Lincoln Eastern Bypass

Forecast and Economic Evaluation Update Note

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Purpose of the Exercise

LCC carried out a full forecast/economics assessment on Lincoln Eastern Bypass (LEB) as required at the time that the planning permission and final bid process was undertaken. With the update and greater refinement of the traffic information following the work carried out recently Lincolnshire County Council (LCC) has reassessed the situation and has issued this document in response to those new figures.

Forecasting Approach

The forecast approach replicates the analysis previously conducted in terms of specification of highway networks, identification of specific developments and application of background growth. Some salient differences have been reflected These include; lower growth totals reflecting updates to the DfT National Travel Model (NTM) applied through the Trip End Model Presentation Program (TEMPRO); and a revised approach to reflecting dependent development (development which is only permitted following mitigation by infrastructure).

Model Outputs

Traffic model results for 2018 and 2033 have been presented, both in terms of usage of LEB and traffic flow on the adjacent network in the vicinity of Hawthorn Road. Usage of LEB is slightly lower than previously forecast, primarily related to the lower growth rates. However the LEB continues to fulfil its role of providing important traffic relief to congested suburban areas of central and east Lincoln. The impacts on traffic flows in the villages to the east of the LEB is positive with through movements reallocated to appropriate alternative routes, or continuing to use Hawthorn Road, dependent upon destination.

The traffic forecasts have undergone a value for money assessment based on the latest version of the DfT Transport User Benefit Assesment (TUBA) programme. The scheme is forecast to realise strong time saving and operating cost savings across the Lincoln area. Accident savings are reduced from previous analysis due to revised guidance on dependent development. Taken in total the benefits of the scheme outweigh the costs by a ratio of 9 to 1.

Conclusions

The model recalibration has led to a revised set of forecasts, demonstrating a healthy demand for LEB. Local traffic flows in the vicinity of Hawthorn Road benefit from modest reductions over certain sections of route.

The scheme continues to represent excellent value for money whilst reflecting the latest relevant assumptions.

1 Introduction

1.1 Purpose of the Report

This Forecasting Report describes the approach adopted to produce the traffic forecasts required to inform the design and support the statutory processes 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).

Mouchel carried out a full forecast/economics assessment as required at the time that the planning permission and final bid process was undertaken. With the update and greater refinement of the traffic information following the work carried out recently LCC has reassessed the situation and has issued this document in response to those new figures.

This reassessment confirms that the forecast which was used in both the planning application and the best and final bid process remains robust but given the information has developed this report has been produced to assess those alterations.

The report describes the traffic forecasting process, methodology and assumptions adopted and used within the 2015 model refinement.

1.2 Structure of this Report

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. Value for Money Appraisal;
- Chapter 8. Comparative Analysis; and
- Chapter 9. Summary and Conclusions.

1.3 Forecasting & 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. These include the prediction of the future year travel demands and the assumptions relating to changes in the future year highway network.

The report has been issued as a sequal to the earlier Local Model Addendum Report (LMVR), issued in May 2015, with the updated base model forming the platform for the current analysis. The document should be read in conjunction with the earlier report and as such the current document concentrates on those new elements of analysis rather than the historic information.

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

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 (2018) and Design year (2033). 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).

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.

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 Model Overview

A broad overview of the updated 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 covers the urban area of Lincoln and surrounding hinterland, and broadly aligns with the Local Planning Area (LPA).

Zoning System - The zoning system designed for the Lincoln Traffic Model comprises 178 zones, of which 143 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).

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, with refinement of zoning in.

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 Addendum.

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 (2018) and opening (2033), 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; and
- 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 M4 (November 2014).

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 (base year) through to the opening year (2018) and the design year (2033).

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) supplemented with recent (April 2015) data from Lincoln City Council and West Lindsey regarding developments since 2006. 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 development is limited to 150 houses until the LEB is constructed. On this basis, under the assumption that the LEB will be complete in 2018 and the developers have suggested that they could achieve 200 dwellings per annum on each site, by the design year (2033) 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 50 two-way trips in any modelled time period. The local impact of the smaller developments is considered negligible and the overall additional traffic associated with these developments will be accounted for by TEMPRO growth the larger developments of which will be netted out of the background.

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

Level of Certainty	Descriptive Level of Certainty
90-100%	Certain/Near 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 Appendix A.

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.

Table 3-2 Definitions of Certainty

Development Scenario	Level of Certainty
Certain/Near Certain	Pessimistic
More than Likely	Core
Reasonably Foreseeable	Optimistic
Less than 50% certain	Not modelled

LEB Dependent Developments

The scoping work for the Transport Assessment also identified three key developments that were dependent on the LEB; these were the Western Growth Corridor, 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 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.

The aggregate data has been reported later in this document.

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 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:

- New junctions at – Greetwell Road, Hawthorn Road, B1190 Washingborough Road, B1188 Lincoln Road and A15 Sleaford Road. At the northern end the LEB connects into the existing roundabout at Wragby Road.

- Junction Type – 'at-grade' roundabouts (Greetwell Road, Washingborough Road, Lincoln Road and Sleaford Road) and left in left out junction at Hawthorn Road on the eastern side with no access provided on the western side.

The sections of LEB are summarised in Table 4.1 below.

Table 4-1 Description of LEB Sections

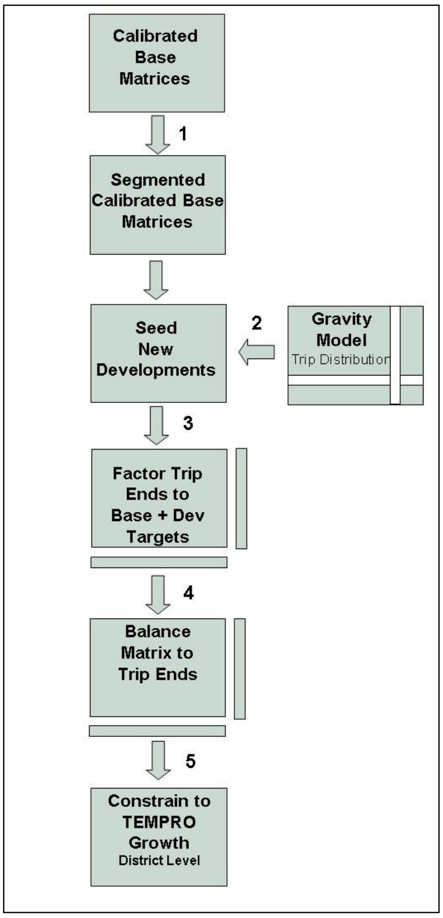
LEB Section	Start Point	End Point	Speed Limit	Length (km)
Section 1a	Wragby Rd East	Hawthorn Rd	96kmph	0.45
Section 1b	Hawthorn Rd	Greetwell Rd	96kmph	1.30
Section 2	Greetwell Rd	B1190 Washingb' Rd	96kmph	1.35
Section 3	B1190 Washingb' Rd	B1188 Lincoln Rd	96kmph	2.05
Section 4	B1188 Lincoln Rd	A15 Sleaford Rd	96kmph	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 Unit M4. 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 costs 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, West Lindsey, 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.

Table 5-1 – District Sectors

District	Description
1	Lincoln
2	North Kesteven
3	West Lindsey
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/ Fiskerton	20	3	EM
Nettleham	21	3	EM

Description	TEMPRO sector	District	Region
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 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 be noted that the Do Minimum and Do Something matrix sizes are the same in the 2018 opening year. In the 2033 design year the Do-Something matrices are higher than the Do-Minimum due to the addition of the NEQ and SEQ development trips which are dependent on the construction of the LEB.

Table 5-3 - Summary of Forecast Matrices – 2018

Category		Base	Do-Minimum	Do-Something	% Difference with Base	
					Do-Minimum	Do-Something
AM Peak						
1	Commute	26,258	26,515	26,515	0.98%	0.98%
2	Other	16,923	18,276	18,276	8.00%	8.00%
3	Emp Bus.	5,480	5,587	5,587	1.95%	1.95%
4	LGV	7,774	8,593	8,593	10.54%	10.54%
5	HGV	2,691	2,698	2,698	0.26%	0.26%
	Total	**59,126**	**61,669**	**61,669**	**4.30%**	**4.30%**
Development Trips		-	5,656	5,656	-	-
Background Trips		59,126	56,013	56,013	-	-
Inter Peak						
1	Commute	6,448	6,751	6,751	4.70%	4.70%
2	Other	32,644	33,690	33,690	3.20%	3.20%
3	Emp Bus.	4,837	5,532	5,532	14.37%	14.37%
4	LGV	7,313	8,083	8,083	10.53%	10.53%
5	HGV	3,955	3,966	3,966	0.28%	0.28%
	Total	**55,197**	**58,022**	**58,022**	**5.12%**	**5.12%**
Development Trips		-	3,332	3,332	-	-
Background Trips		55,197	54,690	54,690	-	-
PM Peak						
1	Commute	22,124	22,515	22,515	1.77%	1.77%
2	Other	22,139	23,175	23,175	4.68%	4.68%
3	Emp Bus.	5,603	6,024	6,024	7.51%	7.51%
4	LGV	7,674	8,482	8,482	10.53%	10.53%
5	HGV	2,087	2,092	2,092	0.24%	0.24%
	Total	**59,627**	**62,288**	**62,288**	**4.46%**	**4.46%**
Development Trips		-	6,073	6,073	-	-
Background Trips		59,627	56,215	56,215	-	-

Table 5-4 - Summary of Forecast Matrices – 2033

Category		Base	Do-Minimum	Do-Something	% Difference with Base	
					Do-Minimum	Do-Something
AM Peak						
1	Commute	26,258	28,646	29,587	9.09%	12.68%
2	Other	16,923	19,598	20,238	15.81%	19.59%
3	Emp Bus.	5,480	6,086	6,165	11.06%	12.50%
4	LGV	7,774	11,981	12,112	54.12%	55.80%
5	HGV	2,691	2,983	3,041	10.85%	13.01%
	Total	**59,126**	**69,294**	**71,143**	**17.20%**	**20.32%**
Development Trips		-	12,341	16,545	-	-
Background Trips		59,126	56,953	54,598	-	-
Inter Peak						
1	Commute	6,448	8,057	8,157	24.95%	26.50%
2	Other	32,644	37,153	37,922	13.81%	16.17%
3	Emp Bus.	4,837	6,603	6,693	36.51%	38.37%
4	LGV	7,313	11,269	11,352	54.10%	55.23%
5	HGV	3,955	4,385	4,422	10.87%	11.81%
	Total	**55,197**	**67,467**	**68,546**	**22.23%**	**24.18%**
Development Trips		-	6,795	9,145	-	-
Background Trips		55,197	60,672	59,401	-	-
PM Peak						
1	Commute	22,124	24,712	25,448	11.70%	15.02%
2	Other	22,139	24,837	25,593	12.19%	15.60%
3	Emp Bus.	5,603	6,698	6,816	19.54%	21.65%
4	LGV	7,674	11,827	11,899	54.12%	55.06%
5	HGV	2,087	2,311	2,347	10.73%	12.46%
	Total	**59,627**	**70,385**	**72,103**	**18.04%**	**20.92%**
Development Trips		-	11,485	15,475	-	-
Background Trips		59,627	58,900	56,628	-	-

In accordance with the Development Log the matrix totals are the same in 2018 as there is no dependent development assumed. For this year the NEQ site will have permission for up to, but not exceeding, 150 dwellings irrespective of the LEB availability. By 2033 the full build out of NEQ (2000 dwellings) can only be assumed in the event of LEB's construction.

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 Forecast Flow Pattern

The modelled flows in the vicinity of Hawthorn Road are presented in Appendix B for both the DM and DS case for each of the modelled time periods.

The flow diagrams show that flows on the A15 Wragby Road west of the LEB, Hawthorn Road West, St Augustines Road and the Outer Circle Road all reduce significantly. In addition some modest relief is afforded to parts of Cherry Willingham and Reepham as some north-south movement is attracted to the LEB.

The A158 Wragby Road and Greetwell Road east of LEB sees a traffic increase as the LEB performs a distributor role function and removes vehicles from the suburban areas to the West of LEB.

In each case the impacts of the later forecast year (2033) are more marked than 2018 and the peak periods are impacted more than the inter peak.

The LEB continues to fulfil its role of providing important traffic relief to congested suburban areas of East Lincoln. The impacts on traffic flows in the villages to the east of the LEB is positive with through movements reallocated to appropriate alternative routes, or continuing to use Hawthorn Road, dependent upon destination.

6.3 Specific Model Outputs

Derivation of AADT and 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

AADT Flows on LEB

Table 6.1 below shows AADT flows on each of the five LEB sections for 2017 and 2032.

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

Section	Forecast Two Way AADT Flows		
	2018	2033	Growth over Forecast Period
Section 1a	17,700	21,300	20%
Section 1b	17,400	20,600	18%
Section 2	20,500	27,500	34%
Section 3	14,500	21,800	50%
Section 4	15,800	21,000	33%

The AADT flows on LEB support a single carriageway design. The most significant growth over the forecast period occurs on those segments of NEQ and SEQ.

6.4 LEB Traffic Impacts

LEB will affect the way that trips move across Lincoln, 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 can be used to measure north south movements through Lincoln. Including the LEB, five 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 and used to demonstrate the trip transfer from existing routes onto the LEB are shown in Figures 6-1. The forecast traffic flows detailed in Tables 6-2 and 6-3.

Figure 6-1 – Traffic Distribution Screenline, Lincoln

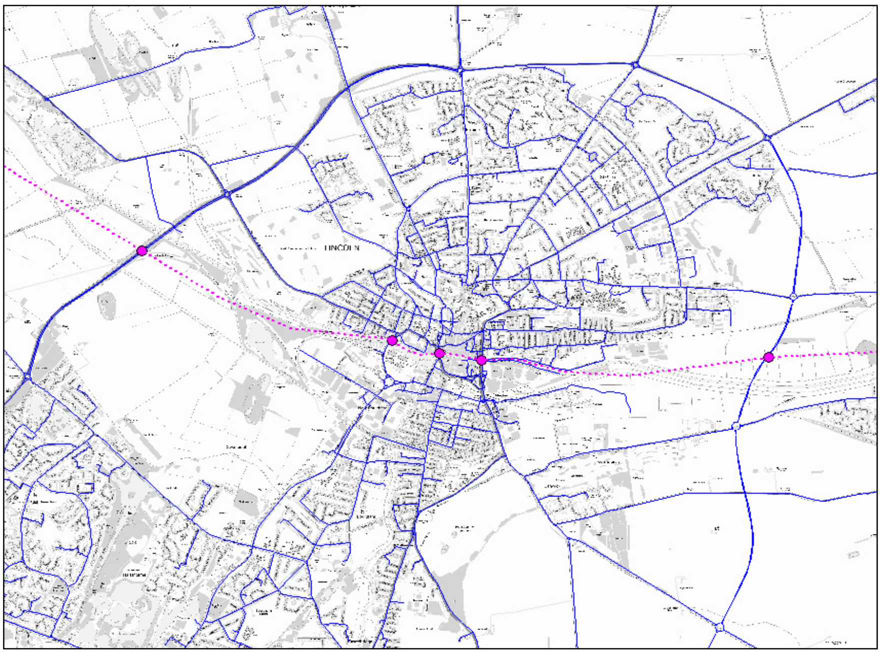


Table 6-2 – AADT Screenline Flows Do Min and Do Something 2018 (Actual Flows)

Part of Cordon	Do Min	Do Some	Difference	% Difference
A46	34,300	32,800	-1,500	-4%
City Centre - Brayford Way	26,400	23,500	-2,900	-11%
City Centre - Wigford Way	13,300	13,600	300	2%
City Centre - A15 Broadgate	38,700	28,800	-9,900	-26%
LEB Section 2	N/A	20,200	N/A	-

Table 6-3 - AADT Screenline Flows Do Min and Do Something 2033 (Actual Flows)

Part of Cordon	Do Min	Do Some	Difference	% Difference
A46	36,400	34,400	-2,000	-5%
City Centre - Brayford Way	30,200	27,600	-2,600	-9%.
City Centre - Wigford Way	14,800	15,200	400	0%
City Centre - A15 Broadgate	39,700	33,300	-6,400	-22%
LEB Section 2	N/A	26,900	N/A	-

The greatest relief is afforded to the A15 corridor, where almost 10,000 vehicles are decanted from the A15 corridor. There is less relief to Wigford Way as this route serves East West Traffic to a greater extent. Useful relief is afforded to Brayford Way and the A46 to a lesser extent.

Overall LEB performs an excellent role in removing traffic from the constrained and historic core of Lincoln. The next chapter examines the economic efficiency of the traffic diversion.

7 Value for Money Appraisal Update

7.1 Introduction

This section provides a brief overview of the procedures followed in deriving the economic assessment for the LEB.

7.2 Economic Appraisal Requirements

The elements included in the value for money assessment are summarised below together with an overview of the variables that have been updated. In all cases, these individual economic assessments were based on comparisons of Do-Minimum and Do Something traffic model forecasts at the specified years.

Table 7-1 Value for Money Appraisal

VfM Element	Description	Update
Scheme Costs	Costs including construction, land, preparation and supervision are incorporated in the economic assessment and discounted to a common (2010) price base (in TUBA).	Updated scheme costs based on tender price from preferred contractor Discounted to 2010 base price Revised Optimism bias
User Benefits	Time savings, fuel vehicle operating costs (VOC), non-fuel VOC, Operator and Government revenues assessed using TUBA)	Based on revised outputs from Lincoln Traffic Model Uses TUBA v1.9.5
Accident Benefits	Undertaken using an established spreadsheet method similar to COBALT. Cost of accidents assessed by multiplying number of accidents with cost per accident.	Based on updated accident values

Annualisation of Benefits

The benefits of the scheme are calculated separately using each of the appraisal models. All traffic model outputs relate to a 12-hour weekday average, derived from the three individual period models. Outputs are in all cases converted from the weekday traffic model outputs to a yearly output using an annualisation factor. The TUBA appraisal also includes off-peak and weekend periods. Inputs to the accident assessment were converted from the model peak periods to AADT using TRADS data.

Appraisal Period

The economic appraisal was carried out over a 60-year period, from 2018 (Opening Year) to 2078, in accordance with the DfT guidance.

7.3 LEB Scheme Costs Update

The scheme base costs are detailed in Table 7-2.This is based on the current scheme cost estimate and most recent quantified risk allowance.

Table 7-2 – Lincoln Eastern Bypass Scheme Cost

Cost Area	Base Costs
Construction	**£65,965,897**
Land & Property exc Part One Claims - Estimate	**£2,000,000**
Third Party Costs	**£361,215**
Design and Procurement	**£3,915,494**
Supervision Cost	**£2,971,672**
QRA	**£7,592,031**
Total	**£82,806,310**

Inflation & Optimism Bias

The impact of inflation and optimism bias has been updated as part of this appraisal. The approach set out in TAG Unit A1.2 identifies that based on the fact that the scheme is at the Conditional Approval Stage an optimism bias of 15% of the contract total is appropriate.

Table 7-3 – Impact of Inflation and Optimism Bias

Cost Estimate Uplift	Package Costs
Optimism Bias	15%
Base Costs + Inflation + Optimism Bias	£118,469,348
Base Costs + Inflation	£103,016,824
Base Costs	£82,806,310

Scheme Expenditure Profile

The revised scheme expenditure profile based on the current scheme programme is set out in Table 7-4 below.

Table 7-4 – Lincoln Eastern Bypass Scheme Expenditure Profile

Year	% of Overall Scheme Expenditure
2010 / 2011	0.2%
2011 / 2012	0.4%
2012 / 2013	0.6%
2013 / 2014	3.7%
2014 / 2015	1.3%
2015 / 2016	4.5%
2016 / 2017	41.2%
2017 / 2018	48.2%
Total	**100%**

7.4 Assessment of User Benefits

The following section provides an overview of the TUBA economic assessment, including the key inputs and parameters used within the assessment and the outputs and results.

Scheme Parameters File - Main Parameters

Table 7-5 below shows the main parameters that have been used in the TUBA scheme file.

Table 7-5 – Parameters for Do Something Option

Parameter	Option – Do-Something
TUBA Version	v1.9.5
First Year	2018
Horizon Year	2033
Modelled Years	2018 & 2033
Current Base Year	2006

Scheme Parameters File - Time Slices

The time slices that were used in the TUBA model are set out below.

Table 7-6 – TUBA Time Slices

Period	Time
AM Peak	08:00 – 09:00
Average Inter Peak hour	10:00 – 16:00
PM Peak	17:00 – 18:00
Off Peak	19:00 – 07:00
Weekends	including bank holidays

Table 7-7 – TUBA Analysis Periods and Corresponding Model Input Periods

TUBA Analysis Periods	Model Input Periods
AM Peak Period (0700-1000)	AM Peak Hour (0800-0900);
Inter-peak Period (1000-1600)	Average Inter-peak Hour (1000-1600)
PM Peak Period (1600-1900)	PM Peak Hour (1700-1800).
Off-Peak Period (1900-0700)	Average Inter-Peak Hour (1000-1600)
Weekend + bank Holiday	Average Inter-Peak Hour (1000-1600)

User Classes

Five user classes were used in the TUBA assessment and are listed below:

- User Class 1: Non Work Commute;

- User Class 2: Non Work Non Commute;
- User Class 3: Employers Business ;
- User Class 4: Light Goods Vehicles (LGVs);
- User Class 5: Heavy Goods Vehicles (including OGV1, OGV2 and PSVs).

Table 7-8 below shows the model user classes with the corresponding TUBA matrices. Model user classes 4 and 5 (LGV and HGV) were split into 2 matrices. The LGV were split into Personal and Business while the HGV were split into OGV1 and OGV2 to give more accurate presentation of the purpose split.

Table 7-8 – Model Output to TUBA Matrices Conversions

Model User Class	TUBA User Classes	TUBA Input		
		Veh / submode	purpose	Factor Split
1	1	1	2	100 %
2	2	1	3	100 %
3	3	1	1	100 %
4	4	3	0	88 %
4	5	2	0	12 %
5	6	4	0	82 %
5	7	5	0	18 %

Night Time and Weekends Calculations

TUBA (Transport User Benefits Assessment) version 1.9.5 (which incorporates the latest DfT values of time in November 2014) was used to provide the benefits of the proposed LEB 60 year appraisal periods (in compliance with WebTAG A.1.1).

The forecast models consist of 3 modelled periods: AM Peak (08:00-09:00), Inter-Peak (hourly average 10:00-16:00) and PM peak (17:00-18:00). TUBA is however required to be carried out for all periods for the whole year, which includes:

- Weekday AM Peak (07:00-10:00);
- Weekday Inter-Peak (10:00-16:00);
- Weekday PM Peak (16:00-19:00);
- Weekday Night-Time period (19:00-07:00); and
- Weekend and Bank Holiday.

For non-modelled periods (such as Pre-AM (07:00-08:00), Post-AM (09:00-10:00), Inter-Peak (10:00-16:00), Pre-PM (16:00-17:00), Post-PM (17:00-19:00), off-peak and weekend/bank holiday) it is only necessary to calculate the benefits for hours in which traffic levels are similar to the modelled hours.

TUBA guidance suggests that a conservative approach should be used to identify benefits/dis-benefits for non-modelled periods so that it would represent as close as possible the changes in travel time between Do-Minimum and Do-Something compared to changes between Do-Minimum and Do-Something in the modelled hours.

Observed traffic counts for number of ATC locations surrounding Lincoln that was collected for two weeks in September-October 2006 for the purpose of base year model validation was used to obtain the daily traffic profile. Figure 7.1 below provides a summary of the traffic daily profile of traffic within Lincoln.

It is noted that the hourly profile was based on 2 weeks count data in September – October 2006 therefore no bank holiday was included.

Figure 7-1 Daily Profile of Traffic within Lincoln

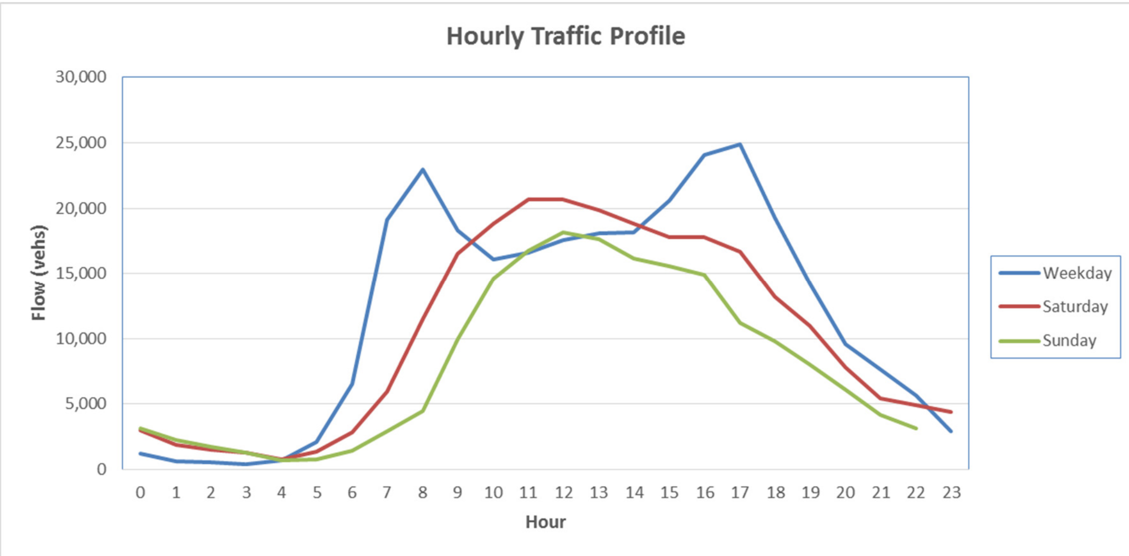


Table 7.9 below provides a summary of traffic flows in Lincoln for weekdays, Saturday and Sunday and also the derivation of the annualisation factors for each modelled period.

Table 7-9 - Derivation of Annualisation Factors

Period	Hour	Traffic Flow	Donor Hour	Factor /Donor Hour	Valid	Period	Hour	Traffic Flow	Donor Hour	Factor /Donor Hour	Valid
Off-Peak	0	1,188	IP	0.07		Sunday	0	3,113	IP	0.17	
	1	642	IP	0.04			1	2,218	IP	0.12	
	2	547	IP	0.03			2	1,759	IP	0.10	
	3	378	IP	0.02			3	1,293	IP	0.07	
	4	692	IP	0.04			4	718	IP	0.04	
	5	2,133	IP	0.12			5	790	IP	0.04	
	6	6,572	IP	0.37			6	1,450	IP	0.08	

Period	Hour	Traffic Flow	Donor Hour	Factor /Donor Hour	Valid	Period	Hour	Traffic Flow	Donor Hour	Factor /Donor Hour	Valid
AM Peak	7	19,078	IP	1.07	1		7	2,881	IP	0.16	
	8	22,975	AM	1.00	1		8	4,475	IP	0.25	
	9	18,298	IP	1.03	1		9	9,910	IP	0.56	
Inter-Peak	10	16,102	IP	0.90	1		10	14,603	IP	0.82	
	11	16,595	IP	0.93	1		11	16,781	IP	0.94	
	12	17,552	IP	0.98	1		12	18,133	IP	1.02	1
	13	18,063	IP	1.01	1		13	17,618	IP	0.99	1
	14	18,186	IP	1.02	1		14	16,150	IP	0.90	
	15	20,579	IP	1.15	1		15	15,577	IP	0.87	
PM Peak	16	24,044	PM	0.98	1		16	14,902	IP	0.84	
	17	24,871	PM	1.02	1		17	11,202	IP	0.63	
	18	19,289	IP	1.08	1		18	9,797	IP	0.55	
Off-Peak	19	14,265	IP	0.80			19	8,000	IP	0.45	
	20	9,606	IP	0.54			20	6,093	IP	0.34	
	21	7,630	IP	0.43			21	4,180	IP	0.23	
	22	5,668	IP	0.32			22	3,162	IP	0.18	
	23	2,914	IP	0.16			23	1,816	IP	0.10	
Saturday	0	3,025	IP	0.17		Bank Holiday	0		IP		
	1	1,918	IP	0.11			1		IP		
	2	1,524	IP	0.09			2		IP		
	3	1,271	IP	0.07			3		IP		
	4	761	IP	0.04			4		IP		
	5	1,359	IP	0.08			5		IP		
	6	2,808	IP	0.16			6		IP		
	7	5,984	IP	0.34			7		IP		
	8	11,470	IP	0.64			8		IP		
	9	16,521	IP	0.93			9		IP		
	10	18,796	IP	1.05	1		10		IP		
	11	20,696	IP	1.16	1		11		IP		
	12	20,666	IP	1.16	1		12		IP		
	13	19,821	IP	1.11	1		13		IP		
	14	18,785	IP	1.05	1		14		IP		
	15	17,810	IP	1.00	1		15		IP		
	16	17,784	IP	1.00	1		16		IP		
	17	16,706	IP	0.94			17		IP		
	18	13,228	IP	0.74			18		IP		
	19	10,980	IP	0.62			19		IP		
	20	7,822	IP	0.44			20		IP		
	21	5,447	IP	0.31			21		IP		
	22	4,942	IP	0.28			22		IP		
	23	4,370	IP	0.24			23		IP		

As can be seen, traffic volume reaches its one hour peak at 08:00-09:00 in the morning. In the PM period, however, traffic volume is at similar level for two hours from 16:00-18:00. It was therefore suggested that only 1 hour for the AM and 2 hours for the PM period will be used for the calculation of the benefits for the scheme.

To claim benefits for the non-modelled periods, the following factors were applied for relevant modelled hour benefits, as listed below:

- Weekday AM Period (08:00 – 09:00): 1 x AM Peak modelled hour;
- Weekday Inter-Peak (09:00 – 16:00): 7 x Inter-Peak modelled hour;
- Weekday PM Period (16:00 – 18:00): 2 x PM Peak modelled hour;
- Weekday Off-Peak Period (07:00-08:00 + 18:00 – 19:00): 2 x Inter-Peak modelled hour;
- Saturday (10:00 – 17:00): 7 x Inter-Peak modelled hour;
- Sunday (12:00 – 14:00): 2 x Inter-Peak modelled hour;
- Bank Holiday (11:00 – 13:00): not included
-

The annualisation factors for each TUBA time period is defined by the number of times the period occurs each year, as below:

- 253 normal weekdays;
- 52 weekends; and
- 8 bank holidays.

The factors obtained from the observed counts above were therefore used to derive the annualisation factors for TUBA assessment. Table 7.10 summarises the annualisation factors to be used for the TUBA analysis.

Table 7-10 - Annualisation Factors

No	Time Slice	Duration (min)	Model	Annualisation Factor
1	Weekday AM Period	60	AM Peak Hour Model	1 x 253 = 253
2	Weekday Inter-Peak Period	60	Inter-Peak Hour Model	7 x 253 = 1,771
3	Weekday PM Period	60	PM Peak Hour model	2 x 253 = 506
4	Weekday Off-Peak period	60	Inter-Peak hour model	2 x 253 = 506
5	Weekend	60	Inter-Peak hour model	9 x 52 = 468

The revised annualisation factors compare against the original annualisation factors which was used for the original Public Inquiry and also in the FABC, as below:

Table 7-11 – Comparative Annualisation Factors

No	Time Slice	Duration (min)	Previous Factors	Revised Factors
1	Weekday AM Period	60	253 x 2.627 = 664	253 x 1 = 253
2	Weekday Inter-Peak Period	60	253 x 6 = 1,518	253 x 7 = 1,771
3	Weekday PM Period	60	253 x 2.724 = 693	253 x 2 = 506
4	Weekday Off-Peak period	60	253 x 0.82 = 209	253 x 2 = 506
5	Weekend	60	52 x 18.88 = 982	52 x 9 = 468

*Note: 0.82 and 18.88 are factors converting off-peak and weekend traffic volume to average inter-peak hour volume

Matrix Data

Matrices have been extracted from the Lincoln VISUM Model to supply time and distance information for each origin-destination pair, and factored into an acceptable format for use in TUBA. The following time periods were extracted:

- 2018 Do - Minimum AM/IP/PM/OP/WE
- 2033 Do - Minimum AM/IP/PM/OP/WE

7.5 Output Checks

The TUBA output file details several analyses of the input file to facilitate checking of the runs by highlighting possible errors or inconsistencies within the input data. These warning messages were checked to ensure:

- Matrix totals were consistent;
- High ratios for DS/DM times were justified;
- Low ratios for DS/DM times were justified;
- High ratios for DS/DM distances were justified; and
- Low ratios for DS/DM distances were justified.

Table 7-12 details the number of warnings for the Core Scenario.

Table 7-12 – TUBA Warning Summary

Warning Type	DM v DS
Ratio of DM to DS travel time lower than limit	13,286
Ratio of DM to DS travel time higher than limit	48,675
Ratio of DM to DS travel distance lower than limit	1,483

Ratio of DM to DS travel distance higher than limit	4,769
DM speeds less than limit	1.009
DS speeds less than limit	66
Total Warnings	68,280

7.6 Scheme Economic Performance

A summary of the revised TUBA outputs are detailed in Table 7-133 below. All Values are in £'000 at 2010 prices and values.

Table 7-13 – TUBA Results Summary Table

Cost and Benefits	DM v DS
Economic Efficiency	
Consumer User (Commute)	76,330
Consumer User (Other)	299,974
Business User and Provider	534,833
Indirect Tax Revenue	-11,018
Carbon Benefits	3,821
Present Value of Benefits (PVB)	893,940
Broad Transport Budget	
Investment Costs	96,304
Present Value of Costs (PVC)	**96,304**
Overall Impacts	
Net Present Value (NPV)	797,636

7.7 Assessment of Accident Benefits

Overview

The calculation of accident savings and benefits relating to the LEB has been undertaken using a spreadsheet-based method which is similar to the Highways Agency's COBA LighT (COBALT) program, and has been used by Mouchel to calculate accident savings/benefits on a number of schemes including Manchester Managed Motorways (MMM) and Heysham-M6 Link. The process calculates accident costs/benefits as described in the COBA / COBALT manual and uses the latest COBA accident rates and WebTAG guidance.

This section provides an outline of the methodology, assumption, and the results of the accident benefits calculated for the LEB.

Methodology

As defined in the COBA manual, the total cost of accidents on a network is calculated by multiplying the number of accidents predicted to occur on the network by the cost per accident. The number of accidents on a given length of road is expressed by accident rates, defined as the number of Personal Injury Accident (PIA) per million vehicle kilometres. The outputs are expressed as the change in the number of accidents and casualties when a scheme is introduced, and the economic cost implications of these changes.

The savings in the number of accidents / casualties as a result of the LEB scheme were calculated from the difference between accident and casualty costs between the Do-Minimum and Do-Something The accident benefits were calculated over a 60 year appraisal period and discounted to 2010 base prices and values.

COBA Networks

COBA uses nodes and links to represent the Do-Minimum and Do-Something highway networks. The COBA networks assessed included all the internal 'simulation' links from the VISUM forecasting models to ensure the full extent of the accident impact. The external 'buffer' links were not included in the assessment as it was felt that these would not be impacted by the LEB and to be consistent with the TUBA methodology. COBA networks were defined for the Do-Minimum and Do-Something networks, for both the opening and design years. The COBA link types and associated COBA accident rates were specified for all links, along with the link distances and free-flow speeds. Junctions were not modelled in the COBA network due to the size of the network.

Input Information

Input information to the assessment of accidents is set out in the table below.

Table 7-14 – Accident Benefits Calculation General Parameters

Parameter	Value
First Year of Assessment	2018
Evaluation Period	60 years
Network Classification	Built-up Principal (PBU)
Traffic Flow Input Format	AADT
Type of Accident Calculations	Link and Junction Separate (SEP)
Traffic Flow Input Year	2018
Traffic Growth Assumption	Default Central (DEFC)
Economic Growth Assumption	Default Central (DEFC)
Fuel Cost Growth Assumption	Default Central (DEFC)
Traffic Composition Input Year	2006

Scheme Accident Benefits

The table below summarises the accident benefits generated by the LEB scheme over the 60 year assessment period, discounted to 2010 prices. It illustrates that the scheme is forecast to result in a slight disbenefit of £815,000.

Table 7-15 – LEB Accident Benefits

	DM v DS
Accident Benefits (£000's)	-815

The slight disbenefit can be attributed to the higher trip matrices totals in the Do-Something scenarios in comparison to the Do-Minimum. This increase in trips is associated with the additional trips associated with the NEQ and SEQ which are large scale LEB dependent developments.

It is clear that the slight disbenefit described above is a result of the additional trips which are present in the Do Something scenario generated by dependant developments which cannot be realised without the scheme, rather than any inherent increase in risk of travelling on the network. Indeed, analysis of the risk expressed as expected pias per million vehicle kilometres shows that, overall, travelling on the Do Something network will be safer than travelling on the Do Minimum network.

This is confirmed by previous accident assessments which were based on Do-Something and Do-Minimum matrices totals controlled to the same level and which showed significant accident benefits resulting from the scheme.

8 Comparative Analysis

8.1 Introduction

This section compares forecast inputs and results against the earlier modelled analysis presented in the 2014 Public Inquiry, prior to the current (Core) model refinement focussed on Hawthorn Road.

8.2 Model Inputs

The modelled forecast matrices are detailed below.

Table 8-1 AM Travel Demands

Scenario	Original Model	Core Model	Difference
2006 Base	59,009	59,126	117
2018 Do-Minimum	67,783	61,669	-6,114
2018 Do-Something	67,783	61,669	-6,114
2033 Do-Minimum	77,091	69,294	-7,797
2033 Do-Something	77,091	71,143	-5,948

Table 8-2 Inter Peak Travel Demands

Scenario	Original Model	Core Model	Difference
2006 Base	55,340	55,197	-143
2018 Do-Minimum	64,734	58,022	-6,712
2018 Do-Something	64,734	58,022	-6,712
2033 Do-Minimum	76,017	67,467	-8,550
2033 Do-Something	76,017	68,546	-7,471

Table 8-3 PM Travel Demands

Scenario	Original Model	Core Model	Difference
2006 Base	57,743	59,627	1,884
2018 Do-Minimum	65,542	62,288	-3,254
2018 Do-Something	65,542	62,288	-3,254
2033 Do-Minimum	74,844	70,385	-4,459
2033 Do-Something	74,844	72,103	-2,741

The travel demands in the core base model show a close fit. The PM modelled flows are increased by around 1,880 trips as part of the matrix estimation process to better match traffic patterns to observed patterns.

Resultant from lower traffic growth implicit in the latest version of TEMPRO figures the future year travel demand matrices show reductions compared to the original model, which used an earlier (and higher growth) version. The 2033 Do Minimum model shows the greatest difference due to the impact of dependent development.

8.3 Model Outputs

LEB flow comparisons between models are included in the Tables below

Table 8-4 – 2018 2-Way AADT Flows (Demand Flows)

Section	Forecast Two Way AADT Flows		
	Previous	Updated	Difference
Section 1a	20,200	17,400	-2,800
Section 1b	19,200	17,000	-2,200
Section 2	26,000	20,200	-5,800
Section 3	18,000	14,400	-3,600
Section 4	18,100	15,600	-2,500

Table 8-5 – 2033 2-Way AADT Flows (Demand Flows)

Section	Forecast Two Way AADT Flows		
	Previous	Updated	Difference
Section 1a	23,100	20,700	-2,400
Section 1b	22,100	20,000	-2,100
Section 2	33,400	26,900	-6,500
Section 3	24,000	21,400	-2,600
Section 4	22,400	20,400	-2,000

The LEB demonstrates reduced flow across each section. Again this is resultant from the lower growth rates applied, as a consequence of the TEMPRO update from November 2014.

9 Summary & Conclusions

9.1 Model Update

The traffic model has been refined based on a desire to ensure greater detail and accuracy in the vicinity of Hawthorn Road. The opportunity has also been taken to tighten the validation criteria to ensure the benefits of the scheme are adequately represented. This has been previously reported in the LMVR Addendum (May 15).

9.2 Forecasting

An opportunity has been taken to review development assumptions and specifically include developments with a much lower trip generation potential than previously incorporated. This is discounted from revised TEMPRO background growth. The results of forecasting, both for LEB and relief of existing highways, have been demonstrated in this report.

9.3 Economic Appraisal

The latest, rebased, TUBA (v1.9.5) has been employed, with updated value of time parameters. Accident analysis has been developed from evidence collated over the most recent years.

LEB economic benefits are summarised below.

Table 9-1- Overall Scheme Benefits Summary (£000s)

Net Present Value for Benefits	DM v DS
Consumer – Commuting User Benefits	76,330
Consumer – Other User Benefits	299,974
Business User Benefits	534,833
Carbon Benefits	3,821
Indirect Taxation	-11,018
Accident Benefits	-815
Present Value of Benefits (PVB)	903,125
Present Value of Costs	
Investment Costs	96,304
Present Value of Costs (PVC)	96,304
Overall Impact	
Net Present Value (NPV)	806,821
Benefit to Cost Ratio (BCR)	**9.4**

9.4 Conclusion

The updated base model has been applied in the forecast scenario. The outturn traffic forecasts demonstrate a strong demand for the new bypass. The value for money assessment demonstrates a strongly positive stream of benefits. The refinement of the model has had some minor impact on the forecasting and appraisal, however the economic case for the scheme remains compelling with Value for Money (VfM) maintained as per the Best and Final Bid (BaFB).

APPENDIX A – Development Log

Development Assumptions

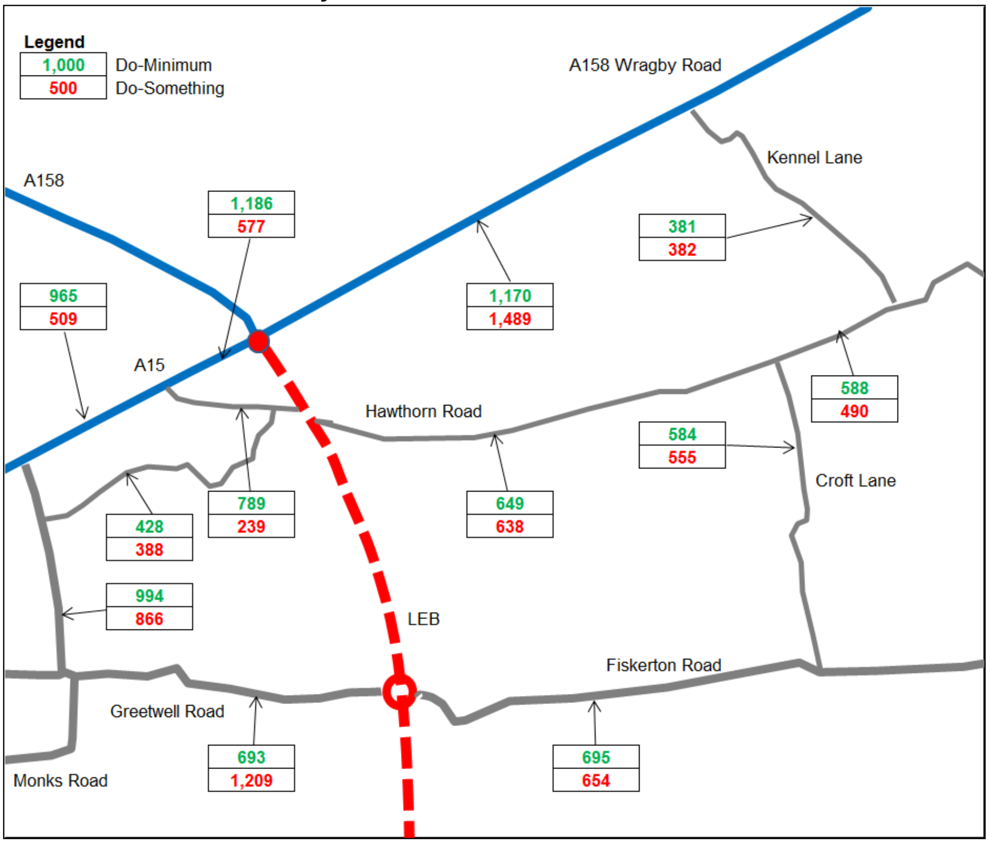
Committed Development: Location & Description	Size (ha)	Dwellings (units)	Scheme Depen-dency	Site Open Date	Do Min/ Do Something	Fore-cast Years
Development: North East Quadrant, Centre bounded by LEB 48.5% B1, 33.5% B2, 18% B8 + housing	5	2,000	LEB	2031	Do Something	Design Year
Development: Teal Park - 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 Avenue junction			N/A	2016	Do Minimum	Opening Year
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. 19 individual sites ranging from 0.71ha – 5.24 ha	1.19		N/A	2016	Do Minimum	Opening Year
Development: Employment Land Review Sites - By 2026 5 individual sites ranging from 0.67 – 7.96	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

Committed Development: Location & Description	Size (ha)	Dwellings (units)	Scheme Depen-dency	Site Open Date	Do Min/ Do Somethin g	Fore-cast Years
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 for housing		244	N/A	2012	Do Minimum	Opening Year
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

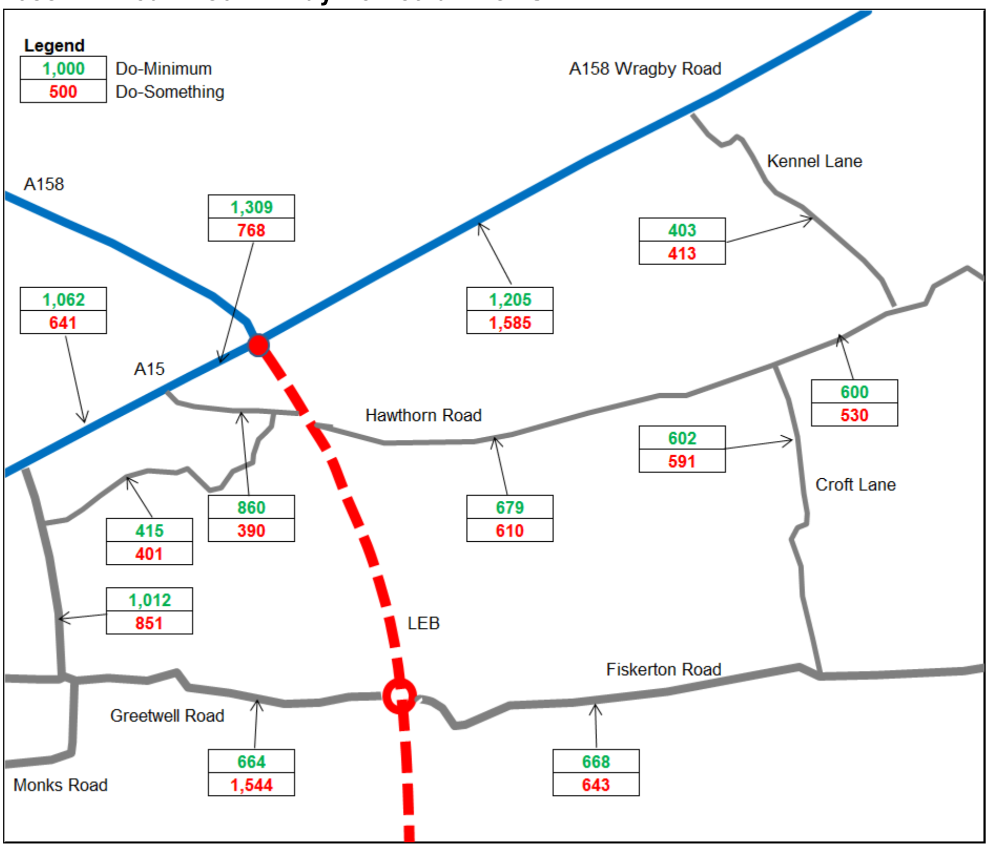
Committed Development: Location & Description	Size (ha)	Dwellings (units)	Scheme Depen-dency	Site Open Date	Do Min/ Do Somethin g	Fore-cast Years
Development: Land between, Newark Road/Mill Lane, North Hykeham, Lincoln (CL58)		206	N/A	2016	Do Minimum	Opening Year
Development: Land at Ruston Way, Brayford 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
Development: Land SE of Carlton Boulevard, Bunker's Hill		124	N/A	2007	Do Minimum	Opening Year
Development: Bunkers Hill Development, Phases 3 - 11		431	N/A	2007	Do Minimum	Opening Year
Development: Former Parade Ground, Nene Road		134	N/A	2011	Do Minimum	Opening Year
Development: Former Simons Construction, 401 Monks Road		170	N/A	2009	Do Minimum	Opening Year
Development: Jubilee Close, Cherry Willingham		110	N/A	2006	Do Minimum	Opening Year
Development: Tentecroft Street Car Park (CL745)		91	N/A	2021	Do Minimum	Design Year
Development: Mill Lane / Newark Road, North Hykehan (CL236)		93	N/A	2016	Do Minimum	Opening Year
Development: Cell 12. Witham St Hughs (CL374)		95	N/A	2016	Do Minimum	Opening Year
Development: Cell 11 and part Cell 17, Witham St Hughs (CL2080)		112	N/A	2016	Do Minimum	Opening Year
Development: Phase 4, land between Newark Road / Mill Lane, North Hykeham (CL79)		154	N/A	2016	Do Minimum	Opening Year
Development: Land to North of Station Road, Waddington (CL1068)		163	N/A	2021	Do Minimum	Design Year
Development: City bus station, Melville Street (CL736)		180	N/A	2021	Do Minimum	Design Year

APPENDIX B – Model Flow Volumes

2018 AM Peak Hour 2-Way Vehicular Flows



2033 AM Peak Hour 2-Way Vehicular Flows



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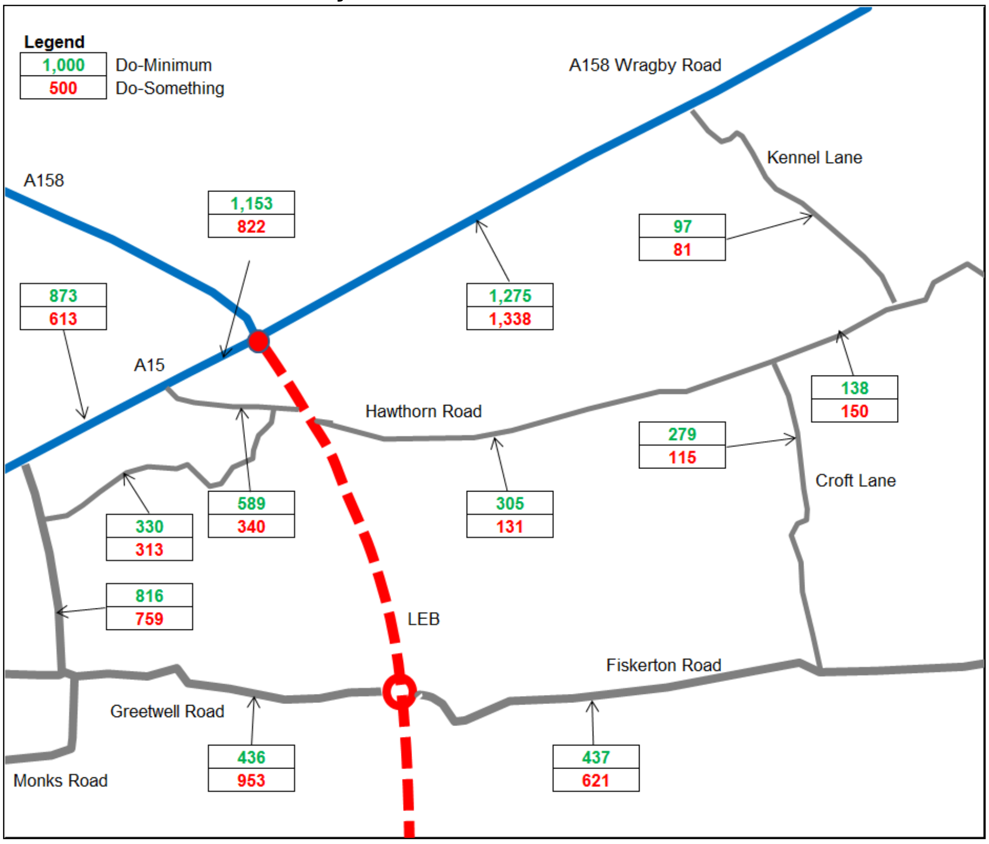

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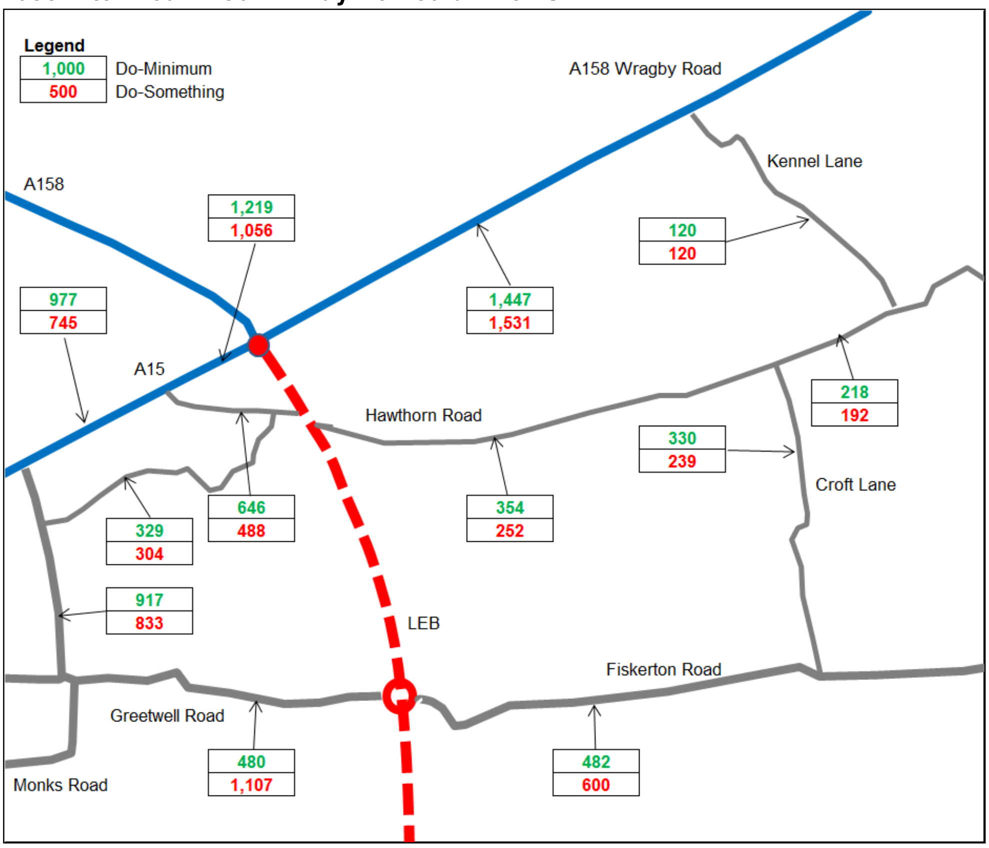
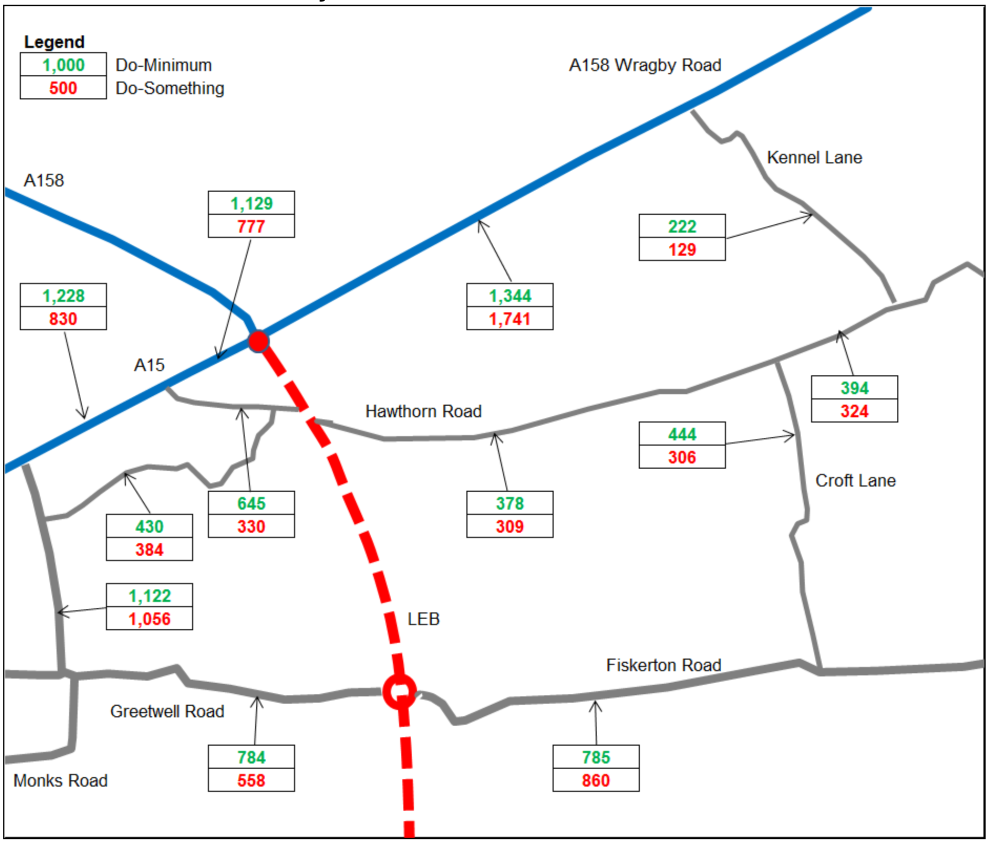


2018 PM Peak Hour 2-Way Vehicular Flows



2033 PM Peak Hour 2-Way Vehicular Flows