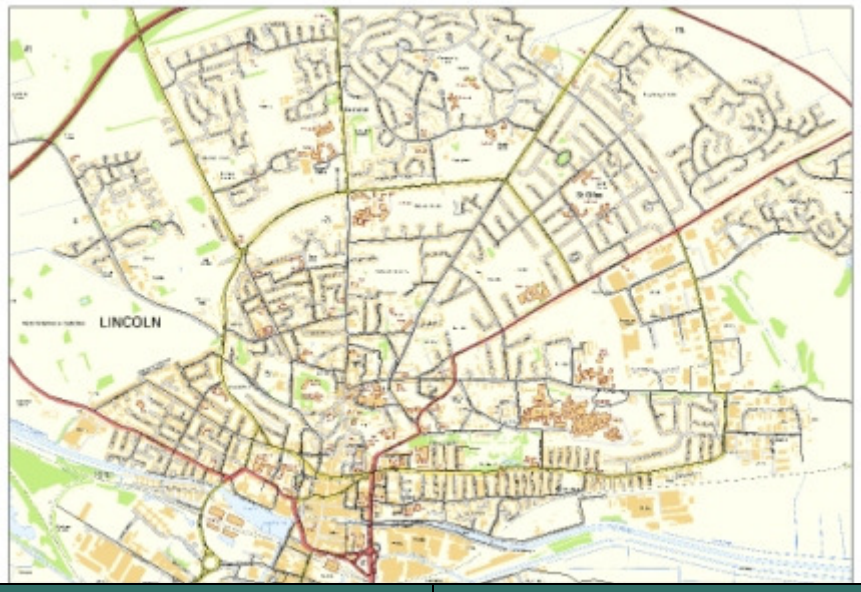


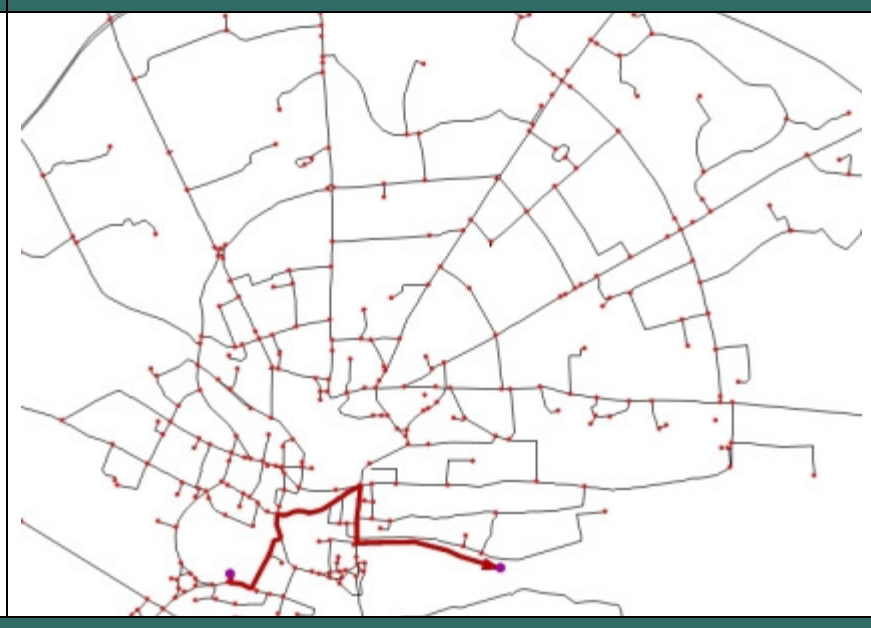


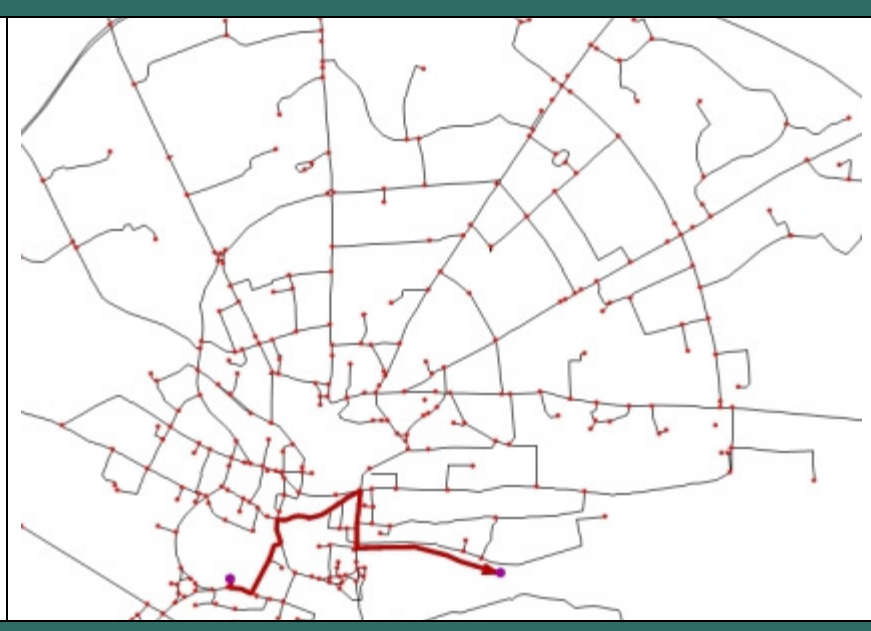
47 - LEB Model Routing Plots Between Enterprise and NHyke



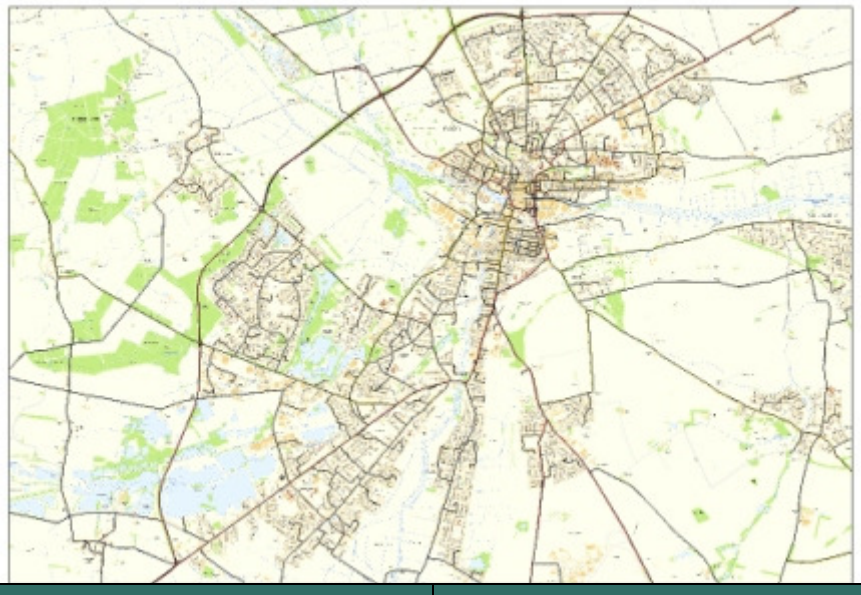
48 - LEB Model Routing Plots Between Enterprise and UniLincoln



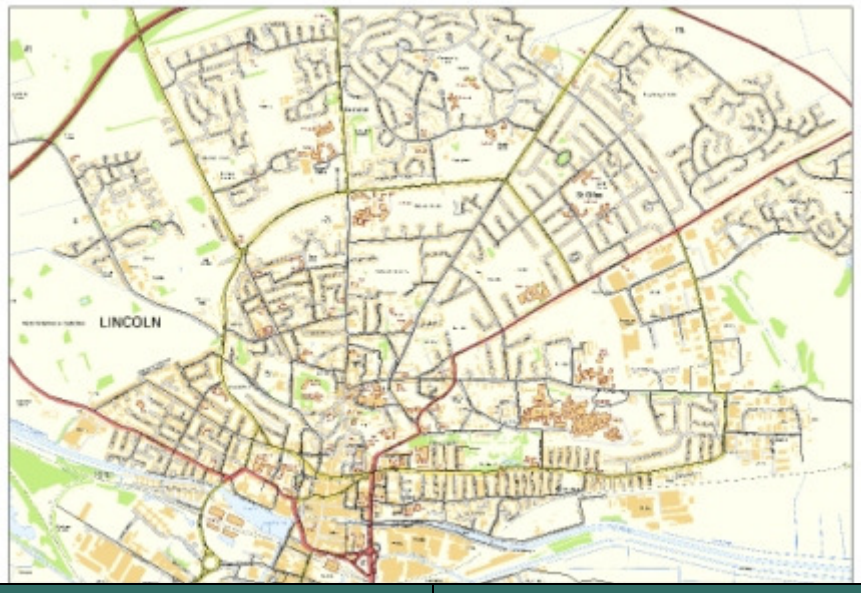


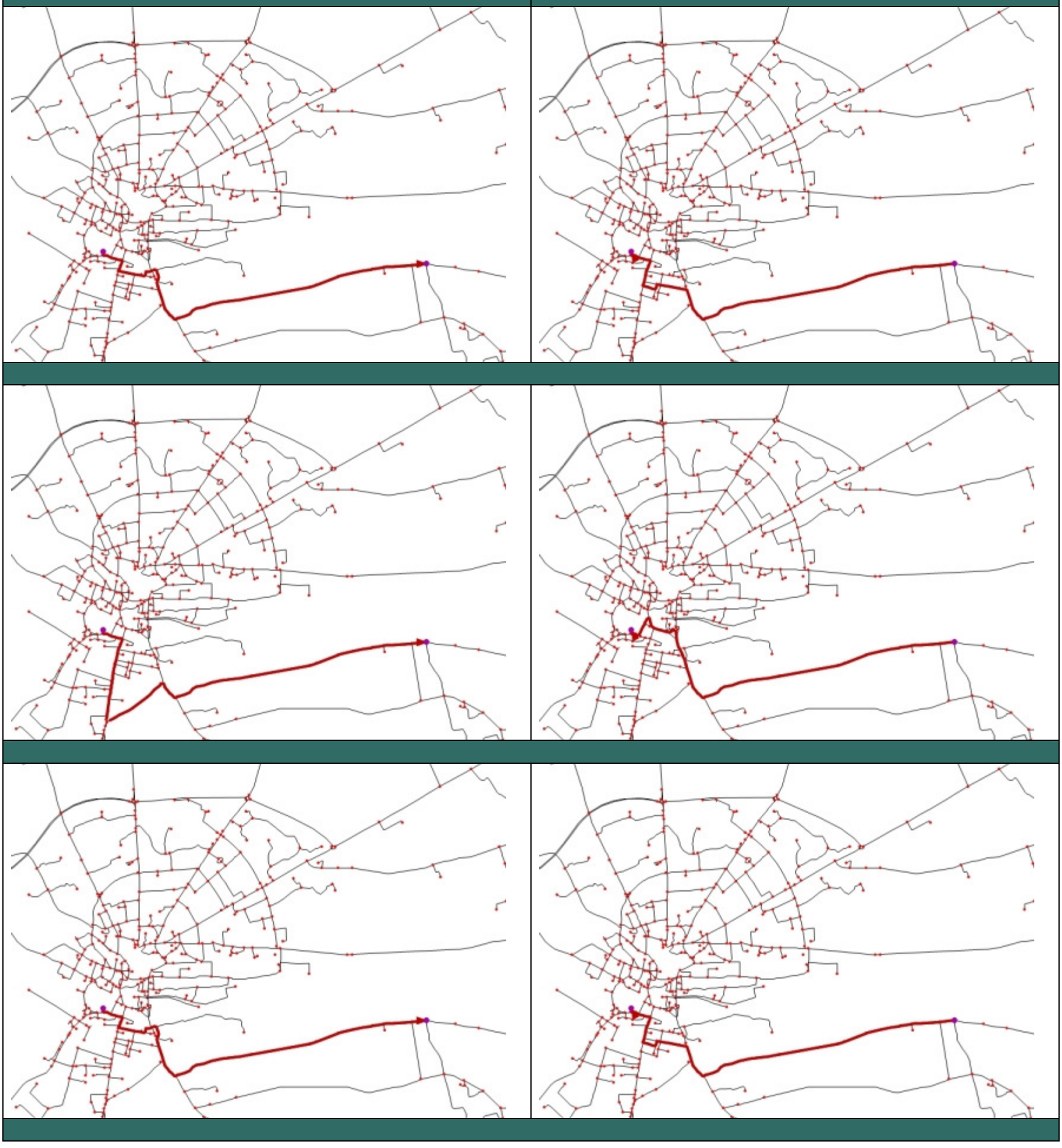


49 - LEB Model Routing Plots Between NHyke and Washingb

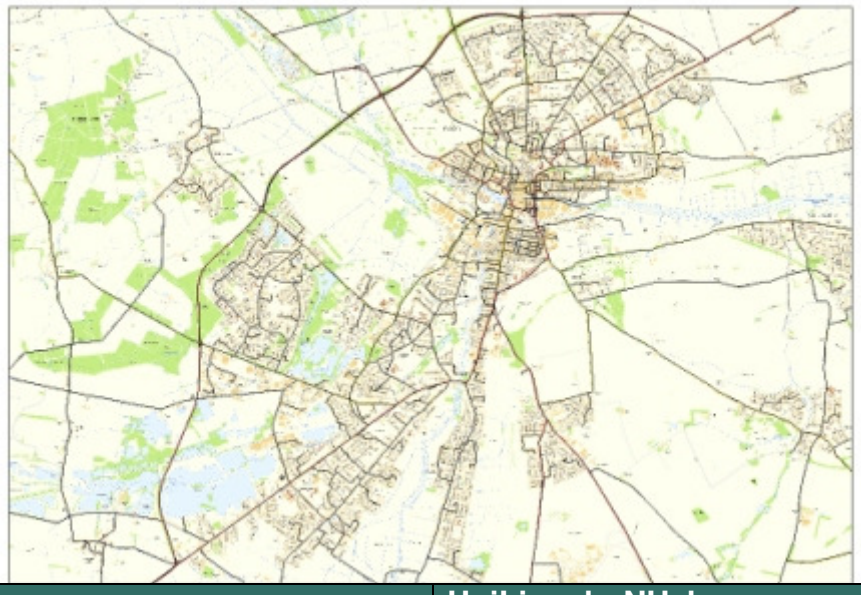


50 - LEB Model Routing Plots Between UniLincoln and WashingB





51 - LEB Model Routing Plots Between NHyke and UniLincoln



NHyke-UniLincoln	UniLincoln-NHyke
AM Peak Hour	
Inter Peak	
PM Peak Hour	

Appendix D – Forecasting Report

Lincoln Eastern Bypass

Forecasting Report

November 2012

Produced By

Lincolnshire COUNTY COUNCIL
HIGHWAYS ALLIANCE

Document Control Sheet

Project Title	Lincoln Eastern Bypass
Report Title	Forecasting Report
Revision	1
Status	Final
Control Date	November 2012

Record of Issue

Issue	Status	Author	Date	Check	Date	Authorised	Date
A	Final	SF/JP	28/11/12	AW	28/11/12	GB	28/11/12

Distribution

Organisation	Contact	Copies
Lincolnshire County Council	N McBride/ K Gibson	1 Electronic 2 Hard Copies

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1 Introduction

1.1 Purpose of the Forecasting Report

This Forecasting Report describes the approach adopted to produce the traffic forecasts required to inform the design process and support the planning application for the Lincoln Eastern Bypass (LEB).

In 2011, a business case was submitted to the DfT as part of a Best and Final Bid (BaFB) submission. The business case stated that the provision of LEB was to achieve three main objectives, these are as follows:

- **Objective 1:** To support the delivery of sustainable economic growth and the Growth Point agenda within the Lincoln Policy Area (LPA) through the provision of reliable and efficient transport infrastructure.
- **Objective 2:** To improve the attractiveness and liveability of central Lincoln for residents, workers and visitors by creating a safe, attractive and accessible environment through the removal of strategic through traffic (particularly HGVs).
- **Objective 3:** To reduce congestion, carbon emissions, improve air and noise quality within the LPA, especially in the Air Quality Management Area in central Lincoln, by the removal of strategic through traffic (particularly HGVs).

This report also describes the traffic forecasting process, methodology and assumptions adopted and used within the Transport Assessment (TA) for the proposed scheme.

1.1.1 Report Structure

Following this introduction and an overview of the forecasting requirements the Forecasting Report is structured as follows:

- Chapter 2. Overview of Forecasting Methodology
- Chapter 3. Future Year Developments
- Chapter 4. Future Year Networks
- Chapter 5. Future Year Travel Demands
- Chapter 6. Model Outputs
- Chapter 7. Summary & Conclusions

1.2 Forecasting and Appraisal Requirements

Forecasting the usage and performance of transport networks is a critical component of any transport appraisal. The principal purpose in the development of the future

year traffic forecasts in this instance is to support a planning application for the single carriageway LEB scheme. This section describes the requirements of the forecasting process for the design, transport assessment and the environmental impact assessment. These include the prediction of the future year travel demands and the assumptions relating to changes in the future year highway network.

The forecasting model has been developed in accordance with the latest guidance provided by the DfT in the TAG series of documents.

1.2.1 Future Year Travel Demand Scenarios

The principal requirement of the traffic model was the provision of traffic forecasts for the LEB scheme for the scheme Opening year (2017) and Design year (2032). Future travel demands at these dates take into account the existing traffic flows together with the effects of forecast traffic growth and the additional traffic expected to be associated with new developments.

The growth in traffic derives largely from forecast increased incomes and reducing household sizes which, together with changes in economic activity, are expected to result in an increase in car availability and car usage. In addition the growth in economic activities is forecast to lead to a redistribution of traffic and increased numbers of goods vehicle journeys.

The new development of residential, retail and employment land-uses in the Lincoln area will also create further demand for travel and these factors also need to be taken into account in the prediction of future travel demands.

There are some development schemes which are dependent on the LEB, i.e. they will not be fully progressed unless LEB is built. How these are dealt with in the forecasting process is presented in Chapter 3 along with the assumptions adopted for the future travel demands for the wider Lincoln area. All development information was provided by the Central Lincolnshire Joint Planning Unit (CLJPU).

1.2.2 Future Year Highway Strategy

The future year traffic models must also take into account the effects of other highway or traffic management schemes that are likely to be in place by the scheme's Opening and Design year. Information in relation to future highway/traffic management schemes was provided by Lincolnshire County Council (LCC). The highway and traffic management schemes that have been adopted in the future year traffic models are discussed in detail in Chapter 4.

1.2.3 Requirement for Scheme Design

The traffic forecasts assist in determining the standard of highway provision and the locations of scheme junctions, together with their layout and form of control. For the purpose of carriageway design the requirements include:

- 24 Hour Annual Average Daily Traffic (AADT) flows;
- Percentage of Heavy Goods Vehicles (HGV%); and

- Link Speeds.

For junction design the requirements include:

- Link flow forecasts for the AM, IP and PM peak hours; and
- Junction turning movements for the AM, IP and PM peak hours.

1.2.4 Requirement for Scheme Appraisal

Traffic flow forecasts were needed for the environmental appraisal including noise and air quality assessments. Outputs from the model therefore included:

- 24 Hour Annual Average Daily Traffic (AADT24) flows;
- 18 Hour Annual Average Weekly Traffic flows (AAWT18);
- Percentage of Heavy Goods Vehicles (HGV%); and
- Link Speeds.

2 Overview of Forecasting Methodology

2.1 Introduction

This chapter describes the main features of the 2006 Base Year model and presents an overview of the forecasting methodology that was adopted in the preparation of the Opening and Design year forecasts.

2.2 Base Year Model Overview

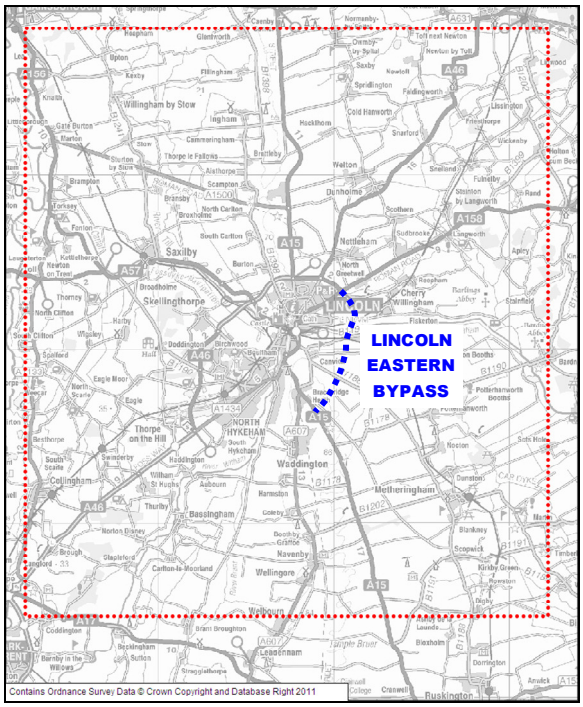
Details of the Base Year model are provided in the Local Model Validation Report (LMVR) (Transport Assessment Appendix A). An overview of the base year model is given below:

Model base Year – the base year for the model is 2006.

Software - The 2006 base year model has been developed using the PTV VISUM (version 12.01-09) suite of programs.

Study Area - The study area shown below in Figure 2-1 covers the urban area of Lincoln and surrounding hinterland, and broadly aligns with the LPA.

Figure 2-1 – LEB Study Area



Zoning System - The zoning system designed for the GLTM comprises 174 zones, of which 139 are internal zones, within the study area, and 35 are external zones. In order to represent traffic patterns to an adequate level of detail, the zoning system in Lincoln encompasses a number of smaller sized zones. Outside the study area the

zoning system is much less detailed with a smaller number of larger zones defined around major travel routes into the Greater Lincoln area.

Modelled Time Periods - Three time periods identified from the survey data were modelled in order to represent different trip patterns during a typical weekday, these were:

- AM Peak hour (08:00 – 09:00);
- PM Peak hour (17:00 – 18:00); and
- Average Inter-Peak hour (10:00 – 16:00).

Private Vehicle Classes - Three vehicle classes have also been modelled, including:

- Cars (including motor-cycles);
- Light Goods Vehicles;
- Heavy Goods Vehicles (including OGV1, OGV2 and PSV).

Modelled Highway Network - Within the study area, the modelled network includes all 'A' and 'B' class roads and most minor roads. Within Lincoln, residential roads that act as distributor routes or 'rat-runs' have also been included in the model. The network has been coded in detail to reproduce the effects of traffic queues and delays on vehicle routing patterns. Outside the study area, a coarse network of buffer links has been defined to include all major 'A' roads; from the A1 in the west to the A153 in the east, and from the M180 in the north to the A52 south. This ensures that long distance traffic is properly routed into and around the Greater Lincoln area.

Highway Matrix Development - The process of building demand matrices was based on a comprehensive review of available data sources and their application. Following analysis of available survey data and other data sources, the principle task included construction of the observed trip matrices, largely from the Lincoln cordon survey, and development of complementary synthetic matrices to represent the unobserved demand components. The observed and synthetic matrices were merged to form the final base year model demand matrices.

Highway Model Calibration - The calibration of the Base Year Traffic Model was undertaken using a standard approach where the network was adjusted to ensure that the model realistically replicated routing and vehicle speeds through the study area. Matrix estimation was incorporated in the model calibration process in order to obtain matrices based on the routing patterns to which the network was calibrated.

Highway Model Validation – Network validation was undertaken to establish that the network structure was accurate and that characteristics of the network are suitably represented in the model. A number of range and logic checks were undertaken,

including routing checks. Assignment validation was then undertaken for traffic flows (links and turns) and journey times.

The development of the Base Year Traffic Model and its validation against observed traffic flows and journey times are fully documented in the Local Model Validation Report (A).

2.3 Forecast Model Overview

The Greater Lincoln Traffic Model (GLTM) is designed to predict the results of development options and transport interventions under different future travel scenario assumptions. Forecasting has been carried out using a fixed matrix approach. This means that future demand matrices are solely based on assumptions on the level of future development and growth estimates of background traffic; i.e. forecast models have not been produced using a variable demand process and so forecast matrices are not affected by changes in future travel costs.

'Strategies' refer to combinations of different transport interventions, which in broad terms encompass changes in capacity, e.g. new infrastructure, operating conditions, and prices. Strategies typically include a Reference Strategy, referred to as the Do-Minimum (DM), against which a scheme is tested, referred to as the Do-Something (DS).

'Scenarios' refer to the level, distribution and structure of population, number of households, employment, as well as general economic variables such as the level of GDP and fuel prices.

The forecasting work has been undertaken for two years; design (2017) and opening (2032), using two strategies (DM and DS) and adopting a single scenario (Core Scenario) which relates to future growth forecasts and assumptions in the Development Log. The assumptions adopted in defining these scenarios are described in Chapter 3 of this report.

2.4 Forecast Model Stages

The forecasting process comprised the following stages:

- Define future year travel Scenarios;
- Define future year intervention Strategies;
- Undertake DM and DS forecasting ;
- Reporting of model outputs.

Each of these stages is described in the following chapters.

3 Future Year Developments

3.1 Introduction

This chapter presents the development assumptions adopted in the derivation of the future year forecasts for the scheme's Opening and Design years. Assumptions relating to future developments have been produced in accordance with DfT's guidance included in the Web TAG Unit 3.15.5 (April 2011).

3.2 Uncertainty Log

A robust set of assumptions relating to land use and future developments within the Lincoln Policy Area was generated as part of the forecasting process. The land use forecasting assumptions were based on two broad key land use types:

- Employment – Measured by site area (hectares); and
- Housing – Measured by number of dwellings.

A detailed development log was generated to collate all developments built, proposed or planned for the Lincoln Policy Area covering the period from 2006 through to the opening year (2017) and the design year (2032).

The list of committed developments to be considered was provided by the Central Lincolnshire Joint Planning Unit (CLJPU) and taken from the Strategic Housing Land Allocation Assessment (SHLAA) database (June 2012). This was undertaken with guidance from the CLJPU and included the following site classifications:

- Class A – Sites which are expected to come forward within the next five years which mainly have extant planning permission or are under construction.
- Class B – Developable sites, which in terms of the National Planning Policy Framework (NPPF) cannot be said to be deliverable but there are no specific known constraints to their development and are expected to come forward in years 2016/17 to 2020/21.
- Class C – These are proposed Sustainable Urban Extensions. In Central Lincolnshire the following three sites are proposed around Lincoln:
    - The Western Growth Corridor – Following a number of discussions with the site proponents the CLJPU is currently working on the assumption that the site could deliver 180 dwellings per annum commencing construction in 2016/17, which would amount to 2,700 dwellings by 2031.
    - The South East Quadrant (SEQ) and North East Quadrant (NEQ) – Lincolnshire Highways Alliance have advised that no development can take place on either site until the LEB is constructed. On this basis, under the assumption that the LEB will be complete in 2017/18

and the developers have suggested that they could achieve 200 dwellings per annum on each site, by the design year (2032) the NEQ could contain 2,000 dwellings (maximum) and SEQ 2,800 homes.

- Class D - The rest of the Lincoln Principal Urban Area requirement will be drawn from SHLAA sites classed D, which are sites considered to be constrained in some way and it is unknown if those constraints can be overcome at the current time, together with any other identified sites which come forward over the plan period.

It was agreed with the CLJPU to filter the SHLAA database to include developments that are inside the study area and to only include housing developments above 200 units in size. The local impact of smaller developments is considered negligible and the overall additional traffic associated with these developments will be accounted for by TEMPRO growth.

The employment data was given by total site area in hectares and where sufficient detail was not available development density factor of 0.35 was used to calculate the actual Gross Floor Area (GFA). The specific details relating to each development were collated from the respective Transport Assessment or from the technical knowledge of LCC Transportation Group.

Each development detailed within the development log was assessed against the likelihood of it being built. Table 3-1 below explains the relationship between the certainty of a development being built and the certainty classification used in the development log.

Table 3-1- Certainty Log Criteria

Certainty Log:	
90-100%	Certain/Nr Certain
70-90%	More than Likely
50-70%	Reasonably Foreseeable
<50%	Less than 50% Certain

3.3 Scenario Definition

The resulting 'certainty' classification was then assigned to a particular scenario and also assessed as to whether developments were also dependent on the LEB scheme. Each development was categorised and assigned to one of the travel scenarios detailed in Table 3-2.

Table 3-2 – Development Scenario Classification

Development Scenario:	
Certain/Nr Certain	Pessimistic
Pessimistic + More than Likely	Core
Core + Reasonably Foreseeable	Optimistic
Less than 50% Certain	Not Modelled

It was agreed with the LCC Principal Transportation Projects Officer that only those developments that formed the Core Scenario would be included within the assessments for the LEB single carriageway planning application.

3.3.1 *LEB Dependent Developments*

The scoping work for the Transport Assessment also identified two key developments that were dependent on the LEB; these were the North East Quadrant (NEQ) and South East Quadrant (SEQ) sustainable urban extension sites. In this instance it was decided in conjunction with LCC that the Do Something Scenario should include the LEB dependent developments (NEQ & SEQ) as this would provide the most realistic and robust set of forecasts that would be in line with the emerging Core Strategy.

3.4 Development Assumptions

The Core Scenario development assumptions that form the basis for forecasts are summarised in Table 3-3.

Table 3-3 – Core Scenario Development Assumptions

Committed Development: Location & Description	Size (ha)	Dwellings (units)	Scheme Depen-dency	Site Open Date	Do Min/ Do Something	Fore-cast Years
Development: North East Quadrant, Centre bounded by LEB 48.5% B1, 33.5% B2, 18% B8 + housing	5	2,000	LEB	2031	Do Something	Design Year
Development: Teal Park - Whisby Road/ Station Rd SW Lincoln Phase 1: B1, B2, B8 (Siemens) 21,140sqm, 6,500 hotel, public house, restaurant, 14,300 sqm trade counters, showrooms, leisure.	10		N/A	2016	Do Minimum	Opening Year
Development: Western Growth Corridor (WGC) - W & SW of Lincoln city centre. C3 Residential Units, 5,750sqm (A1, A2,A3,A4), 36ha B1/B8, 6.35ha D1, 3.1ha Park & Ride	36	2,700	N/A	2031	Do Minimum	Design Year
Network Change: Part of the WGC From A46 to Tritton Road with a connection to the Skellingthorpe Road/Birchwood			N/A	2016	Do Minimum	Opening Year

Committed Development: Location & Description	Size (ha)	Dwellings (units)	Scheme Depen-dency	Site Open Date	Do Min/ Do Something	Fore-cast Years
Avenue junction						
Development: South East Quadrant; SE of Lincoln between Bracebridge Heath and Canwick between the A15 and the B1188 19 ha of employment land and 2,800 homes by 2031	19	2,800	LEB	2031	Do Something	Design Year
Development: Employment Land Review Sites - By 2016. 33 individual sites ranging from 0.05ha – 2 ha	1.19		N/A	2016	Do Minimum	Opening Year
Development: Employment Land Review Sites - By 2026 7 individual sites ranging from 0.14 – 2.79	0.64		N/A	2026	Do Minimum	Design Year
Network Change: Clasketgate one-way from Broadgate to West Parade Lincoln City Centre Highway improvement scheme.			N/A	2009	Do Minimum	Opening Year
Network Change: Beaumont Fee one-way from West Parade Lincoln City Centre Highway improvement scheme. Now signalised junction between West parade/ Clasketgate/ Beaumont Fee			N/A	2009	Do Minimum	Opening Year
Network Change: High Street environment improvements (from Portland Street to St Catherines) Now formalising parking by reducing footway and creating two lanes including informal bus priority lane.			N/A	2011	Do Minimum	Opening Year
Development: Lindongate development, Lincoln City Centre. Approx 34,000sqm of A1 retail, 4,000sqm of A3 restaurant & bar use, 21 apartments of C3 residential, New Bus station, up to 900 space carpark (680 short stay, 20 residential, 150 long stay network rail)	3.8	21	N/A	2015	Do Minimum	Opening Year
Network Change: East West Link Phase 1 - Lincoln City Centre			N/A	2014	Do Minimum	Opening Year
Network Changes/Development: Sainsbury's, Tritton Road, Lincoln. Expansion of the existing store from 3,756 to 9,170 sqm and redevelopment of the Tritton Road/ Doddington Road Junction.			N/A	2010	Do Minimum	Opening Year
Network Changes: Railway Crossings, Brayford Wharf East. Barrier downtime increased to 27min/hr			N/A	2014	Do Minimum	Opening Year
Development: Carholme Road, Lincoln Ex industrial site now being redeveloped		244	N/A	2012	Do Minimum	Opening Year

Committed Development: Location & Description	Size (ha)	Dwellings (units)	Scheme Depen-dency	Site Open Date	Do Min/ Do Something	Fore-cast Years
for housing						
Development: Ruston Works, Pelham Street, Lincoln (CL533)		819	N/A	2021	Do Minimum	Design Year
Development: Land at Firth Road (CL534)		200	N/A	2021	Do Minimum	Design Year
Development: Mill Lane/Newark Road, North Hykeham (CL1113)		314	N/A	2016	Do Minimum	Opening Year
Development: BW(M)1 (part of remaining capacity) (CL1535)		302	N/A	2016	Do Minimum	Opening Year
Development: G11 Foxby Lane, Park Springs Road (CL1633)		275	N/A	2016	Do Minimum	Opening Year
Development: LF2/3 Land off Wolsey Way (CL1687)		374	N/A	2016	Do Minimum	Opening Year
Development: Former Lincoln Castings Site A, Plot 1, Station Road, North Hykeham (CL2098)	10.3	310	N/A	2021	Do Minimum	Design Year
Development: Former Lincoln Castings Site A, Plot 1, Station Road, North Hykeham (CL248)		229	N/A	2021	Do Minimum	Design Year
Development: Local Plan Allocation H9, Land North-West of Nettleham Road (CL515)		213	N/A	2016	Do Minimum	Opening Year
Development: Land between, Newark Road/Mill Lane, North Hykeham, Lincoln (CL58)		206	N/A	2016	Do Minimum	Opening Year
Development: Land at Ruston Way, Brayford Enterprise Park, Lincoln LN6 7FS (CL607)		226	N/A	2016	Do Minimum	Opening Year
Development: E2V Engineering works, Carholme Road, Lincoln (CL770)		255	N/A	2016	Do Minimum	Opening Year
Development: Cardinal Grange, 544 Newark road , North Hykeham, Lincoln (CL81)		322	N/A	2016	Do Minimum	Opening Year
Development: Former Lincoln Castings Site B, Station Road, North Hykeham (CL927)	1.02		N/A	2016	Do Minimum	Opening Year
Development: Land east of Lincoln Road, Skellingthorpe (CL994)		207	N/A	2016	Do Minimum	Opening Year

3.5 Trip Rate Extraction

Using the development data presented in the tables presented above, trip rates were calculated using the TRICS software package. The TRICS software package is a database of observed arrivals and departures for a variety of sites and land use types across the UK, and is used to estimate trip generation for proposed developments. All developments contained within the development log were classified into the TRICS land uses and their respective trip rates generated using

the TRICS software. All housing was classified as privately owned households and the different land uses within the wider development zones (e.g. NEQ, SEQ and WGC) were treated separately and then combined to generate a total number of trips arriving/leaving at each site.

Residential trip ends using these trip rates were compared with predicted residential trip end increases from TEMPRO. The total number of new residential dwellings compared well between the development log and TEMPRO, however the increase in trip ends was inconsistent, as TEMPRO trip ends were approximately half of those calculated using the TRICS trip rates. This is due to there being no directly comparable datasets within TRICS for large scale residential developments such as the wider development zones (e.g. NEQ, SEQ, WGC) resulting in a higher trip rate being calculated for these sites than would normally be expected. In addition because forecast matrices were ultimately to be constrained to TEMPRO growth, the trip rates for the development sites were factored to provide trip ends consistent with TEMPRO. Table 3.4 below shows a comparison between the trip ends at development sites using TRICS trip rates and trip ends calculated through TEMPRO.

Table 3-4 – Comparison of Trip Ends for Development Sites using TRICS and TEMPRO

Time Period	Development Type	TRICS Trip Ends		TEMPRO Trip Ends		TEMPRO Adjustment Factor	
		Trip Ends Origin	Trip Ends Dest.	Trip Ends Origin	Trip Ends Dest.	Trip Ends Origin	Trip Ends Dest.
2017							
AM	Residential	340	954	224	409		
	Non-residential	992	616	414	279		
	Total	**1332**	**1570**	**638**	**688**	**0.48**	**0.44**
IP	Residential	854	928	426	580		
	Non-residential	1128	3562	745	1524		
	Total	**1983**	**4490**	**1171**	**2104**	**0.59**	**0.47**
PM	Residential	3418	2248	1389	1011		
	Non-residential	3127	3291	1569	2061		
	Total	**6545**	**5540**	**2958**	**3071**	**0.45**	**0.55**
2032							
AM	Residential	3641	1514	1685	1004		
	Non-residential	7574	3898	3072	1762		
	Total	**11215**	**5412**	**4757**	**2765**	**0.42**	**0.51**
IP	Residential	2923	7723	1877	3229		
	Non-residential	705	459	364	305		
	Total	**3628**	**8182**	**2240**	**3533**	**0.62**	**0.43**
PM	Residential	726	792	333	349		
	Non-residential	739	967	462	447		
	Total	**1465**	**1760**	**795**	**797**	**0.54**	**0.45**

4 Future Year Networks

4.1 Introduction

This section describes the development of the future year highway network models. These include the initial Do-Minimum (or Without-Intervention case) networks and subsequent Do-Something (or With-Intervention case) networks for both Opening (2017) and Design (2032) Year. These future year networks were developed from the base year networks by coding in proposed highway improvement schemes, based on the information obtained from LCC.

In summary, the two networks considered in this report are:

- Do-Minimum (DM) – The validated base Lincoln road network 2006, plus DM schemes coded. The network also includes new access links to Sustainable Urban Extension developments.

- Do-Something (DS) – The DM networks plus Lincoln Eastern Bypass.

4.2 Do Minimum Networks

The following changes have been made to the validated base networks:

- East West Link (Phase 1): the scheme involves changes with new link from High St to A15 including several new roundabout signalised junctions, closure of High Street section from Tentercroft to A57 St Mary St.

4.3 Do Something Networks

The Do Something (DS) network combines the Do Minimum network and the preferred LEB single carriageway scheme (including its associated junctions). The scheme consists of the following elements:

- Junctions at – Greetwell Road, Hawthorn Road, B1190 Washingborough Road, B1188 Lincoln Road and A15 Sleaford Road.

- Junction Type – ‘at-grade’ roundabouts (Greetwell Road, Washingborough Road, Lincoln Road and Sleaford Road) and left in left out junction at Hawthorn Road.

The sections of LEB are summarised in Table 4.1 below.

Table 4-1 –Description of LEB Sections

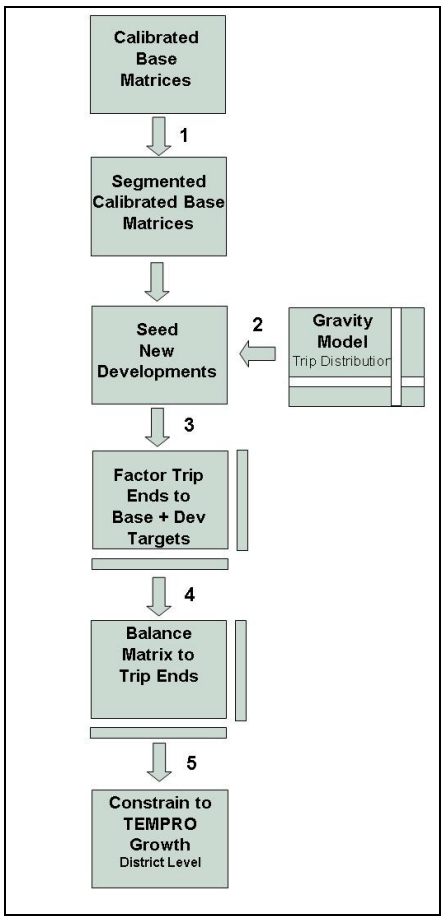
LEB Section	Start Point	End Point	Speed Limit	Length (km)
Section 1a	Wragby Rd East	Hawthorn Rd	60mph	0.45
Section 1b	Hawthorn Rd	Greetwell Rd	60mph	1.30
Section 2	Greetwell Rd	B1190 Washingb' Rd	60mph	1.35
Section 3	B1190 Washingb' Rd	B1188 Lincoln Rd	60mph	2.05
Section 4	B1188 Lincoln Rd	A15 Sleaford Rd	60mph	2.35
			Total (km)	**7.50**

5 Future Year Travel Demands

5.1 Introduction

Detailed guidance on the forecasting process using transport models and the derivation of future year travel demands using growth factors is given in TAG units 3.15.1 and 3.15.2. This chapter discusses the process used in the preparation of the forecasts for the LEB single carriageway planning application. The process includes a number of distinct stages which are summarised in Figure 5-1 below.

Figure 5-1 – Summary of Matrix Building Process



5.2 Overview of Matrix Building Process

The following text briefly explains the process that has been used to develop the forecast matrices:

1. Fully segmented calibrated base matrices were produced using the peak hour calibrated base year matrices. Fully segmented calibrated base matrices are derived from the fully segmented prior matrices and applying the matrix changes that are made during calibration of the base model. These include alterations made to specific cell during the matrix estimation (ME) process.

2. A gravity model was developed to provide realistic trip distributions for the new developments. The gravity model produces trip distributions based on the level of trip productions (e.g. number of households), level of trip attractions (e.g. number of jobs, shops etc.) and the generalised cost between the zones. Zones that contain new developments are then seeded in the segmented calibrated base matrices, using the trips distribution from the gravity model. Two land uses were assumed for future developments; residential and employment.

3. Trip ends in the seeded segmented calibrated base matrices are then factored to match the "base plus development" trip ends.

4. The matrix is balanced using a single constrained factor based on the trip productions.

5. Finally, the balanced matrix is constrained to match TEMPRO growth forecasts at district level for car trips. LGV and HGV trips were factored up to opening year and design year levels through application of growth forecasts derived from DfT's National Transport Model (NTM).

5.3 Gravity Model

A gravity model was used to produce a trip distribution for new development sites. Distributions were calculated by taking into account the level of development at each zone, the generalised travel cost between each set of zones and the likely trip distribution for each trip purpose.

For the Do Minimum strategy, generalised costs were taken from the calibrated base year models, whilst for the Do Something strategy, generalised costs were taken from a "base plus LEB" strategy that allowed for changes in generalised that would occur following opening of LEB.

Distributions were produced for the full segmentation of trip purposes and modelled time periods as described below.

Trip Purposes:

- HB Work;
- HB Education;
- HB Shopping;
- HB Other;
- HB Employers Business;
- NHB Employer Business;
- NHB Other

Note – Trip purpose "Other" includes Personal Business, Recreation/Social, Visiting friends / relatives, Holiday/Day Trip.

5.4 TEMPRO Growth Factors

The second source of traffic growth was extracted from the Trip End Model PROgram (TEMPRO) software. TEMPRO provides projections of growth over time for use in local and regional transport models. Based on the outputs provided by the DfT's National Trip End Model (NTEM), it presents projections of growth in planning data, car ownership, and resulting growth in trip-making by different modes under a constant cost assumption.

TEMPRO includes travel by vehicles owned by households but does not include freight vehicles. Forecasts of freight traffic (available by region, road type and vehicle class) were provided by the National Transport Model (NTM). See section 5.5 for further details on the derivation of growth factors for freight matrices.

Growth factors for HB trips (P/A based pattern) and growth factors for NHB trips (O/D based pattern) were used for estimating the proportion of each trip purpose in the future. The growth factors for All Purposes (O/D based trip pattern) were used to obtain the future demand target matrices.

Growth factors were obtained for the four different levels of Geographic Area available in TEMPRO (Region, County, Local Authority, and TEMPRO Zone), forming 31 sectors which include all the traffic model zones. A breakdown of these sectors by TEMPRO Geographic Area (from high to low level) is provided below:

- Regional Level: 3 sectors including East Of England, South East, London, North East, North West, York & Humber, East Midlands, South West, West Midlands, Wales;
- County Level: 2 sectors including North East Lincolnshire, North Lincolnshire, East Riding Of Yorkshire, City Of Kingston Upon Hull;
- Districts level: 4 sectors including Bassetlaw, Newark And Sherwood, East Lindsey, Boston, City Of Nottingham, Broxtowe, Gedling, Ashfield, Mansfield, Derbyshire County, South Kesteven, Melton, Rushcliffe, South Holland;
- TEMPRO Zones level: 22 sectors including Lincoln (main), Birchwood, North Kesteven (rural), Lincoln (part of) 32UE1, Metheringham, Skellingthorpe, Waddington, Sleaford, Heighington/Washingborough, Ruskington, Bracebridge Heath, Woodhall Spa (part of), Branston, Heckington, West Lindsey, Lincoln (part of) 32UH1, Gainsborough, Welton/Dunholme, Saxilby, Cherry Willingham/Reepham, Nettleham, Market Rasen.

Table 5.1 below shows the description of the districts. Table 5.2 below shows the description of the TEMPRO zones and the corresponding districts. TEMPRO growth factors are shown in Appendix A.

Table 5-1 – District Sectors

District	Description
1	Lincoln
2	North Kesteven
3	West Linsey
4	Bassetlaw, Newark And Sherwood
5	East Lindsey, Boston
6	East Of England, South East, London, East Midlands (Part)
7	North East Lincolnshire
8	North East, North West, York & Humber (Part)
9	North Lincolnshire, East Riding Of Yorkshire, City Of Kingston Upon Hull
10	City Of Nottingham, Broxtowe, Gedling, Ashfield, Mansfield, Derbyshire County
11	South Kesteven, Melton, Rushcliffe, South Holland
12	South West, West Midlands, Wales

Table 5-2 – TEMPRO Zones and Districts

Description	TEMPRO sector	District	Region
Lincoln(main)	1	1	EM
Birchwood	2	1	EM
North Kesteven (rural)	3	2	EM
Lincoln(part of) 32UE1	4	2	EM
Metheringham	5	2	EM
Skellingthorpe	6	2	EM
Waddington	7	2	EM
Sleaford	8	2	EM
Heighington/ Washingborough	9	2	EM
Ruskington	10	2	EM
Bracebridge Heath	11	2	EM
Woodhall Spa(part of)	12	2	EM
Branston	13	2	EM
Heckington	14	2	EM
West Lindsey (rural)	15	3	EM
Lincoln(part of) 32UH1	16	3	EM
Gainsborough	17	3	EM
Welton/ Dunholme	18	3	EM
Saxilby	19	3	EM
Cherry Willingham/ Reepham	20	3	EM

Description	TEMPRO sector	District	Region
Nettleham	21	3	EM
Market Rasen	22	3	EM
Bassetlaw, Newark And Sherwood	23	4	EM
East Lindsey, Boston	24	5	EM
East Of England, South East, London, East Midlands (Part)	25	6	
North East Lincolnshire	26	7	YH
North East, North West, York & Humber (Part)	27	8	
North Lincolnshire, East Riding Of Yorkshire, City Of Kingston Upon Hull	28	9	YH
City Of Nottingham, Broxtowe, Gedling, Ashfield, Mansfield, Derbyshire County	29	10	EM
South Kesteven, Melton, Rushcliffe, South Holland	30	11	EM
South West, West Midlands, Wales	31	12	

5.5 LGV & HGV Growth Factors

Growth factors for Light and Heavy goods vehicles were obtained from the 'Road Transport Forecasts 2009' document which can be found on DfT's website. The forecasts are produced by the ITEA division of the DfT using the National Transport Model (NTM). The NTM provides detailed growth factors at regional level.

The NTM is a multi-modal model of land-based transport in Great Britain. This provides a systematic means of comparing the national consequences of alternative national transport policies or widely-applied local transport policies, against a range of background scenarios which take into account the major factors affecting future patterns of travel. Although the NTM is essentially a passenger transport model, freight road traffic is modelled for the purpose of assessing the impact of freight vehicles on congestion.

Heavy goods vehicle traffic growth is modelled using the Great Britain Freight Model (GBFM) which takes base year data from 2004 on international and domestic freight movements for 15 different commodities. The model then grows the traffic over time by modelling the effect of changes in macroeconomic variables and also changes in generalised cost. Light goods vehicle traffic is projected by a separate time series model relating LGV kilometres in a given year to the levels of GDP and fuel price.

The growth figures are central forecasts and represent percentage changes on base year (2006) values. The percentage changes from the base year are provided for 2010, 2015 and 2025 and therefore they had to be interpolated so that the percentage change for 2017 and 2032 could be established. For 2032 it was assumed that the growth follows the same trend as in the period 2015-2025.

Goods vehicle growth was applied at a regional level as outlined in TAG. These growth factors are presented in detail in Table 5.3 below, with the relevant region, East Midlands, in bold.

Table 5-3 – NTM LGV and HGV Growth

Region	Growth Index			
	Base – Opening Year		Base – Design Year	
	LGV	HGV	LGV	HGV
North East	1.3911	1.0901	1.9736	1.2668
Yorkshire & Humber	1.3729	1.1187	1.9568	1.2790
East Midlands	**1.3807**	**1.1260**	**1.9678**	**1.2852**
East of England	1.3849	1.1450	1.9769	1.3117
South East	1.3859	1.1146	1.9689	1.3046
London	1.3811	1.1196	1.9253	1.1645
South West	1.3820	1.0696	1.9604	1.1897
West Midlands	1.3800	1.1224	1.9540	1.2885
North West	1.3832	1.0910	1.9588	1.2325
England	1.3801	1.1109	1.9626	1.2555
Wales	1.3982	1.0568	1.7355	1.1801
Scotland	1.3801	1.0335	1.7411	1.1434

5.6 Summary of Future Travel Demands

Applying TEMPRO growth to the development scenarios involved a two stage process; this included constraining development growth at TEMPRO zone level and by purpose and time period, and then constraining to the TEMPRO by District growth and by time period.

Tables 5-4 and 5.5 below provide summaries for the growth factors that resulted from applying TEMPRO factors using this two stage growth process. It is to the noted that the Do Minimum and Do Something matrix sizes are the same between time periods and years.

Table 5-4 - Summary of Forecast Matrices - 2017

Flow Group		Base	Do Minimum				Do Something			
			Dev Trips	Non Dev Trips	Forecast Matrices	% Diff (wrt Base)	Dev Trips	Non Dev Trips	Forecast Matrices	% Diff (wrt Base)
AM Peak										
1	Commute	26534	1769	26807	28576	8%	1833	26758	28591	8%
2	Other	17016	565	18622	19187	13%	592	18585	19177	13%
3	Emp Bus.	5537	0	5700	5700	3%	0	5696	5696	3%
4	LGV	7975	0	11011	11011	38%	0	11011	11011	38%
5	OGV	2945	0	3306	3306	12%	0	3306	3306	12%
Total		**60007**	2334	65446	**67780**	**13%**	2425	65356	**67781**	**13%**
Interpeak										
1	Commute	6464	1273	6373	7646	18%	1304	6362	7666	19%
2	Other	32585	974	36395	37369	15%	997	36355	37352	15%
3	Emp Bus.	4874	0	4990	4990	2%	0	4986	4986	2%
4	LGV	7404	0	10224	10224	38%	0	10224	10224	38%
5	OGV	4013	0	4503	4503	12%	0	4503	4503	12%
Total		**55340**	2248	62484	**64732**	**17%**	2300	62431	**64731**	**17%**
PM Peak										
1	Commute	21503	1308	21933	23241	8%	1353	21899	23252	8%
2	Other	21472	719	23505	24224	13%	745	23472	24217	13%
3	Emp Bus.	5307	0	5531	5531	4%	0	5528	5528	4%
4	LGV	7455	0	10293	10293	38%	0	10293	10293	38%
5	OGV	2005	0	2250	2250	12%	0	2250	2250	12%
Total		**57742**	2027	63512	**65539**	**14%**	2098	63,442	**65540**	**14%**

Table 5-5 - Summary of Forecast Matrices - 2032

Flow Group		Base	Do Minimum				Do Something			
			Dev Trips	Non Dev Trips	Forecast Matrices	% Diff (wrt Base)	Dev Trips	Non Dev Trips	Forecast Matrices	% Diff (wrt Base)
AM Peak										
1	Commute	26534	3618	26836	30454	15%	4860	25937	30797	16%
2	Other	17016	1012	20260	21272	25%	1497	19521	21018	24%
3	Emp Bus.	5537	0	5927	5927	7%	0	5838	5838	5%
4	LGV	7975	0	15670	15670	96%	0	15670	15670	96%
5	OGV	2945	0	3766	3766	28%	0	3766	3766	28%
	Total	**60007**	4630	72459	**77089**	**28%**	6357	70732	**77089**	**28%**
Interpeak										
1	Commute	6464	2298	6251	8549	32%	2861	6003	8864	37%
2	Other	32585	1746	40841	42587	31%	2638	39715	42353	30%
3	Emp Bus.	4874	0	5196	5196	7%	0	5114	5114	5%
4	LGV	7404	0	14556	14556	97%	0	14556	14556	97%
5	OGV	4013	0	5127	5127	28%	0	5127	5127	28%
	Total	**55340**	4044	71971	**76015**	**37%**	5499	70515	**76014**	**37%**
PM Peak										
1	Commute	21503	2549	22280	24829	15%	3438	21609	25047	16%
2	Other	21472	1276	25706	26982	26%	1901	24938	26839	25%
3	Emp Bus.	5307	0	5819	5819	10%	0	5744	5744	8%
4	LGV	7455	0	14649	14649	96%	0	14649	14649	96%
5	OGV	2005	0	2563	2563	28%	0	2563	2563	28%
	Total	**57742**	3825	71017	**74842**	**30%**	5338	69504	**74842**	**30%**

6 Model Outputs

6.1 Introduction

This section provides a summary of the model outputs used to assess the DM and DS Strategy performance. It also contains details of key model statistics that are later used in the transport, noise and air quality assessment process.

6.2 Model Outputs

6.2.1 *Derivation of AADT & AAWT Flows*

Factors are required to convert the peak hour and inter-peak flows to Average Annual Daily Traffic (AADT) and Average Annual Weekday Traffic (AAWT) for the purposes of appraisal and accident analysis. These factors were derived from the traffic count data that was collected at numerous locations during the survey period.

The first stage of this process involved expanding the peak hour flows into 12-hour flows. This was achieved by using the factors that were obtained from the analysis of the ATC data collected over the period of 2 weeks (October 2006). To obtain the factors used to expand the peak hour flows into the peak period flows it was necessary to divide the observed peak period flows by the observed peak hour flows. The resulting factors for the AM and PM Periods were 2.627 and 2.720 respectively. For the Inter-peak period the factor was assumed to be equal to 6 since an average of the six hours consisting the Inter-peak period has been modelled. The process is summarised with the help of the following equations:

- 12-hour Flow = (F1*AM Hourly Flows + 6*IP Hourly Flows + F2*PM Hourly Flows)

Where:

- F1 = AM Period Flows (07:00-10:00) / AM Peak Hour Flows (08:00-09:00) = 2.627
- F2 = PM Period Flows (16:00-19:00) / PM Peak Hour Flows (17:00-18:00) = 2.720

Once the 12-hour flows have been established further adjustments were needed in order to convert into AADT and AAWT levels.

AADTs are required for air quality assessment and are calculated over a 24-hour period. The factors were calculated as part of the traffic count data analysis. The formula that was used to derive the AADT flows from the 12 hour flows is as follows:

- AADT24 = (12-hour flows) * F3 Where:
- F3 = observed average 24-hour 7-day flows / observed 12-hour (07:00-19:00) average weekday flows = 1.100796

6.2.2 *AADT Flows on LEB*

Table 6.1 below shows AADT flows on each of the five LEB sections for 2017 and 2032. A map of the arterial routes into Lincoln and the AADT flows for the Do Minimum and Do Something tests for the scheme opening year (2017) and design year (2032) can be found in Appendix A.

Table 6-1 – Forecast AADT Flows on each Section of the LEB

Section	Forecast Two Way AADT Flows	
	2017	2032
Section 1a	20,000	24,000
Section 1b	20,000	23,000
Section 2	26,000	32,000
Section 3	18,000	23,000
Section 4	18,000	22,000

6.2.3 *Trip Transfer – All Vehicles*

LEB will affect the way that trips move across Lincolnshire, particularly for trips travelling on a north-south axis as trips transfer onto LEB from existing north-south corridors. In order to measure the effect that LEB has on travel patterns, flows across a north-south cordon have been compared between the Do Minimum and Do Something Tests.

The River Witham flows through Lincolnshire on an east-west orientation and this forms a convenient screenline that has be used to measure north south movements through Lincoln. Including the LEB, six points have been used to measure these movements across the city together with two wider screenlines used to capture and summarise the movements to the east and west of the city. The links that have been chosen to define this screenline are shown in Figures 6-1 and 6-2. In addition the flows across the 14 links (see Figure 6-1 and 6-2) have bee aggregated into seven sections and then used in the analysis to demonstrate the trip transfer from existing routes onto the LEB; the seven sections are:

- West of Lincoln
- A46
- City Centre - Brayford Way
- City Centre - Wigford Way
- City Centre - A15 Broadgate
- LEB Section 2
- East of Lincoln

Figure 6-1 – North-South Screenline – Lincolnshire View

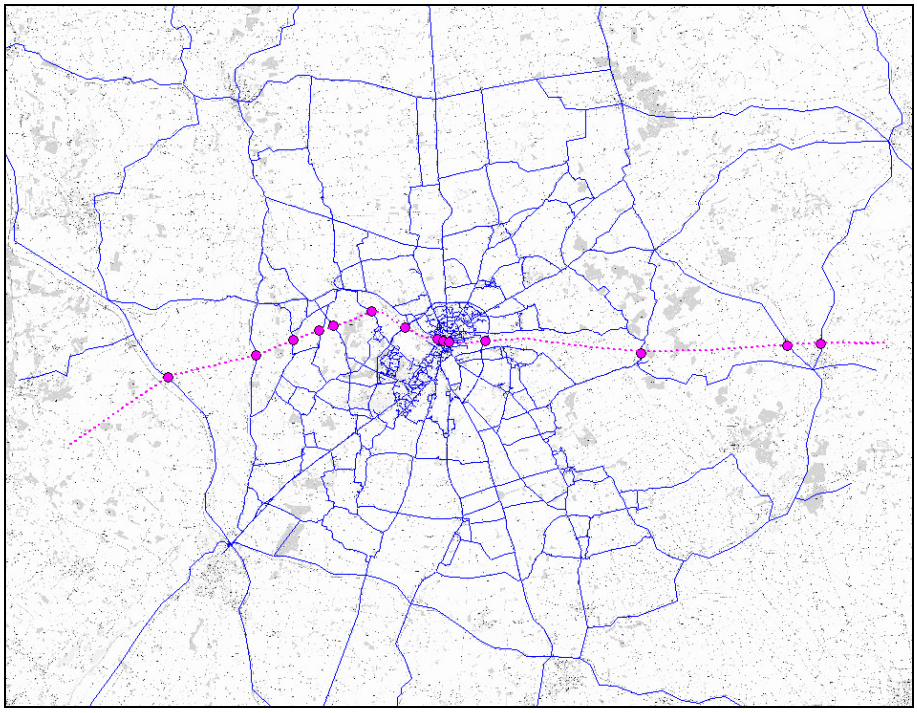
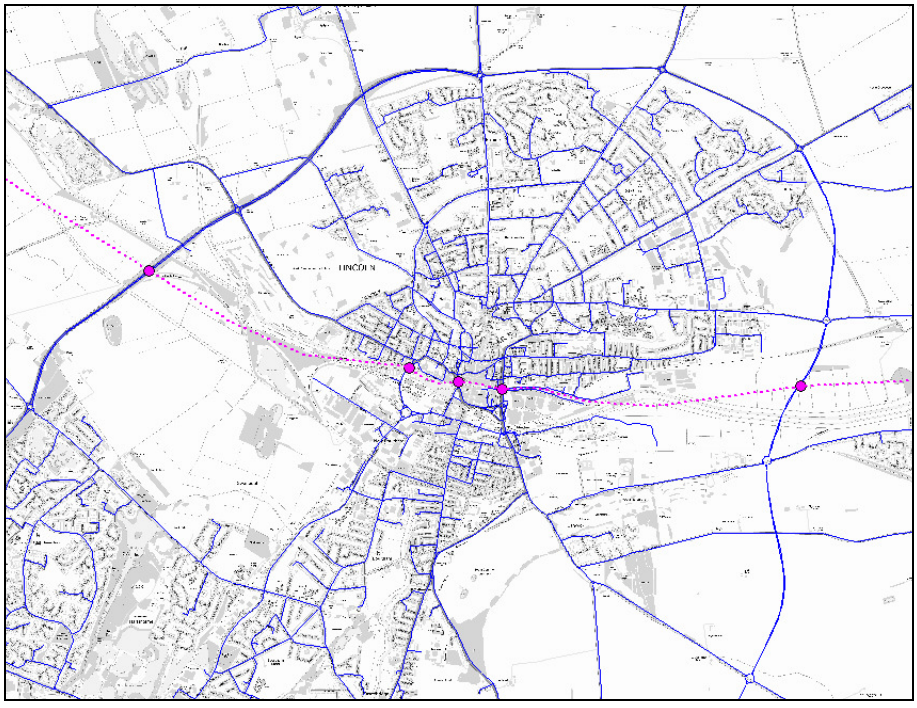


Figure 6-2 – North-South Screenline – Lincoln City View



6.3 Network Statistics Summary

Total vehicle km and total vehicle hours have also been calculated for the three modelled time periods (AM, IP and PM) and the same factors that have been applied to hourly link flows produce AADT link flows have been used to calculate the following statistics:

- Total vehicle km across entire network at AADT level
- Total vehicle hours across entire network at AADT level

These network statistics illustrated in Table 6-2 show the overall impact that LEB has on travel movements across the study area. It shows that in both 2017 and 2032, the total vehicle km reduces by approximately 1% as a result of LEB opening, whilst the total vehicle hours reduces by approximately 4%.

Table 6-2 – AADT Vehicle KM and Total Vehicle Hours – Do Minimum & Do Something

Year	Network Statistics			
	Do Min	Do Some	Diff	% Diff
Total Vehicle km				
2017	14,390,000	14,250,000	-140,000	-0.97%
2032	17,364,000	17,170,000	-194,000	-1.12%
Total Vehicle Hours				
2017	220,000	210,000	-10000	-4.5%
2032	291,000	280,000	-11000	-3.8%

7 Summary & Conclusions

7.1 Summary

This report demonstrates that the methods and assumptions used in preparing the future year traffic forecasts using the 2006 Base year traffic model for the Greater Lincoln area are in line with the Department for Transport's latest guidance.

The aim of the forecasting work is to demonstrate that the scheme fulfils the three objectives set out in the LEB business case. These three objectives are stated below:

- Objective 1: To support the delivery of sustainable economic growth and the Growth Point agenda within the Lincoln Policy Area through the provision of reliable and efficient transport infrastructure.
- Objective 2: To improve the attractiveness and liveability of central Lincoln for residents, workers and visitors by creating a safe, attractive and accessible environment through the removal of strategic through traffic (particularly HGVs).
- Objective 3: To reduce congestion, carbon emissions, improve air and noise quality within the Lincoln Policy Area, especially in the Air Quality Management Area in central Lincoln, by the removal of strategic through traffic (particularly HGVs).

In addition the purpose of the forecasting process was to generate the information required to support the LEB design process and to undertake the transport, noise and air quality assessment in support of the planning application. On this basis, the following outputs were produced:

- AADT flows across Lincolnshire for DM and DS tests;
- Change in AADT flows across north-south screenline;
- Analysis on effect that LEB has on selected travel times;
- Overall travel statistics for DM and DS tests; and
- Junction assessments to support the scheme design process.

The calibrated base year model was developed to represent AM, IP and PM peak hour traffic movements across Lincolnshire in 2006. Forecast models were developed using the base model and applying changes to the network and demand matrices, specifically these changes were based on the following:

- Committed developments (e.g. East-West Link)

- Future land use developments (e.g. NEQ and SEQ)
- Background growth in traffic (i.e. application of TEMPRO factors)

The forecasting work was undertaken for two years; design (2017) and opening (2032), using two strategies (Do Minimum and Do Something) and adopting a single scenario (Core Scenario) which represented the medium growth forecasts.

We have used our reasonable endeavours to provide information that is correct and accurate and have discussed above the reasonable conclusions that can be reached on the basis of the information available. Having issued the range of conclusions it is for the client to decide how to proceed with this project.

8 Appendix

8.1 TEMPRO Zones & Districts

Table 8-1 – TEMPRO Zones & Districts

Description	TEMPRO sector	District	Region
Lincoln(main)	1	1	EM
Birchwood	2	1	EM
North Kesteven (rural)	3	2	EM
Lincoln(part of) 32UE1	4	2	EM
Metheringham	5	2	EM
Skellingthorpe	6	2	EM
Waddington	7	2	EM
Sleaford	8	2	EM
Heighington/ Washingborough	9	2	EM
Ruskington	10	2	EM
Bracebridge Heath	11	2	EM
Woodhall Spa(part of)	12	2	EM
Branston	13	2	EM
Heckington	14	2	EM
West Lindsey (rural)	15	3	EM
Lincoln(part of) 32UH1	16	3	EM
Gainsborough	17	3	EM
Welton/ Dunholme	18	3	EM
Saxilby	19	3	EM
Cherry Willingham/ Reepham	20	3	EM
Nettleham	21	3	EM
Market Rasen	22	3	EM
Bassetlaw, Newark And Sherwood	23	4	EM
East Lindsey, Boston	24	5	EM
East Of England, South East, London, East Midlands (Part)	25	6	
North East Lincolnshire	26	7	YH
North East, North West, York & Humber (Part)	27	8	
North Lincolnshire, East Riding Of Yorkshire, City Of Kingston Upon Hull	28	9	YH
City Of Nottingham, Broxtowe, Gedling, Ashfield, Mansfield, Derbyshire County	29	10	EM
South Kesteven, Melton, Rushcliffe, South Holland	30	11	EM
South West, West Midlands, Wales	31	12	

Table 8-2 – District Sectors

District	Description
1	Lincoln
2	North Kesteven
3	West Linsey
4	Bassetlaw, Newark And Sherwood
5	East Lindsey, Boston
6	East Of England, South East, London, East Midlands (Part)
7	North East Lincolnshire
8	North East, North West, York & Humber (Part)
9	North Lincolnshire, East Riding Of Yorkshire, City Of Kingston Upon Hull
10	City Of Nottingham, Broxtowe, Gedling, Ashfield, Mansfield, Derbyshire County
11	South Kesteven, Melton, Rushcliffe, South Holland
12	South West, West Midlands, Wales

8.2 TEMPRO Zones Growth Factors

Table 8-3 – TEMPRO Zone Growth Factors All Purposes – Base to Opening Year

Sector	AM Peak		Inter Peak		PM Peak	
	O	D	O	D	O	D
1	1.1311	1.0534	1.1097	1.1153	1.0690	1.1154
2	1.1202	1.0540	1.1255	1.1272	1.0786	1.1156
3	1.0998	1.0928	1.1485	1.1508	1.1061	1.1129
4	1.1219	1.1010	1.1663	1.1691	1.1160	1.1327
5	1.1215	1.1207	1.1868	1.1808	1.1361	1.1330
6	1.1143	1.1172	1.1803	1.1714	1.1292	1.1266
7	1.1046	1.0797	1.1430	1.1490	1.0935	1.1150
8	1.0890	1.1072	1.1514	1.1523	1.1146	1.1024
9	1.1214	1.1242	1.1852	1.1787	1.1423	1.1297
10	1.1262	1.1147	1.1788	1.1779	1.1322	1.1370
11	1.1115	1.0945	1.1726	1.1707	1.1099	1.1244
12	1.0976	1.1842	1.1875	1.1500	1.1600	1.1176
13	1.1307	1.1240	1.1858	1.1840	1.1374	1.1409
14	1.1305	1.1097	1.1819	1.1832	1.1275	1.1449
15	1.1067	1.0652	1.1491	1.1495	1.0912	1.1167
16	1.0870	1.0968	1.1975	1.1744	1.1200	1.1184
17	1.0439	1.0415	1.0959	1.0965	1.0532	1.0545
18	1.1202	1.0829	1.1743	1.1695	1.1114	1.1314
19	1.1222	1.0837	1.1761	1.1751	1.1128	1.1322
20	1.1445	1.1090	1.2007	1.1935	1.1355	1.1526
21	1.1436	1.0722	1.1684	1.1715	1.1010	1.1498
22	1.1290	1.0732	1.1613	1.1642	1.1005	1.1357
23	1.1106	1.1606	1.1994	1.1980	1.1644	1.1320
24	1.0538	1.0747	1.1265	1.1246	1.0841	1.0703
25	1.1101	1.1093	1.1391	1.1392	1.1142	1.1147
26	1.0747	1.0872	1.1232	1.1226	1.0908	1.0820
27	1.0684	1.0683	1.1103	1.1103	1.0750	1.0751
28	1.0827	1.0847	1.1392	1.1389	1.0945	1.0935
29	1.0677	1.0714	1.1264	1.1254	1.0813	1.0790
30	1.0650	1.0760	1.1276	1.1265	1.0850	1.0782
31	1.0618	1.0618	1.1150	1.1150	1.0717	1.0717

Table 8-4 – TEMPRO Zone Growth Factors All Purposes – Base to Design Year

Sector	AM Peak		Inter Peak		PM Peak	
	O	D	O	D	O	D
1	1.2926	1.1091	1.2432	1.2571	1.1488	1.2601
2	1.2788	1.1204	1.2866	1.2919	1.1790	1.2689
3	1.2086	1.1842	1.3181	1.3225	1.2161	1.2373
4	1.2593	1.1981	1.3552	1.3614	1.2350	1.2815
5	1.2600	1.2431	1.3996	1.3907	1.2809	1.2860
6	1.2393	1.2328	1.3837	1.3683	1.2661	1.2666
7	1.2297	1.1645	1.3139	1.3270	1.1967	1.2538
8	1.1778	1.2006	1.3096	1.3116	1.2202	1.2061
9	1.2512	1.2516	1.3975	1.3841	1.2900	1.2765
10	1.2619	1.2276	1.3843	1.3801	1.2673	1.2875
11	1.2373	1.1928	1.3751	1.3711	1.2367	1.2663
12	1.2439	1.2368	1.4250	1.3875	1.3200	1.2941
13	1.2761	1.2435	1.3918	1.3891	1.2793	1.2972
14	1.2807	1.2205	1.3936	1.3917	1.2619	1.3080
15	1.1162	1.1359	1.2658	1.2601	1.1639	1.1500
16	1.0725	1.2258	1.3333	1.2674	1.1400	1.1447
17	1.0569	1.1102	1.2084	1.2070	1.1239	1.0898
18	1.1306	1.1571	1.2956	1.2808	1.1815	1.1636
19	1.1318	1.1558	1.2983	1.2848	1.1829	1.1648
20	1.1724	1.1955	1.3396	1.3198	1.2221	1.2038
21	1.1851	1.1541	1.3155	1.3139	1.1921	1.2166
22	1.1673	1.1581	1.3029	1.3032	1.1916	1.1969
23	1.2226	1.3143	1.4140	1.4118	1.3262	1.2670
24	1.0559	1.1162	1.2198	1.2150	1.1321	1.0928
25	1.2127	1.2117	1.2961	1.2962	1.2244	1.2250
26	1.1339	1.1468	1.2135	1.2131	1.1556	1.1455
27	1.1614	1.1609	1.2315	1.2315	1.1726	1.1729
28	1.1743	1.1839	1.2883	1.2873	1.2020	1.1964
29	1.1492	1.1477	1.2675	1.2662	1.1701	1.1713
30	1.1394	1.1527	1.2674	1.2657	1.1738	1.1659
31	1.1614	1.1614	1.2500	1.2500	1.1784	1.1784

8.3 TEMPRO District Growth Factors

Table 8-5 – TEMPRO District Growth Factors – Base to Opening Year

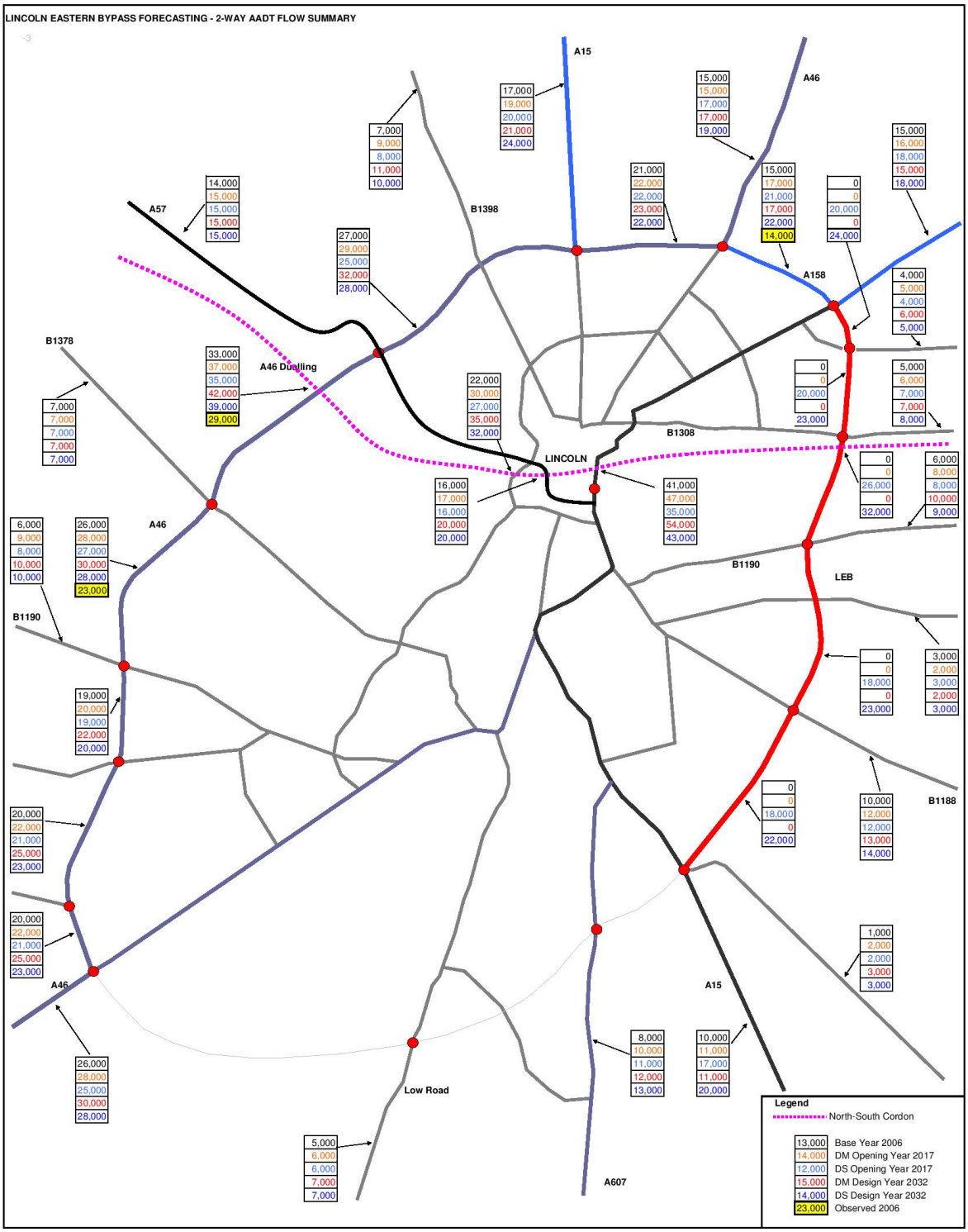
TEMPRO District	AM Peak		Inter Peak		PM Peak	
	O	D	O	D	O	D
1	1.1293	1.0535	1.1115	1.1167	1.0700	1.1155
2	1.1082	1.1003	1.1599	1.1609	1.1140	1.1202
3	1.0995	1.0621	1.1421	1.1423	1.0855	1.1087
4	1.1106	1.1606	1.1994	1.1980	1.1644	1.1320
5	1.0538	1.0747	1.1265	1.1246	1.0841	1.0703
6	1.1101	1.1093	1.1391	1.1392	1.1142	1.1147
7	1.0747	1.0872	1.1232	1.1226	1.0908	1.0820
8	1.0684	1.0683	1.1103	1.1103	1.0750	1.0751
9	1.0827	1.0847	1.1392	1.1389	1.0945	1.0935
10	1.0677	1.0714	1.1264	1.1254	1.0813	1.0790
11	1.0650	1.0760	1.1276	1.1265	1.0850	1.0782
12	1.0618	1.0618	1.1150	1.1150	1.0717	1.0717

Table 8-6 – TEMPRO District Growth Factors – Base to Design Year

TEMPRO District	AM Peak		Inter Peak		PM Peak	
	O	D	O	D	O	D
1	1.2904	1.1101	1.2482	1.2612	1.1519	1.2614
2	1.2266	1.1972	1.3405	1.3426	1.2306	1.2530
3	1.1132	1.1345	1.2619	1.2565	1.1598	1.1459
4	1.2226	1.3143	1.4140	1.4118	1.3262	1.2670
5	1.0559	1.1162	1.2198	1.2150	1.1321	1.0928
6	1.2127	1.2117	1.2961	1.2962	1.2244	1.2250
7	1.1339	1.1468	1.2135	1.2131	1.1556	1.1455
8	1.1614	1.1609	1.2315	1.2315	1.1726	1.1729
9	1.1743	1.1839	1.2883	1.2873	1.2020	1.1964
10	1.1492	1.1477	1.2675	1.2662	1.1701	1.1713
11	1.1394	1.1527	1.2674	1.2657	1.1738	1.1659
12	1.1614	1.1614	1.2500	1.2500	1.1784	1.1784

8.4 Do Minimum/ Do Something AADT Flows

Figure 8-1 – Do Minimum/ Do Something AADT Flows



Appendix E – ARCADY Analysis

Key

Colour of RFC Box	Capacity
	Exceeds predicted absolute capacity
	Exceeds practical reserve capacity

ARCADY Testing Results for Junctions on LEB – 2017 (Peaked Profile)

Junction 1 - Wragby Road Roundabout

Profile Type:	**Peaked Profile**			
Scenario:	**2017 - LEB as single carriageway**			
Time Period:	**AM**		**PM**	
Arm:	**RFC**	**Max Q**	**RFC**	**Max Q**
A - LEB N	0.681	2	0.641	2
B - Wragby Rd E	0.796	4	0.568	1
C - LEB S	0.527	1	0.727	3
D - Wraby Rd W	0.249	0	0.693	2

Junction 3 - Washingborough Road Roundabout

Profile Type:	**Peaked Profile**			
Scenario:	**2017 - LEB as single carriageway**			
Time Period:	**AM**		**PM**	
Arm:	**RFC**	**Max Q**	**RFC**	**Max Q**
A - LEB N	0.784	4	0.720	3
B - Washingb Rd E	0.313	1	0.176	0
C - LEB S	0.615	2	0.631	2
D - Washingb Rd W	0.257	0	0.307	0

ARCADY Testing Results for Junctions on LEB – 2025 (Flat & Peaked Profile)

Junction 1 - Wragby Road Roundabout

Profile Type:	**Flat Profile**				**Peaked Profile**			
Scenario:	**2025 - LEB as single carriageway**				**2025 - LEB as single carriageway**			
Time Period:	**AM**		**PM**		**AM**		**PM**	
Arm:	**RFC**	**Max Q**	**RFC**	**Max Q**	**RFC**	**Max Q**	**RFC**	**Max Q**
A - LEB N	0.61	2	0.547	1	0.684	2	0.637	2
B - Wragby Rd E	0.698	2	0.504	1	0.8	4	0.576	1
C - LEB S	0.431	1	0.631	2	0.49	1	0.712	2
D - Wraby Rd W	0.21	0	0.575	1	0.244	0	0.696	2

Junction 2 - Greetwell Road Roundabout

Profile Type:	**Flat Profile**				**Peaked Profile**			
Scenario:	**2025 - LEB as single carriageway**				**2025 - LEB as single carriageway**			
Time Period:	**AM**		**PM**		**AM**		**PM**	
Arm:	**RFC**	**Max Q**	**RFC**	**Max Q**	**RFC**	**Max Q**	**RFC**	**Max Q**
A - LEB N	0.744	3	0.494	1	0.828	5	0.56	1
B - Greetwell Rd E	0.259	0	0.108	0	0.299	0	0.123	0
C - LEB S	0.553	1	0.476	1	0.621	2	0.526	1
D - Greetwell Rd W	0.128	0	0.361	1	0.144	0	0.408	1

Junction 3 - Washingborough Road Roundabout

Profile Type:	**Flat Profile**				**Peaked Profile**			
Scenario:	**2025 - LEB as single carriageway**				**2025 - LEB as single carriageway**			
Time Period:	**AM**		**PM**		**AM**		**PM**	
Arm:	**RFC**	**Max Q**	**RFC**	**Max Q**	**RFC**	**Max Q**	**RFC**	**Max Q**
A - LEB N	0.663	2	0.642	2	0.729	3	0.709	2
B - Washingb Rd E	0.265	0	0.149	0	0.303	0	0.169	0
C - LEB S	0.463	1	0.531	1	0.524	1	0.591	1
D - Washingb Rd W	0.216	0	0.267	0	0.245	0	0.303	0

Junction 4 - Lincoln Road Roundabout

Profile Type:	**Flat Profile**				**Peaked Profile**			
Scenario:	**2025 - LEB single carriageway**				**2025 - LEB as single carriageway**			
Time Period:	**AM**		**PM**		**AM**		**PM**	
Arm:	**RFC**	**Max Q**	**RFC**	**Max Q**	**RFC**	**Max Q**	**RFC**	**Max Q**
A - LEB N	0.636	2	0.674	2	0.709	2	0.76	3
B - Lincoln Rd E	0.428	1	0.261	0	0.486	1	0.294	0
C - LEB S	0.518	1	0.611	2	0.582	1	0.681	2
D - Lincoln Rd W	0.227	0	0.388	1	0.255	0	0.442	1

Junction 5 - Sleaford Road Roundabout

Profile Type:	**Flat Profile**				**Peaked Profile**			
Scenario:	**2025 - LEB as single carriageway**				**2025 - LEB as single carriageway**			
Time Period:	**AM**		**PM**		**AM**		**PM**	
Arm:	**RFC**	**Max Q**	**RFC**	**Max Q**	**RFC**	**Max Q**	**RFC**	**Max Q**
A - Sleaford Road N	0.253	0	0.314	1	0.283	0	0.354	1
B - LEB	0.698	2	0.6	2	0.775	3	0.667	2
C - Bloxholm Lane	0.222	0	0.071	0	0.257	0	0.083	0
D - Sleaford Road S	0.383	1	0.458	1	0.427	1	0.51	1

ARCADY Testing Results for Junctions on LEB – 2032 (Flat & Peaked Profile)

Junction 1 - Wragby Road Roundabout

Profile Type:	Flat Profile				Peaked Profile			
Scenario:	2032 - LEB as single carriageway				2032 - LEB as single carriageway			
Time Period:	AM		PM		AM		PM	
Arm:	RFC	Max Q	RFC	Max Q	RFC	Max Q	RFC	Max Q
A - LEB N	0.617	2	0.615	2	0.694	2	0.716	3
B - Wragby Rd E	0.689	2	0.49	1	0.795	4	0.568	1
C - LEB S	0.508	1	0.706	2	0.578	1	0.794	4
D - Wraby Rd W	0.287	0	0.548	1	0.332	1	0.668	2

Junction 2 - Greetwell Road Roundabout

Profile Type:	Flat Profile				Peaked Profile			
Scenario:	2032 - LEB as single carriageway				2032 - LEB as single carriageway			
Time Period:	AM		PM		AM		PM	
Arm:	RFC	Max Q	RFC	Max Q	RFC	Max Q	RFC	Max Q
A - LEB N	0.819	4	0.633	2	0.92	10	0.712	2
B - Greetwell Rd E	0.26	0	0.118	0	0.305	0	0.135	0
C - LEB S	0.642	2	0.628	2	0.718	3	0.693	2
D - Greetwell Rd W	0.239	0	0.297	0	0.269	0	0.34	1

Junction 3 - Washingborough Road Roundabout

Profile Type:	Flat Profile				Peaked Profile			
Scenario:	2032 - LEB as single carriageway				2032 - LEB as single carriageway			
Time Period:	AM		PM		AM		PM	
Arm:	RFC	Max Q	RFC	Max Q	RFC	Max Q	RFC	Max Q
A - LEB N	0.816	4	0.735	3	0.896	8	0.811	4
B - Washingb Rd E	0.304	0	0.191	0	0.351	1	0.217	0
C - LEB S	0.581	1	0.704	2	0.658	2	0.786	4
D – Washb Rd W	0.208	0	0.322	1	0.237	0	0.371	1

Junction 4 - Lincoln Road Roundabout

Profile Type:	Flat Profile				Peaked Profile			
Scenario:	2032 - LEB as single carriageway				2032 - LEB as single carriageway			
Time Period:	AM		PM		AM		PM	
Arm:	RFC	Max Q	RFC	Max Q	RFC	Max Q	RFC	Max Q
A - LEB N	0.817	4	0.787	4	0.91	9	0.885	7
B - Lincoln Rd E	0.439	1	0.33	1	0.503	1	0.375	1
C - LEB S	0.619	2	0.764	3	0.7	2	0.855	6
D - Lincoln Rd W	0.258	0	0.4	1	0.292	0	0.46	1

Junction 5 - Sleaford Road Roundabout

Profile Type:	**Flat Profile**				**Peaked Profile**			
Scenario:	**2032 - LEB as single carriageway**				**2032 - LEB as single carriageway**			
Time Period:	**AM**		**PM**		**AM**		**PM**	
Arm:	**RFC**	**Max Q**	**RFC**	**Max Q**	**RFC**	**Max Q**	**RFC**	**Max Q**
A - Sleaford Road N	0.324	1	0.4	1	0.363	1	0.453	1
B - LEB	0.786	4	0.713	3	0.875	6	0.796	4
C - Bloxholm Lane	0.335	1	0.136	0	0.392	1	0.159	0
D - Sleaford Road S	0.429	1	0.549	1	0.481	1	0.612	2
E - LSB								