Leicestershire County Council

A511 GROWTH CORRIDOR

Appraisal Specification Report (ASR)

ASR001
JUNE 2019

CONFIDENTIAL

Leicestershire County Council

A511 GROWTH CORRIDOR

Appraisal Specification Report (ASR)

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PROJECT NO. 70056642

OUR REF. NO. ASR001

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CONTENTS

TABLES

FIGURES

APPENDICES

APPENDIX D

DMRB A511 RISK REGISTER REV D

1 INTRODUCTION

1.1 OVERVIEW

1.1.1. This document represents the Appraisal Specification Report (ASR) for the Outline Business Case (OBC) for the A511 Growth Corridor Scheme. The OBC is required to be developed for the scheme to secure approval as part of the Department for Transport (DfT) Major Road Network (MRN) funding process.

1.2 PURPOSE OF THIS REPORT

1.2.1. This ASR has also been developed to ensure alignment with DfT's MRN funding application process and the Department's Transport Business Case Guidance as well as the Leicester and Leicestershire Enterprise Partnership's (LLEP) own assurance framework. Subsequently the OBC will need to be upgraded into the Full Business Case for a final DfT funding decision, once statutory processes have been completed.

1.2.2. The ASR is intended to inform the following bodies or organisations:

- Leicestershire County Council (LCC), the promoters of the scheme;
- Transport for the East Midlands as part of the Regional Evidence Base;
- Midlands Connect:
- Department for Transport (DfT), to whom LCC are submitting the Business Case;
- AECOM and WSP, the scheme development consultants; and
- Stakeholders.

1.2.3. The ASR is the first step of a WebTAG compliant business case, as required by DfT. The purpose of this ASR is to set out how appraisal will be undertaken and details the:

- Strategic case and the transport objectives to be addressed by the scheme;
- Scope, methodology, assumptions and associated risks of the transport appraisal and how it will be supported by traffic/transport modelling;
- The level of uncertainty about estimated impacts; and
- The focus of the local objectives, reflecting the need for intervention.

1.2.4. The aim of the ASR is to propose an appraisal approach which is in the process of being agreed with the DfT. Once agreed, the ASR will form the basis of the appraisal of the A511 Growth Corridor Scheme

1.2.5. The ASR remains the live document and is reviewed and updated regularly during the project life-cycle to reflect any changes in the scope and approach.

1.2.6. In addition, a Distributional Impact Appraisal Screening Proforma has been completed (**Appendix A**) to summarise the approach to the Distributional Impact Assessment of the scheme, as required by WebTAG guidance.

1.3 STAKEHOLDER ENGAGEMENT AND APPROACH VERIFICATION

1.3.1. The ASR allows all stakeholders related to the project to understand the assessment and appraisal work required during the OBC stage of the work. In relation to the A511 Growth Corridor, the ASR operates as a reference for the scheme consultants (WSP & AECOM), the DfT, Midlands Connect, the Leicester and Leicestershire LEP (LLEP), Leicestershire County Council (LCC) and North West Leicestershire District Council (NWLDC) to ensure that the technical work is carried out in the approved manner.

1.3.2. To ensure a consistent approach and reduce the risk of re-work due to different opinions on the approach to modelling and the Value for Money assessment, the following sequence of the ASR approval is proposed:

- Agree the modelling and Value for Money assessment methodology with LCC;
- Update the ASR to reflect any changes to the scope or methodology following discussion with LCC; and
- Submit the final draft ASR to MC and DfT for approval.

1.3.3. The ASR contains details of risks that exist within the proposed work. This increases the visibility of these risks and provides greater understanding of how the technical work detailed may impact on project timescales and cost.

1.4 REPORT STRUCTURE

1.4.1. The structure of the ASR is set out in accordance with WebTAG guidance and generally follows the Guidance Note for the Production of an Appraisal Specification Report (IAN 176/13), and following this introduction includes:

- **Section 2** – Project Definition;
- **Section 3** – Strategic Case;
- **Section 4** – Transport Modelling and Forecasting;
- **Section 5** – Economic Assessment;
- **Section 6** – Commercial Case;
- **Section 7** – Financial Case;
- **Section 8** – Management Case; and
- **Section 9** – Appraisal Specification Summary Table.

2 PROJECT DEFINITION

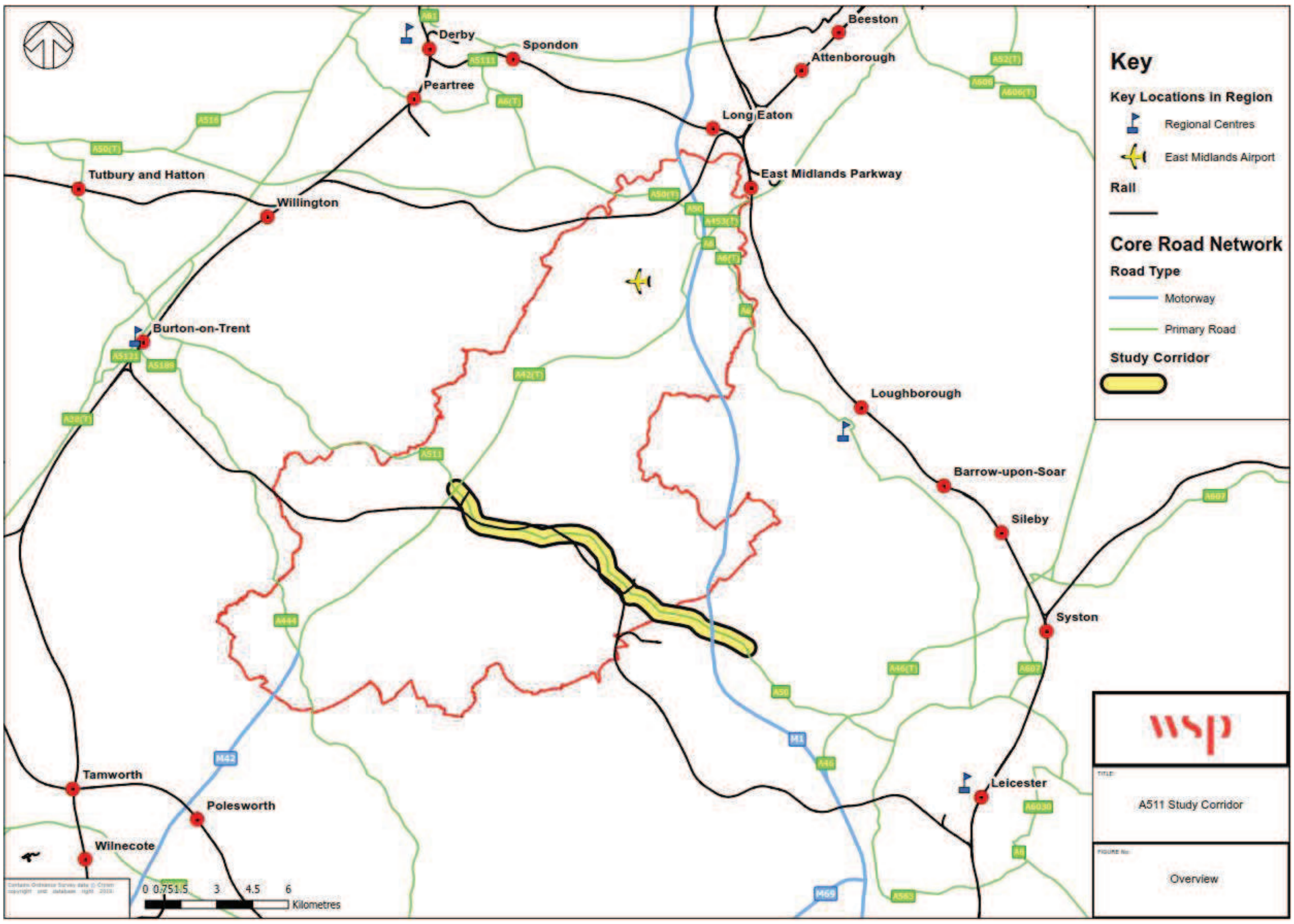
2.1 DESCRIPTION OF SCHEME

2.1.1. The A511 Growth Corridor is in the district of North West Leicestershire and relates to the section of the road between the A42 Junction 13 and the Field Head Interchange on the A50 east of the M1 Junction 22. This section of road centres on the town of Coalville which, in turn, sits north-west of the city of Leicester and is shown in **Figure 2-1**.

2.1.2. Work undertaken by North West Leicestershire District Council as part of its Core Strategy identified that there was a need for improvements to all junctions along the A511 between Junction 22 of the M1 and Junction 13 of the A42. It is therefore important that improvements are carried out to ensure that the necessary development can take place.

2.1.3. The A511 is a wide single carriageway between the A42 to the immediate north of the access for the Bardon Hill Industrial Park. From this point to the M1 the A511 is dual carriageway. A notable feature of the road is the bypass around Coalville, which also provides access to a range of industrial estates to the north of the town.

Figure 2-1 - A511 Corridor Location



2.1.4. The A511 is regionally important following its identification as one of the five growth areas identified in the Leicester and Leicestershire Local Enterprise Partnership's (L&L LEP) Strategic Economic Plan (SEP). The area surrounding the corridor has been identified as having the potential to deliver circa 5000 additional houses and 25ha of employment land, should infrastructure investment be provided.

2.1.5. The A511 Growth Corridor is part of the Major Road Network (MRN) and is a key east–west road link in Leicestershire. It links the A42 (Junction 13, Ashby de la Zouch) to the M1 (Junction 22 north-west of Leicester) and therefore acts as a connecting route to and between the Strategic Road Network (SRN). Following extensive evidence based work the scheme now considers improvement at the Field Head Interchange along the A50 to the east of M1 Junction 22.

2.1.6. Leicestershire County Council's Prospectus for Growth document[1] sets out the Coalville Transport Strategy which aims at supporting the delivery of planned growth in the town by improving the A511/A50 corridor. The project will identify suitable improvements at key junctions along the corridor, as well as delivering a local link road which is a key element of the North-West Leicestershire Local Plan[2], to provide an alternative route for drivers to limit the impact of growth. The scheme will do this by improving local connectivity and improving access to Leicester, East Midlands Airport (EMA) and the East Midlands Gateway Strategic Rail Freight Interchange (SRFI).

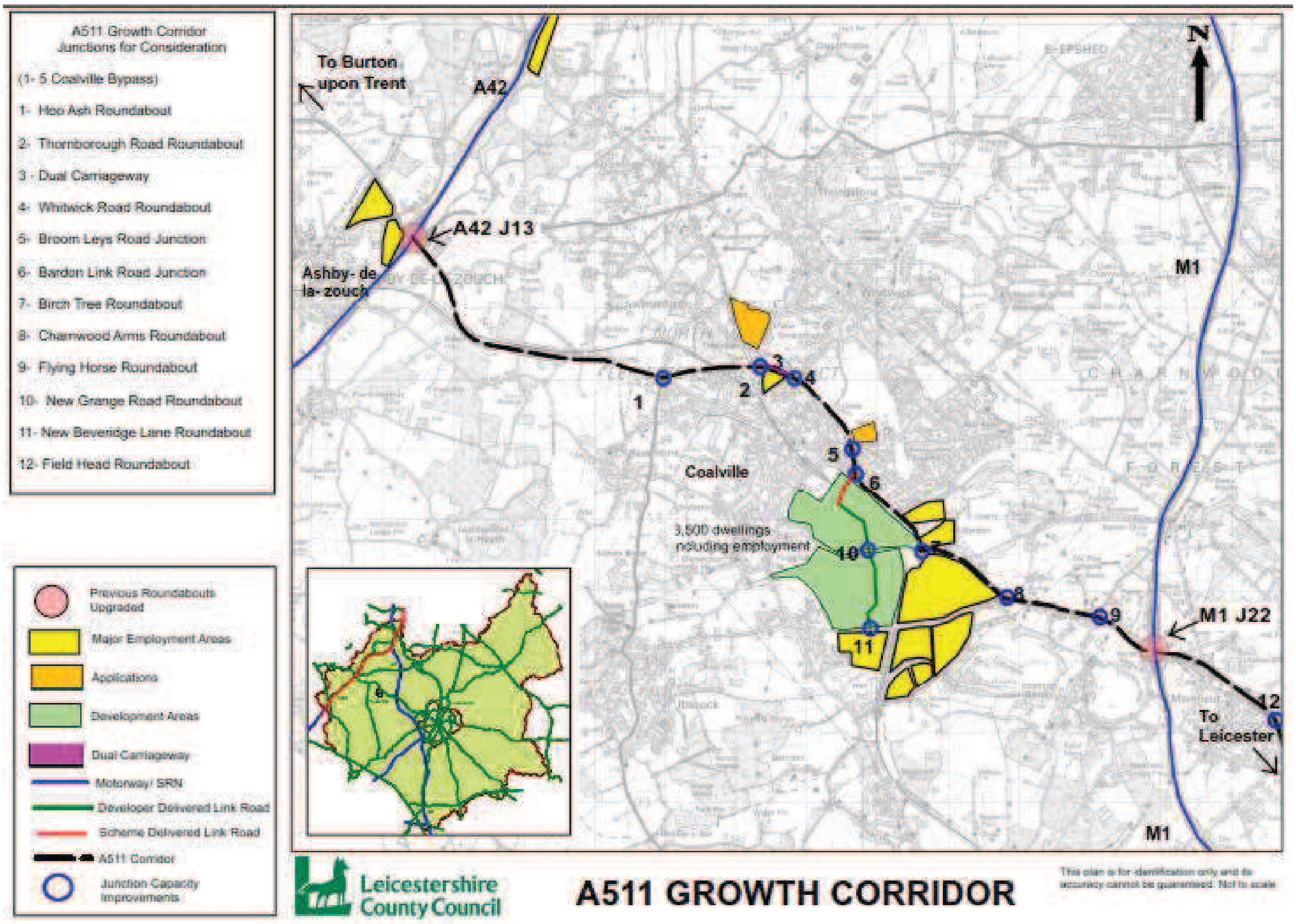
2.1.7. An overview of the proposed A511 Growth Corridor scheme is shown on Figure 2-2 and involves:

- Junction capacity improvements at the following nine key junctions along the A511/A50 link;
  - Junction 1 - Hoo Ash Roundabout;
  - Junction 2 - Thornborough Road Roundabout;
  - Junction 4 - Whitwick Road Roundabout;
  - Junction 5 - Broom Leys Road Junction;
  - Junction 6 - Bardon Link Road Junction;
  - Junction 7 - Birch Tree Roundabout;
  - Junction 8 - Charnwood Arms Roundabout;
  - Junction 9 - Flying Horse Roundabout; and
  - Junction 12 - Field Head Roundabout.
- Dualling of the link between Thornborough Road Roundabout (Junction 2) and Whitwick Road Roundabout (Junction 4);
- Provision of the northern section of the Bardon Link Road which goes through the south east Coalville SUE i.e. a punch through from where the Bardon Link Road ends at SUE to the A511/ Bardon Road Junction (Junction 6). The southern section of the Bardon Link Road including the two new junctions with Grange Road and Beveridge Lane (i.e. Junctions 10 and 11 respectively on Figure 2-2) are being funded by the developers of the south east Coalville SUE, with the

[1] Leicestershire County Council: Prospectus for Growth Leicestershire (February 2019)
[2] North-West Leicestershire Local Plan 2011 to 2031 (November 2017)

possibility of LCC funding the Beveridge Lane Junction (i.e. Junction 11) should funding be secured, due to the key role the link will play in relieving congestion on the A511/Bardon Road to A511/B585 Beveridge Lane link as well as the A511/Regs Way/Grange Road junction (i.e. Junction 7 on **Figure 2-2**).

Figure 2-2 - Proposed A511 Growth Corridor Scheme

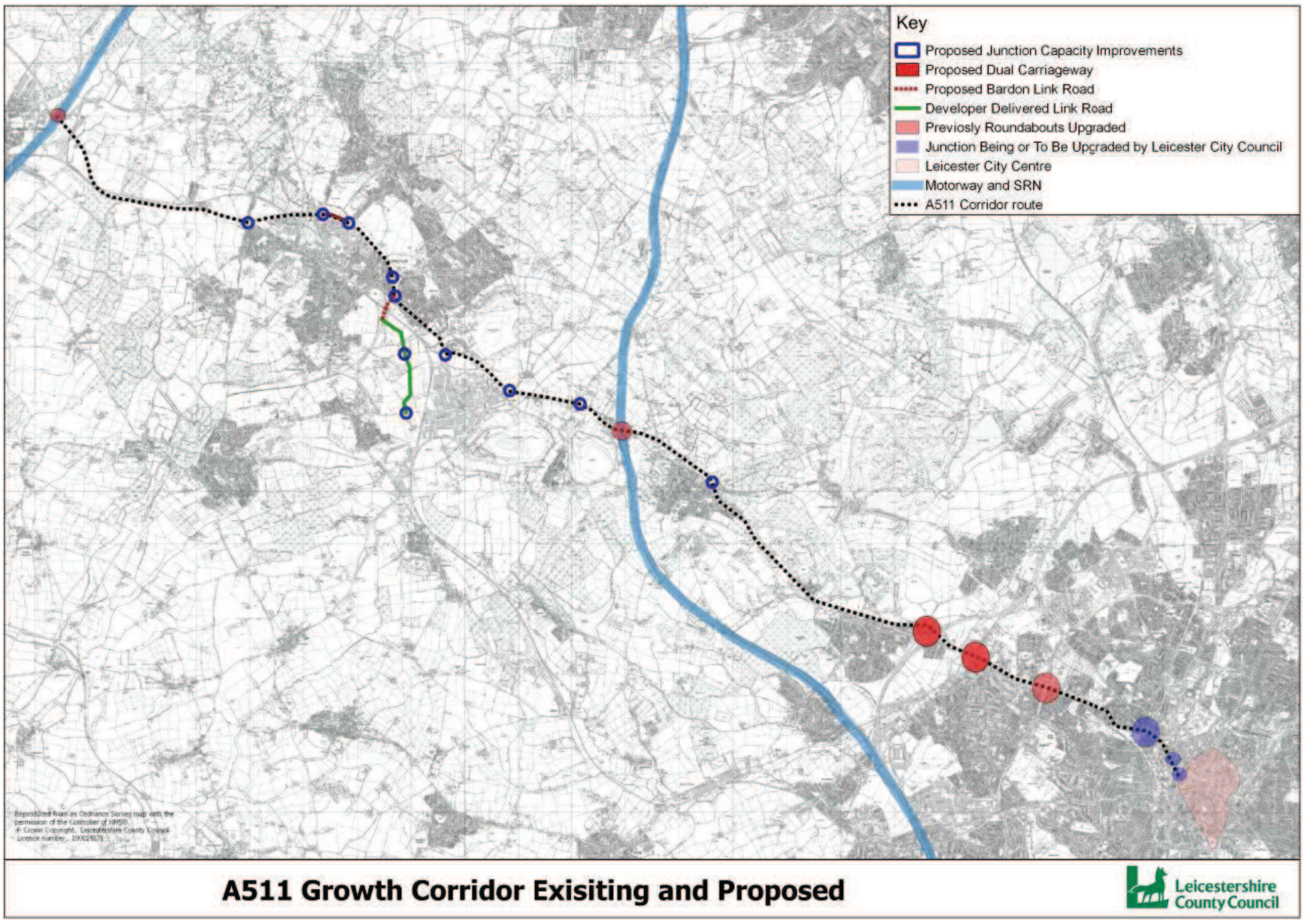


2.1.8. Layouts of the proposed improvements making up the preferred scheme are provided in **Appendix B** of the ASR.

2.1.9. There are also complimenting nearby schemes along the A511/A50 corridor that have been recently completed or are ongoing, these include improvements at A42 Junction 13 and M1 Junction 22 which were both completed in 2017. Also, there are other schemes to the east of the M1 junction 22 being undertaken by LCC and Leicester City Council. These include the dualling of selected sections of the A511 on the western edge of Leicester (but still within the County Council's remit) and junction capacity improvements at three junctions on the corridor being undertaken by Leicester City Council.

2.1.10. The location of the interventions proposed by the County Council, as well as the proposed City Council schemes complementary to this project, are shown in **Figure 2-3**.

Figure 2-3 - Intevention Locations



2.2 SCHEME BACKGROUND

2.2.1. In 2011 Coalville Transport Study was commissioned to undertake a Transport Study in support of two Sustainable Urban Extensions (SUEs), along with several smaller sites (up to 1000 houses) being promoted through the Local Development Framework (LDF) Core Strategy in and around the area of Coalville, North West Leicestershire.

2.2.2. This study set out several improvements along the A511 which would alleviate congestion modelled to 2026 with expected and committed development. This study formed the basis of the prioritisation of transport schemes for the Coalville Transport Strategy.

2.2.3. Following successful funding bids for M1 Junction 22 and A42 Junction 13 highway improvements, LCC commission a report in 2016 by SYSTRA to "provide a robust evidence base to support the series of transport schemes for the A511 Growth Corridor to enable economic regeneration of the area…"

2.2.4. This work supported the view that the ongoing effective functioning of the A511 corridor is key to supporting housing and job growth in (at least) Coalville and Ashby and has been a key aspect of the Local Plan. This approach has stood the test of scrutiny by an independent planning inspector. NWLDC have just begun work to review their Local Plan, and the A511 corridor is likely to remain a key aspect of the next Local Plan.

2.2.5. Leicestershire County Council's Prospectus for Growth Leicestershire (Feb 2019) considers the benefits of the A511 Growth Corridor to include the supporting of the delivery of at least 9600 homes, 7300sqm of retail and up to 66ha of employment across the North West Leicestershire district.

2.2.6. An options assessment exercise was carried out accordance with WebTAG guidance using the DfT Early Assessment Sifting Tool (EAST) methodology to review the current and future issues relating to the A511 Growth Corridor with the aim of assessing the need for intervention along the route, this is described within the Option Assessment Report. The options assessment exercise examined various strategic options for resolving the identified current and future issues for the corridor. This evidence based work included, previous work undertaken as part of the Coalville Transport Study and the North West Leicestershire Infrastructure Delivery Plan which both highlighted current levels of congestion, through traffic and limited spare capacity issues along the A511 corridor.

2.2.7. This exercise identified congestion problems at many existing junctions along the A511 Growth Corridor causing delays and network resilient issues, creating limited route choice. Also, existing congestion problems along the corridor create a knock-on effect on the performance on the Strategic Route Network (SRN) regarding the A42 and M1. The interventions will help reduce traffic queues and the frequency of stationary traffic, thus providing improvements in air quality.

2.2.8. This exercise provided both the need for intervention and the strategic objectives which were used to assess an initial long list of 28 options (ranging from individual junction improvements, packaged junction improvements and public transport options) using a tailored option appraisal tool based on DfT's Early Assessment and Sifting Tool (EAST) in conjunction with Midlands Connect's Multi Criteria Assessment Framework (MCAF) tool. This led to the 13 initially sifted options being taken forward for further assessment.

2.2.9. The 13 initially sifted options were further compared in more detail using a framework of the study objectives, to arrive at a short list of five options, which were taken through a detailed assessment using the DfT's EAST approach, to arrive at a preferred option.

2.2.10. The option appraisal process demonstrated that a full mitigation scheme which addresses congestion issues at all key junctions along the A511 is most able to solve existing congestion and through traffic issues, as well as being best placed to accommodate the significant levels of housing and employment growth coming forward and support the construction of the HS2 compound near A42 Junction 13.

2.2.11. A preferred option 'Package 1' was taken forward as it addresses both existing and future issues identified during the assessment process. The Option Assessment Report details the methodology and assumptions used during the options assessment process in full.

2.2.12. A Strategic Outline Business Case for Package 1 was developed which discussed the need for intervention (the case for change) and how this will further government aims and objectives (the "strategic fit") further assessing the preferred options against the Department for Transport's (DfT) Transport Business Case 'Five Case Model' (the Strategic, Economic, Financial, Management and Commercial cases).

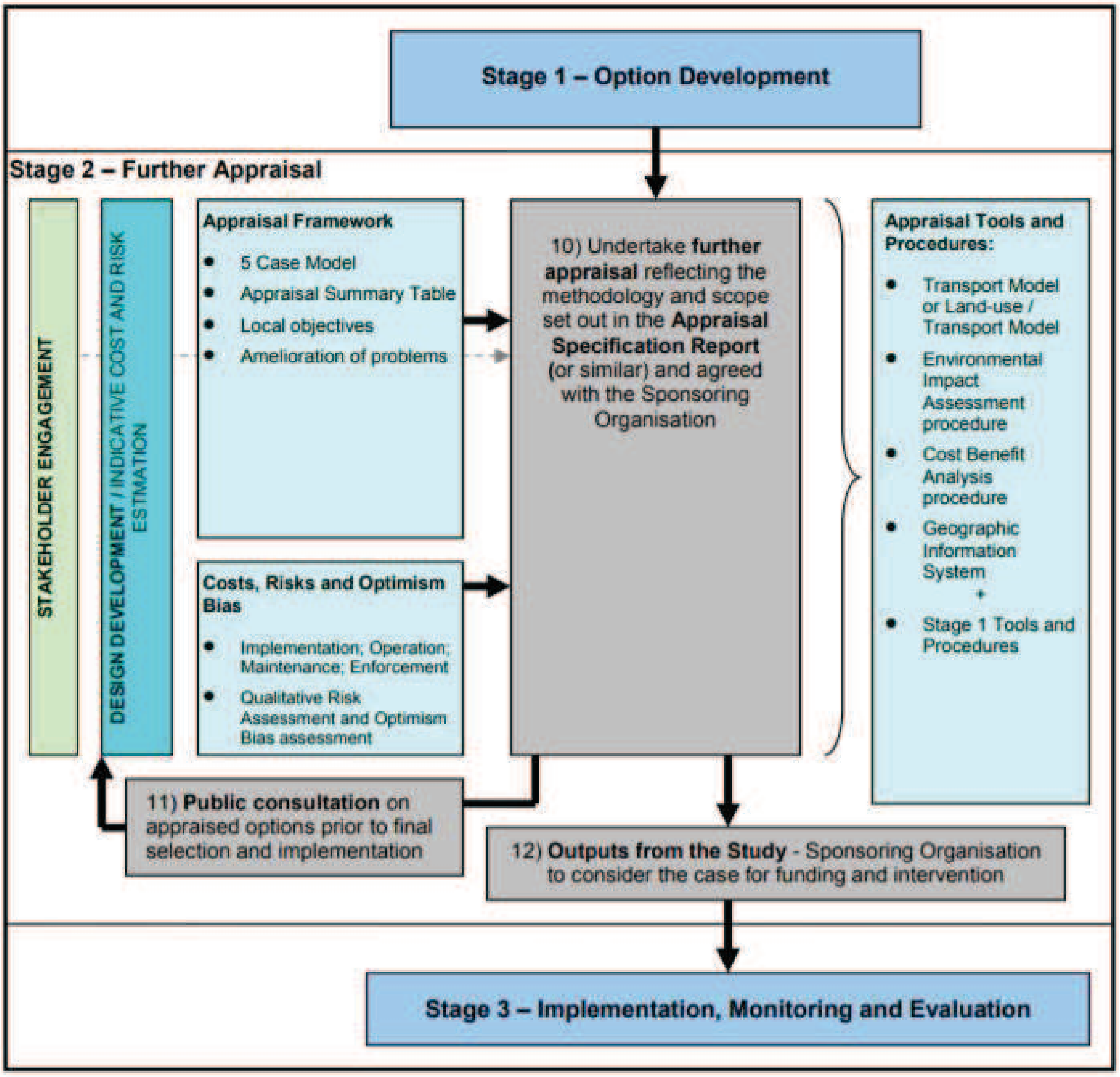
2.2.13. The assessment utilised the Pan-Regional Transport Model (PRTM) produced by AECOM on behalf of LCC. The PRTM is an extension of the of the Leicester and Leicestershire Integrated Transport Model (LLITM) with enhancements in model detail outside of Leicestershire.

2.3 CURRENT STAGE OF THE PROJECT

2.3.1. To progress to OBC, further analysis will be undertaken to reconfirm the conclusions within the SOBC while further detailed assessment of the preferred option is undertaken to help build the case for the intervention. Full economic and financial appraisals take place at this stage (building up the economic and financial cases), and, where relevant, preparations are made for the potential contract through the development of the commercial case. The arrangements required to ensure successful delivery are set out in the management case. These details are presented in the OBC.

2.3.2. The ASR provides the specification of the methodology and scope for Stage 2 of the Web TAG appraisal process for the option assessment process and delivery of the OBC submission (**Figure 2-4**); this will also include the underlying assumptions and limitations.

Figure 2-4 - Stage 2 of Transport Appraisal Process



3 STRATEGIC CASE

3.1 STRATEGIC CASE OBC

3.1.1. The development of the Outline Business Case for the A511 Growth Corridor will start with preparation of the Strategic Case. The Strategic Case determines the need for investment. At the OBC stage it will clearly demonstrate the case for change – that is, a clear rationale for making the investment. The Strategic Case demonstrates 'strategic fit', which is how an investment will further the aims and objectives of Leicester and Leicestershire County Council, LLEP and Department for Transport.

3.1.2. More specifically, the Strategic Case will

- Specify the business need for a project;
- Set the context and identify a series of investment aims; and
- Assess the investment aims against what the Government and LLEP want to achieve.

3.1.3. Determining the case for change and strategic fit is an iterative process as the business case develops, and will be supported by robust evidence, such as identifying key risks and constraints. It will be developed with close contact with main stakeholders of the project.

3.1.4. The following list of actions summarises the proposed approach to the preparation of the Strategic Case for the proposed scheme:

- Describe how the scheme aligns with the aims and objectives of the DfT, Major Road Network Objectives, the LLEP, its SEP, LCC Strategic Growth Plan and the North West Leicestershire District Council Local Plan;
- Identify the current transport situation in Leicestershire (LCC) and around Coalville by analysis of the following data, supporting and drawing on, as appropriate:
  - Average speed data available from Trafficmaster to highlight the congestion and current issues;
  - The latest PRTM model to obtain AADT, AM peak, PM peak and interpeak hourly traffic flows at key locations on the network, supported by the evidence base already produced for the Coalville Transport Strategy, from which the need for the scheme has been derived;
  - Locations of strategic development sites within Leicestershire County Council and around Coalville itself, and how they relate to, and depend on, the scheme;
  - Details of the demographics of the area (e.g. population, age breakdown, car ownership, employment details, travel to work distances and mode) through the Census 2011;
  - Details of the locations and causes of Road Traffic Accidents;
  - Details of the location, frequency and quality of public transport facilities;
  - Index of Multiple Deprivation scores for each LSOA in the study area; and
  - Locations and details of any Air Quality Management Areas.
- Describe current transport problems, and how these impact on the provision of further growth around Coalville and the A511 Growth Corridor;
- Describe what would be the impact of not changing (Do Nothing Scenario); in both transport and economic terms;
- Analyse the future year networks and future year delays, without the scheme, but with proposed scale of development using the latest PRTM transport model;
- Outline internal and external drivers for change; and potential synergies;
- Identify key stakeholders and the level of support for the scheme; and

- Outline the options and the potential consideration of the new options specified in the OAR.

3.1.5. The Strategic Case will thus provide an evidence-led, compelling narrative based on both transport and economic growth objectives of the need for the scheme.

3.2 EXISTING AND FORECAST ISSUES

3.2.1. Previous work undertaken during the option assessment process identified the existing issues. These have been provided within **Table 3-1.**

Table 3-1 - Current and Existing Issues

Theme	Current Issue	Future Issues	Underlying Cause	Need for Intervention
Sustaining and supporting economic growth	Delays along the A511, creates network resilience issues with limited route choice. This has a knock-on impact on the performance of its strategic junctions with the M1 J22 and A42 J13. This also poses journey time reliability issues for the logistics and mining activities which is prevalent along the corridor. Pockets of deprivation.	A failure to address the issues posed by underperforming junctions will increase delays to traffic accessing the SRN at M1 J22 and A42 J13, and impact on the economic output and productivity of the area. There is potential to unlock 5000 jobs and this would not be realised without the	80% of residents in North West Leicestershire and 76% of Coalville residents travel to work by car or van. This contributes to traffic congestion and air quality issues which ultimately has an increased cost on the local economy.	The addition of essential infrastructure to the existing highway network would enable it to operate more efficiently and support development within North West Leicestershire. The development and delivery of the suggested package of measures will support the efficient operation of the logistics and quarry needs on the corridor and the continued sustainable economic and housing growth in North The growth of these logistics companies requires not just improvements in journey times, but also greater reliability on journey times to their destinations.
Support all road users	Very high proportion of people travelling to work by non-sustainable transport modes. This is somewhat attributable to no publicly accessible railway services within North West Leicestershire and slow and indirect bus services available in Coalville. Increased congestion also contributes to air quality issues which has consequently led to the A511 (by Coalville) becoming an AQMA.	Continued growth in background traffic and freight related activities leading to poor air quality and safety issues for vulnerable road users.	There are limited sustainable interventions in place / proposed for North West Leicestershire. This, coupled with the lack of public transport opportunities in the area, creates a car culture which would require significant behavioural change for a mode shift.	At a local level residents and businesses will benefit from improved road, cycle and pedestrian connectivity in the area, providing more opportunities to access jobs in Coalville, Ashby and the wider area. This will help to alleviate air quality issues. In addition, route improvements would assist the safety of vulnerable road users on the A511.

Theme	Current Issue	Future Issues	Underlying Cause	Need for Intervention
Facilitating	Existing traffic data indicates that	North West Leicestershire	Development is constrained by lack of infrastructure.	Need to support the development of future housing including SUEs, as well as the visions from the LTP3 to support economic growth and more sustainable communities. The scheme will accelerate delivery of transport infrastructure necessary to facilitate housing growth. This will reduce the barrier to developers investing in Coalville by enabling sites to come forward where meeting the full cost of the infrastructure would make delivery unviable.
Support the Strategic Road Network	The A51 Growth Corridor is one of the key east-west road links in Leicestershire linking the A42 to the M1 at Junction 12 and therefore acts a connecting route to the SRN. It also performs a resilience function for the SRN by acting as an alternative route between the M1 and A42.	Continued growth in background traffic and freight related activities can lead to delays and journey time reliability issues for the corridor and in so doing affecting vehicles accessing the SRN. In addition to this the HS2 compound is located near the corridor and would result in additional traffic along the corridor during construction.	Inadequate infrastructure to support the SRN and future growth in the area, as well as HS2 activities. Lack of resilience - the A511 is vulnerable to collisions and incidents which can cause significant disruption over a wide area	The A511 Growth Corridor performs a resilience function for the SRN. It is therefore paramount that is brought to suitable standard to support the SRN and prevalent freight activities along the corridor. It is also required to support the construction of the HS2 railway line through North West Leicestershire, which traffic implications for the area.
Environmental Impacts	North West Leicestershire District Council (NWLDC) has declared an Air Quality Management Area (AQMA) for Nitrogen Dioxide (NO2) exceedances at the junction	Growth in background traffic and planned developments for the area will increase traffic along the corridor and in so exacerbate the exiting	The main source of pollution is caused by emissions from stationary vehicles queuing on the A511 on both approaches to the junction.	Need to reduce congestion along the corridor by providing more available ‘green time’ for A511 traffic and help reduce queuing and engine idling.

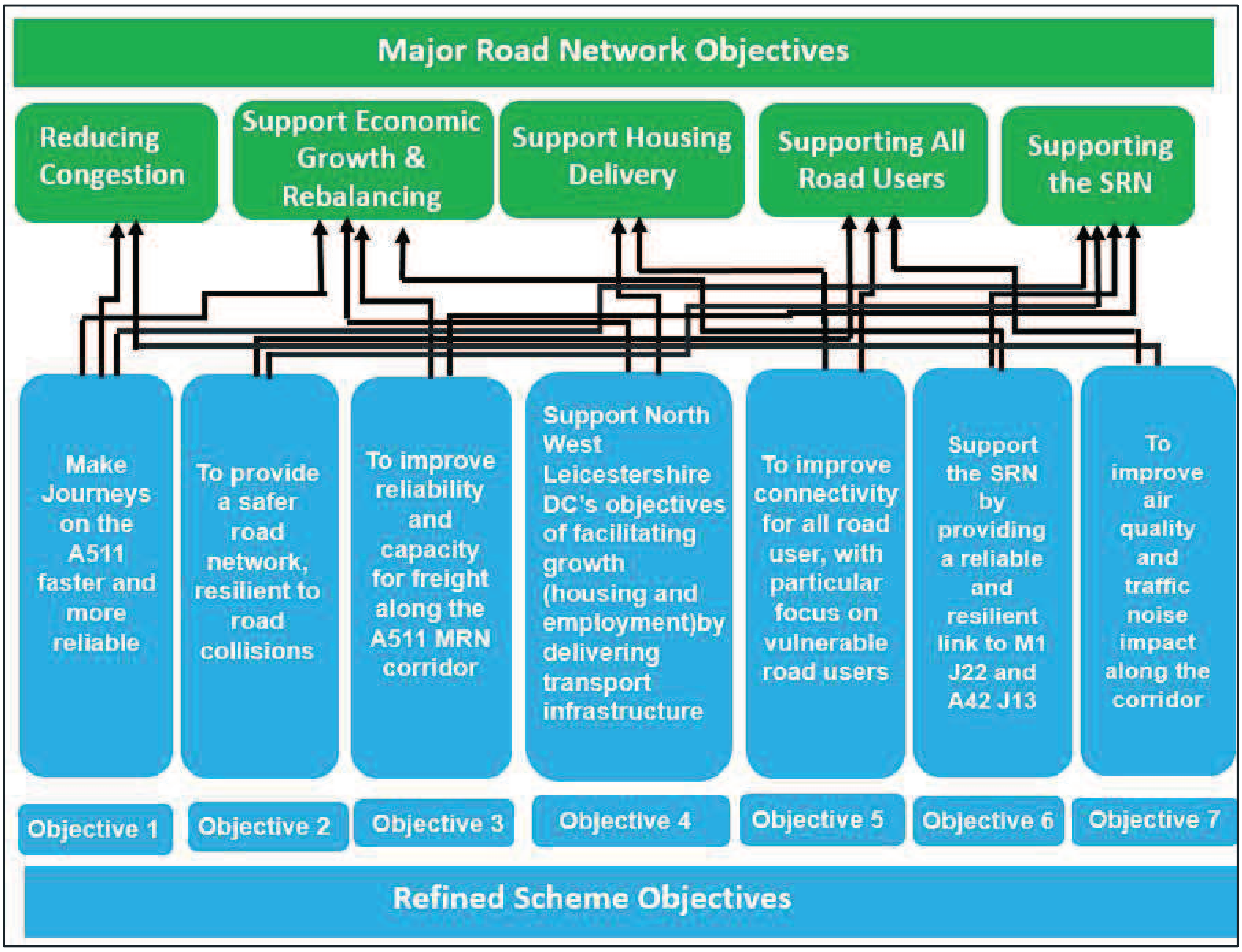
Theme	Current Issue	Future Issues	Underlying Cause	Need for Intervention
	of A511 Stephenson Way and	air quality issues with the		

3.3 SCHEME OBJECTIVES

3.3.1. During the option assessment process discussed within the Option Assessment Report (OAR) a set of scheme-specific objectives were developed based on the specific needs for the intervention, to support opportunities and mitigate issues identified in the corridor and surrounding area.

3.3.2. A pre- identified set of objectives based on the need for intervention were refined to take account of objectives as set out in the Transport Investment Strategy (TIS), which sets out the Government's priorities and approach for future transport investment decisions. The refined scheme objectives are shown in **Figure 3-1**.

Figure 3-1 - A511 Growth Corridor: Refined Objectives



3.3.3. The Strategic Case in the OBC will reconfirm the conclusions of the SOBC Strategic Case but concentrate on further assessment of the option to find the best solution.

3.3.4. The preferred option for the A511 Growth Corridor consists of nine junction improvements (as displayed in the Location Plan contained in **Figure 2-2**) and a bypass situated to the south east of Coalville connecting the Bardon Link Road (Junction 6) to the developer delivered link road. The link road with provide access to both New Grange Road Roundabout and New Beveridge Lane Roundabout to the south.

3.4 IMPACT OF DO NOTHING

3.4.1. If the status quo is retained overall travel demand will increase with natural background growth and there will be likely increases in road congestion and delay leading to further increases in economic inefficiency. Economic competitiveness will be lost and new developments, including regeneration projects, may not take place as investors look elsewhere. Local businesses which are already affected by increased journey times could be persuaded to relocate. Local air quality and accidents will continue to worsen in line with congestion whilst residents on nearby roads will be adversely affected (due to traffic taking inappropriate alternative routes to avoid congestion).

3.4.2. In addition to this the A511 Growth Corridor would not be able to accommodate the additional traffic resulting from the construction of the HS2 line in the area.

3.5 SUPPORTING ORGANISATIONS

3.5.1. The following organisations are involved and committed to supporting the A511 Growth Corridor scheme:

- North West Leicestershire District Council;
- Highways England;
- Leicester City Council;
- Midlands Connect;
- Leicester and Leicestershire Enterprise Partnership;
- Harworth Homes (south east Coalville SUE Developer); and
- Davidsons Homes (south east Coalville SUE Developer).

4 TRANSPORT MODELLING & FORECASTING

4.1 APPROACH TO TRAFFIC MODELLING AND FORECASTING

4.1.1. To understand the future network issues and to forecast the potential impact of the proposed highway options, a traffic modelling exercise will be undertaken to provide an evidential basis for the strategic case, the economic case, value for money statement and the financial case, along with a range of supporting analyses, including environmental, social, safety and regeneration benefits if applicable.

4.1.2. The Leicester and Leicestershire Integrated Transport Model (LLITM) was originally developed for forecasting the effects of transport and land use policies and plans on the transport system and environment across Leicester and Leicestershire, the Pan-Regional Transport Model (PRTM) has been specifically developed from LLITM for use in developing major transport schemes/ development assessments, such as A511 Growth Corridor, which have an influence on the SRN and MRN beyond the Leicestershire boundary.

4.1.3. LLITM was first built in 2009, significantly updated in 2013 (but retaining the base of 2008) and later updated, to a consistent 2014 base year across the County.

4.1.4. LLITM was further updated in 2016/2017 using the latest available data and. Since this time, PRTM has also been developed. Compared with LLITM the model has some additional detail in the highway model in terms of zoning, network and flow / delay functionality in the Midlands Connect area outside Leicestershire.

4.2 MODEL SUITE

4.2.1. The model is maintained by Leicestershire County Council and consists of the following interlinked programmes:

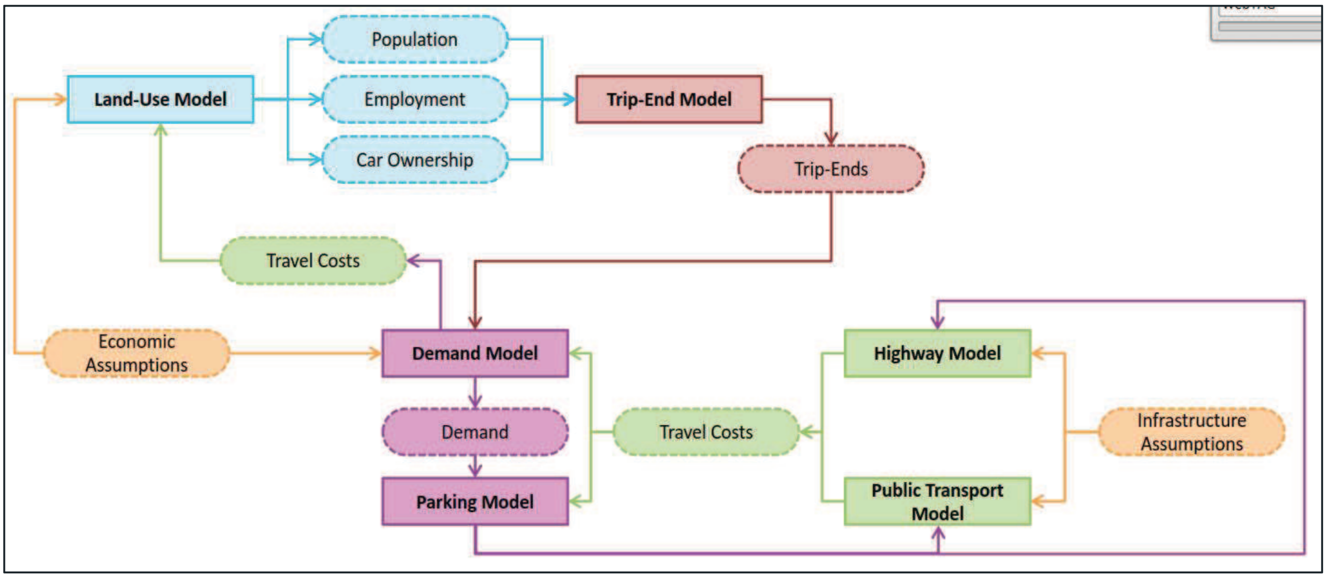
- SATURN - Highway Assignment Model;
- EMME- Public Transport Model;
- DELTA - Land Use Model;
- EASE - Environmental Module; and
- EMME - Demand Model.

4.2.2. The land-use model has been built in DSC's DELTA software. The trip-end model is based on the Department for Transport's National Trip-End Model (NTEM); implemented in Microsoft Access and Visual Basic. The demand model and public transport model are implemented in INRO's EMME transport modelling software, and the highway model is based in the SATURN traffic assignment package.

4.2.3. The land-use and trip-end models carry out specialised tasks that standard transport modelling software does not generally support, hence their construction externally. EMME does not support detailed congestion or quasi-dynamic traffic modelling, so SATURN is preferred for this purpose, but SATURN does not have EMME's matrix manipulation, public transport assignment, or general transport modelling capabilities.

4.2.4. A more detailed discussion of the model development can be found within A511 MRN Growth Corridor OBC LLITM 2014 Base / PRTM Model Specification Report which can be found within **Appendix C**.

Figure 4-1 – PRTM model suite interaction



4.2.5. The model has been built in accordance with the Department for Transport's modelling and appraisal guidance (WebTAG) and other relevant guidance including the DMRB and Traffic Appraisal Manual (TAM), and has been independently assured, and developed as a key tool to secure wider-ranging infrastructure funding for the Council.

4.2.6. The PRTM model comprises additional updates that are of critical importance to a successful appraisal of the A511 Growth Corridor, and to meet WebTAG requirements. These include:

- A validated base year - to support the current OBC;
- Highway Matrices developed from mobile phone data, and validated against a set of 119 RSI's across the County, for journey purpose and trip length data;
- An updated PT model, based on consistently derived, County-wide ETM data;
- New WebTAG Values of Time incorporated;
- Updated forecasting to NTEM v7.2 (and RTF18 for LGV/HGV);
- A simplified, updated parking model, and recalibrated P&R models;
- Updated demand realism testing; and
- LUTI model updates, use of 2011 Census data to derive an updated 2014 base for the DELTA land use model, and data transfer efficiencies between the models.

4.2.7. The land use model generates residential and employment travel demand which is translated into trips between locations by mode and frequency using the demand model.

4.2.8. These trips are assigned to their respective highway and public transport networks to determine route choice. The entire process recognises the interdependency between demand, travel choices and travel costs by looping runs of each of the models until the relationship between trip patterns and trip costs are stable.

4.2.9. Much of routing and traffic analysis will be derived from a final assignment of trips to the public transport and highway networks; from which economic appraisal, following a full VDM run of the model will be derived.

4.2.10. Whilst the land use model will be used to derive an updated, and suitable reference case for the purposes of the OBC, the LUTI aspect of the model will be switched off for the economic appraisal of the do-minimum and do-something scenarios itself[3].

4.2.11. Local calibration and validation checks along with updates of the model will also be made to support the OBC, reported in a Local LMVR for DfT. This will be one of the first modelling tasks to be completed if the OBC proceeds, and any updates (and their need) will be discussed/ confirmed with DfT.

4.2.12. Full, A511 model specific, and wider area model calibration and validation statistics will be reported, alongside convergence statistics for each time period, along with versions of the software used.

4.2.13. These will be checked against specific WebTAG units, and overarching DfT major Scheme Submission Requirement Guidance, to ensure full compliance.

4.2.14. The PRTM will contain the following time periods:

- Morning peak hour (AM) 07:00-10:00 (considered 08:00-09:00);
- Average inter-peak hour (IP) 10:00-16:00;
- Evening peak hour (PM) 16:00-1900 (considered 17:00-18:00);

4.2.15. The highway assignment model groups traffic into 'user classes'. These segmentations differentiate between the characteristics of road users, both in terms of their use and their physical attributes. The user classes are summarised as follows:

- User Class 1: Cars used for Employers Business;
- User Class 2: Cars used for Commuting;
- User Class 3: Cars used for Other purposes;
- User Class 4: Light Goods Vehicles (LGVs); and
- User Class 5: HGVs.

4.3 DATA SOURCES

4.3.1. A number of data sources have been incorporated in to the model development process in order to develop the most robust model in line with WebTAG guidance. These include the sources listed in **Table 4-1**.

Table 4-1 – Data sources used in model development

Data Type	Source
Roadside Interview	2014 RSIs
Mobile Phone Data	Mobile phone positioning data (mobile data)

[3] It is also intended that the LUTI aspect of the model is also 'switched off' for the dependent development testing work; apart from Reference Case creation in the first place.

Data Type	Source
Traffic Count Data	2014 Traffic count data
Highway Journey Time Data	Trafficmaster and TIF congestion monitoring data collection programme GPS data
Highway Network Data	Various
Public Transport Ticket Sales Data	Ticket sales for rail and bus
Public Transport Passenger Interview Data	Passenger interviews
Public Transport Passenger Count Data	Boarding and alighting counts
Public Transport Service Pattern Data	Traveline National Dataset (TNDS)
Household Interview Data	Leicestershire HH survey 2009 and National Travel Survey (NTS)
Land-Use Data	Council Tax Register (for the numbers of
Census Data	The 2011 Census
Parking Data	Parking supply data / Parking demand
Freight Demand Data	The Continuing Survey of Road Goods Transport (CSRGT)
Economic Data	Department for Transport's WebTAG advice

4.4 CALIBRATION

4.4.1. A localised model calibration and validation exercise has been undertaken using the observed count information alongside an updated PRTM base year model (network and zoning).

4.4.2. Calibration of the PRTM transport model involves ensuring the model represents the on-site observed conditions by adjusting model inputs and parameters. The process involves examination of the network, checking for errors, and improving the performance of the model in terms of comparisons with observed data. Calibration statistics are presented using the DfT's WebTAG criteria.

4.4.3. Calibration is undertaken for the four main components of the model:

- Network;
- Route Choice;
- Trip Matrix; and
- Assignment.

4.4.4. Each of the tasks above is linked with each other and it is often a combination of all that are required to address each problem identified by the calibration process.

NETWORK CALIBRATION

4.4.5. During the network building calibration process, the following activities are undertaken:

- Review of the network coding warnings produced by the SATURN network building program SATNET;
- Network distance and speed checks;
- Review of junction approaches and saturation flows;
- Detailed review of the coding of complex junctions; and
- Exclusion of neighbouring turning counts from the validation spreadsheet.

ROUTE CHOICE CALIBRATION

At various stages of model development, the minimum cost routes for a range of selected origin-destination pairs should be plotted and checked for plausibility. Modelled route choice depends on:

- Zone size;
- Network structure;
- Centroid connectors;
- Trip matrix accuracy;
- Representation of speeds and delays; and
- Junction coding accuracy.

4.4.6. Where routes are found to be implausible one or more of the above aspects have been adjusted.

TRIP MATRIX CALIBRATION

4.4.7. As part of the trip matrix calibration it is essential to validate the trip matrices by comparing assigned flows with traffic counts with the Geoffrey E. Havers (GEH) statistic used to compare observed and assigned flow. The statistic uses the following formula to calculate a value for the difference between observed (M_E – survey data) and modelled (M_G – SATURN flow) traffic flow:

$$GEH\ Statistic = \sqrt{\frac{(M_E - M_G)^2}{0.5(M_E + M_G)}}$$

4.4.8. The GEH statistic takes account of the fact that when traffic flows are low, the percentage difference between observed and modelled flow may be high but the significance of this difference is small and conversely, a small percentage difference on a large base might be important. A GEH value greater than 10 indicates that closer attention is required, as the match between observed and modelled flows is poor, while a GEH less than five indicates a good fit. The aim is to achieve at least 85% links and turns with a GEH less than 5 as specified in Unit M3.1 of the DfT's WebTAG.

4.4.9. The following sections set out the comparison of the modelled flows and observed flows.

ASSIGNMENT CALIBRATION

4.4.10. Unit M3.1 of the DfT's WebTAG also specifies the following flow validation criteria for links and turns:

- Individual flows within 100 vehicles per hour for flows less than 700 vehicles per hour in more than 85% of cases.
- Individual flows within 15% for flows between 700 – 2,700 vehicles per hour in more than 85% of cases.
- Individual flows within 400 vehicles per hour for flows greater than 2,700 vehicles per hour in more than 85% of cases.

4.4.11. The subsequent model outputs are assessed in compliance with the criteria outlined above.

MODEL SENSITIVITY TEST

4.4.12. In addition to the required WebTAG realism tests on the model's sensitivity to changes in cost, a series of sensitivity/demonstration tests of the model in forecasting mode will be undertaken. These demonstration tests will review the model's responses to changes in land-use, highway and public transport assumptions in forecast years.

4.5 FORECASTING

4.5.1. The base year PRTM transport model will be run to generate land use trip end forecasts for the assessment forecast years. The forecasts will be constrained to NTEM growth with distribution reflecting the changes in transport costs and extent of existing and committed development as identified from the uncertainty log.

4.6 VARIABLE DEMAND

4.6.1. Any changes to transport conditions will, in principle, cause a change in demand. The purpose of Variable Demand Modelling (VDM) is to predict and quantify these changes.

4.6.2. VDM establishes the extent of travel suppression in the "without-scheme" case, and the extra traffic induced in the "with-scheme" case.

4.6.3. All assessments of Government-funded investments in highway or transport schemes need to either model the effects of variable demand (and the resultant trip suppression/ induced traffic) to include their effects upon the assessment of a scheme or strategy, or show that the modelling of variable demand is not necessary.

4.6.4. A fully specified VDM model is incorporated in PRTM, including all required realism tests, and that will be reported as part of the submission.

4.7 OUTPUTS

4.7.1. Traffic flow information from the models will be supplied to the environmental teams for developing air quality and/or noise models to enable the appraisal of environmental impacts, including their quantitative assessment. For each modelled year and modelled option, the following data will be communicated:

- Average link flow and speed data by time period and for;
  - 24-hour annual average daily traffic (AADT) data for air quality modelling.
  - 18-hour annual average weekday traffic (AAWT) data for noise modelling.
- Percentage mix of HGV traffic (all vehicles greater than 3.5 tonnes).

4.7.2. AAWT and AADT will be calculated from the modelled flows, firstly by deriving 12-hour (07:00 to 19:00) AAWT link counts:

- 12-hour AAWT will be calculated by factoring up the AM peak hour, interpeak hour and PM peak hour hourly flows using factors which represent the proportion of traffic for the full AM, interpeak or PM period
- Once the 12-hour AAWT have been derived, the AAWT and AADT required for environmental modelling will be calculated.
- If required for the environment assessment night time and off peak hourly flow proportions can be estimated from traffic counts and controlled to 24 hour AAWT and AADT totals.

4.8 PRTM REFINEMENTS

4.8.1. As discussed in Section **4.1**, the PRTM is an extension of the LLITM model, providing additional detail in the highway assignment model; all other model components are identical to LLITM.

4.8.2. The following outlines the key differences between PRTM and LLITM in terms of the highway assignment model:

- additional zone detail is represented outside Leicestershire within an enhancement area;
- additional buffer network is represented outside Leicestershire, including the use of speed-flow curves on buffer network links in the enhancement area; and
- additional observed link flow and journey time data from Highways England's Midlands Regional Transport Model (MRTM) used in calibration and validation.

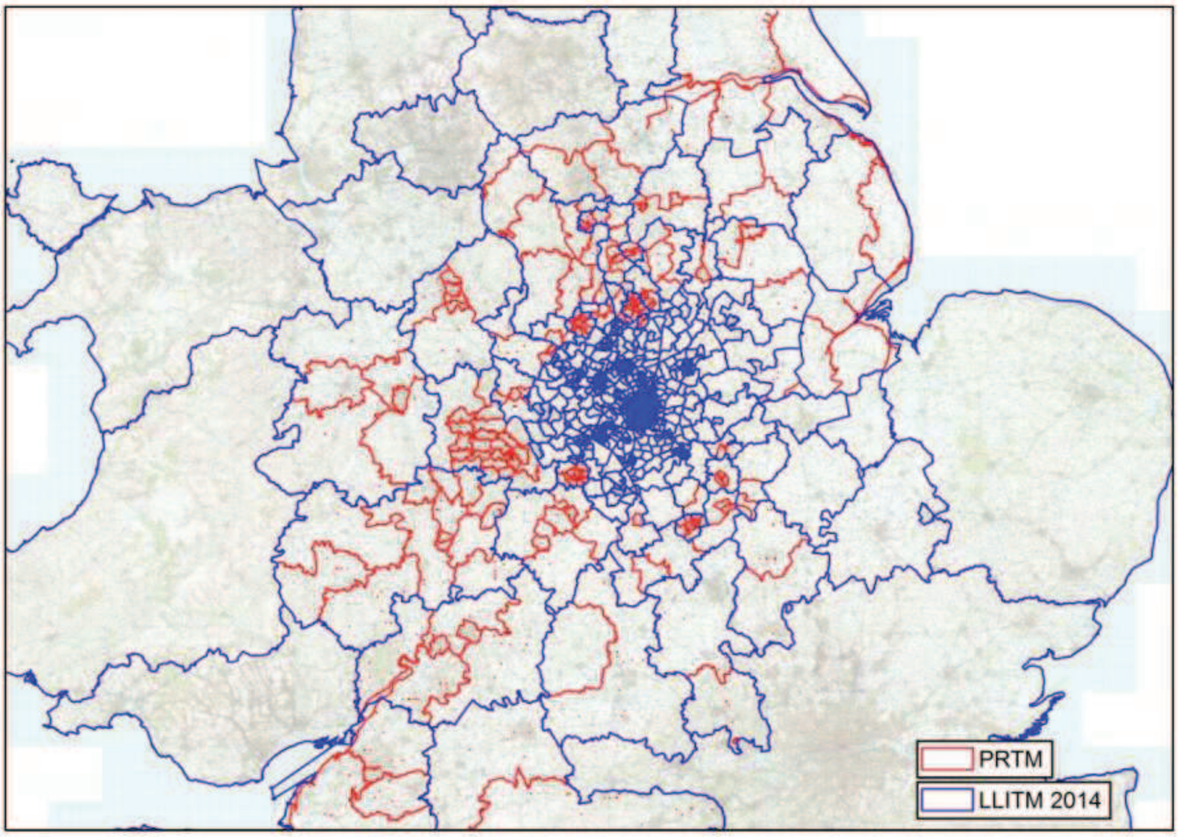
4.8.3. The underlying demand data used within the highway model, developed primarily from mobile phone data, remains unchanged from LLITM, with the highway demand disaggregated where additional zone detail is represented within PRTM. The observed traffic flow and journey time data used within Leicester and Leicestershire as part the highway model calibration and validation process is also unchanged, with additional data sourced from the MRTM used outside the county.

4.8.4. The additional zone and network detail has only been adopted in the highway assignment model (HAM), and therefore the public transport assignment model and demand model within PRTM are consistent in detail with LLITM with the exchange data of costs and demand changes adjusted for the difference in zoning detail between the HAM and the demand model.

4.9 LLITM ZONE SYSTEM

4.9.1. **Figure 4-2** provides a comparison of the LLITM (2014 version) and PRTM zone systems as used within their respective highway assignment models. The red zone boundaries delineate areas where the PRTM zone system contains additional zone detail to that included within LLITM. All the additional zone detail is outside Leicestershire, extending to around Bristol in the south-west and Hull in the north-east.

Figure 4-2 - Overview of PRTM and LLITM 2014 Zoning

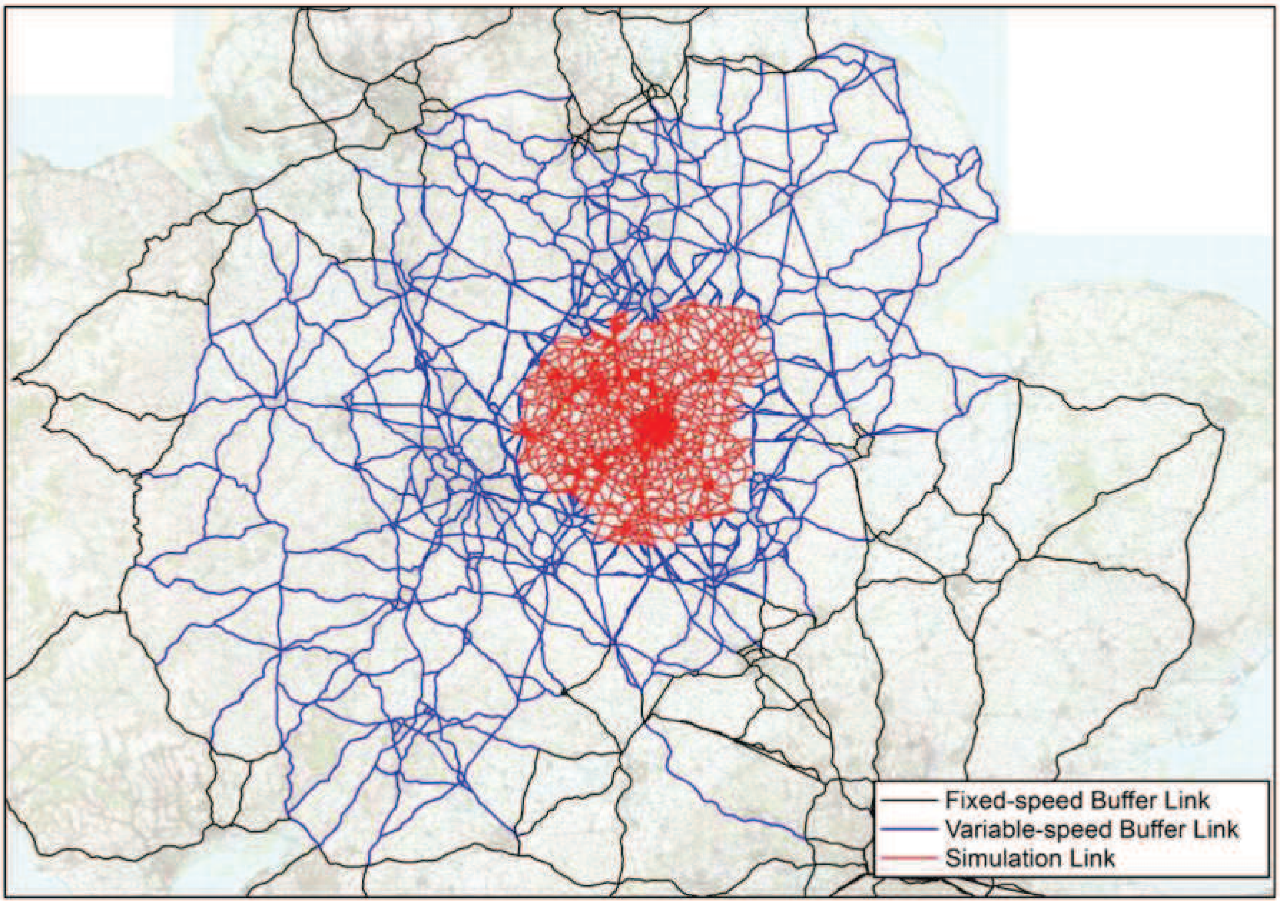


4.9.2. **Figure 4-3** shows the highway network structure of the PRTM base year model. The simulation network, where individual junctions are modelled, is shown in red and this is unchanged from LLITM. In LLITM, the buffer network, where junctions are not modelled, is coded with fixed speeds, which vary between time periods and over time. However, within PRTM additional network detail has been added into the buffer network where model zones have been disaggregated, and a subset of buffer links surrounding Leicestershire have been coded with speed-flow curves. These are shown in blue.

4.9.3. The application of speed-flow relationships to these buffer links allows the modelled speed on these links to respond to changes in modelled traffic levels on these routes, whereas in LLITM 2014 the modelled speed is independent of the modelled flow.

4.9.4. This additional zone and network detail within PRTM allows the model to better forecast the routeing of trips entering, leaving or passing through Leicestershire, and how these routes change over time as traffic volumes are forecast to change.

Figure 4-3 - Overview of the PRTM Highway Network Structure



5 ECONOMIC ASSESSMENT

5.1 INTRODUCTION

5.1.1. Economic assessment involves the determination of costs and benefits of a scheme using travel demand, traffic flows, journey times and other inputs from the transport model.

5.1.2. By comparing the costs with the benefits of a scheme over a 60 year assessment period, a Benefit Cost Ratio (BCR) can be calculated, which represents the value for money of the scheme.

5.1.3. In line with HM Treasury's appraisal requirements, non-monetised impacts of the scheme should also be considered as part of the value for money assessment.

5.1.4. This chapter provides a general description of the economic appraisal approach proposed for the A511 Growth Corridor scheme.

5.1.5. The economic appraisal will be undertaken in accordance with DfT's TAG Units:

- TAG unit A1.1 'Cost-benefit analysis' (May 2018);
- TAG unit A1-2 'Scheme costs' (July 2017);
- TAG unit A1-3 'User and provider impacts' (March 2017); and
- DfT Value for Money Framework (July 2017).

5.1.6. The PRTM transport model will be used to generate the inputs into the economic appraisal, summarised in the Transport Economic Efficiency (TEE) table. The use of the PRTM model will determine the trips and cost matrices by user class which will be used in the Transport User Benefit Appraisal (TUBA) software.

5.2 SCHEME COSTS

BASE COSTS

5.2.1. Scheme costs will be estimated by quantity surveyors working close with highways and structural engineers. They will include:

- Investment costs, including:
  - construction costs;
  - land and property costs; and
  - preparation and administration).
- Operating, maintenance and renewal costs, to estimate the whole life costs for the scheme.

5.2.2. These costs will provide the base cost estimate. A real cost adjustment will be applied to the base costs to account for the difference between general inflation and construction inflation forecasts over the appraisal period.

5.2.3. Base cost estimates will include construction, land / property, preparation / administration and supervision, including adjustment for risk and inflation.

5.2.4. Costs will be converted into the DfT's standard base year 2010. It is assumed that cost estimates derived will meet the following criteria, and will be checked against them:

- Includes costs based on the latest scheme design;
- Includes expenditure spread over calendar years;

- Exclude any costs already incurred;
- Exclude both recoverable and non-recoverable VAT;
- Exclude any costs that are present in both the Do-Minimum and the Do-Something scenarios;
- Includes costs to be incurred by Central Government, and local government provided separately; and
- Includes the amount of developer contribution if any.

5.2.5. The adjusted costs will be fed into TUBA to derive the Present Value Cost (PVC) for construction, land/ property, preparation and administration.

5.2.6. The capital cost of maintenance is the cost of people, machinery and materials to maintain the highway network. Maintenance costs will be derived using typical maintenance profiles from LCC, or if not available, costs provided in Part 2, Chapter 4 of the QUADRO manual, designed for such assessments. The maintenance cost estimates will need to be converted to 2010 prices to make them consistent with other costs.

5.2.7. Maintenance costs will be fed into TUBA to derive operating costs and total PVC of the scheme.

RISK-ADJUSTMENT

5.2.8. A full Quantified Risk Assessment (QRA) will be used in the risk-adjustment process at this stage. A risk register has already been prepared and risks have been quantified, which will facilitate this process. The current risk register is included in **Appendix D** of the ASR.

OPTIMISM-BIAS ADJUSTMENT

5.2.9. Optimism bias will be applied to the scheme costs (after the application of risk-adjustment) with an uplift of 15% for the roadworks and 23% for any specified bridges or tunnels which are priced individually. This is in line with WebTAG at the Outline Business Case stage (TAG Unit A1.2: Tables 7 and 8).

5.2.10. The scheme includes both road and structures and is considered a combined project. The relative size of each sub-project will be determined and the uplifts will be identified and applied to that part of the project.

DISCOUNTING

5.2.11. To present scheme costs in present values, scheme costs will be discounted back to 2010. A discount rate of 3.5% will be applied for the first 30 years with a 3% discount rate applied thereafter.

MARKET PRICE-ADJUSTMENT

5.2.12. Costs will be converted from factor costs to market prices using the indirect tax correction factor contained within the most recent databook (May 2019).

5.3 SCHEME IMPACTS/ BENEFITS

5.3.1. Scheme impacts will be captured in the following categories as of the DfT VfM Framework:

- Established monetised impacts (to produce an initial Benefit Cost Ratio);
- Evolving monetised impacts (to produce an adjusted Benefit Cost Ratio);
- Indicative monetised impacts and non-monetised impacts, which will be used to derive the final VfM category, with use of ‘switching-value’ analysis.

5.3.2. We will supplement the appraisal with the production of an Economic Narrative to articulate and justify the scope of the analysis. Table **5-1** shows the impacts which are currently being considered for appraisal.

Table 5-1 - Proposed benefits of A511 Growth Corridor Scheme

Established Monetised Impacts	Evolving monetised impacts	Indicative monetised impacts	Non-monetised impacts
Quantitative and qualitative: ▪ Journey time savings ▪ Vehicle operating costs ▪ Indirect taxation ▪ Accidents ▪ Construction and maintenance impacts ▪ Noise ▪ Air Quality ▪ Greenhouse gasses	Quantitative and qualitative ▪ Reliability ▪ Static clustering ▪ Output in imperfectly competitive markets ▪ Labour supply	Quantitative and qualitative ▪ None	Security Severance Accessibility Townscape Historic environment Landscape Biodiversity Water environment Affordability Access to services Option and non-use values
Qualitative only: ▪ Physical activity ▪ Journey Quality		Qualitative only: ▪ Other wider economic benefits	

5.3.3. No development is identified as being dependant on the scheme, therefore the land value uplift associated with enabling new homes and employment growth is not included within the assessment.

5.4 TRANSPORT ECONOMIC EFFICIENCY (TEE) – TUBA

5.4.1. TUBA is the industry-standard software used to derive the TEE of a scheme. It considers both the business and consumer traveller impacts and the private sector provider revenues and cost elements of the WebTAG requirements.

5.4.2. TUBA takes trip, time and distance matrices for each future year, vehicle type, journey purpose (i.e. each User Class) by time period from the traffic forecast model to calculate travel time saving benefits. It does this by comparing the travel times in the Without Scheme scenario with those in the With Scheme scenario. It then applies monetary values or Values of Time (VOT) to derive the monetary benefits of those time savings extrapolated over a standard 60 year appraisal period.

5.4.3. TUBA also calculates Vehicle Operating Cost (VOC) changes which occur over the standard 60 year appraisal period accounting for changes in fuel, maintenance and wear and tear. These occur due to changes in speed and distance when the scheme is implemented. Changes in vehicle operating costs due to the scheme affect the level of indirect taxation received and this is also calculated over the appraisal period.

5.4.4. The travel time and VOC benefits are then discounted to 2010, the DfT's standard base year for appraisal, and converted to 2010 market prices.

5.4.5. **Table 5-2** provides a summary of the key assumptions to be adopted as part of the TUBA assessment.

5.4.6. Modelled time periods are expanded in TUBA to represent a full year of data, and this will be undertaken using traffic count data to derive appropriate expansion factors. As only AM peak, interpeak and PM peak are modelled in PRTM no benefits will be calculated for the weekend and off peal / night time periods.

5.4.7. In accordance with best practice, the results of the TUBA assessments will be checked at a sector level.

5.4.8. Other checks will include:

- Analysis of benefits by time period and journey purpose;
- Benefits profile over 60 year period;
- Analysis of benefits by size of time-saving/ distance; and
- In addition, TUBA warnings will be closely checked to ensure that the results are logical and the input data was loaded correctly.

Table 5-2 - TEE TUBA assumptions

Item	Assumptions/Notes
Software	TUBA Version 1.9.12
Current year Scheme completion Final appraisal year	2019 (defines the first year in which the discount rate is applied) 2024 2085
Appraisal period /	60 years after scheme opening, in line with WebTAG requirements
Forecast year trip, time and distance matrices from traffic model	PRTM produces forecasts at 5 year intervals from 2021. The forecast years to be used in the option appraisal are to be confirmed but the recommendation is: ▪ 2026 (proxy for opening year); ▪ 2036; and ▪ 2051.
User classes	Trip, time and distance matrices for the following user classes will be ▪ Cars used for Employers Business; ▪ Cars used for Commuting; ▪ Cars used for Other purposes; ▪ Light Goods Vehicles (LGVs); and

Item	Assumptions/Notes
Economic Parameters	Economic parameters (such a Value of Time) are defined in the standard TUBA Economic File.
PCU Factor	The trip matrices obtained from SATURN are in passenger car units
Annualisation factors for modelled time periods (AM, IP, PM weekday)	In accordance with the TUBA guidance, the modelled time periods will be converted to annual time periods using annualisation factors-derived from local traffic counts. Modelled peak periods (AM and PM) will be extended using annualisation factors to include any adjacent periods where there is no significant change in traffic volume. These annualisation factors will be derived using ATC traffic flow data and will include flow factors to convert the average modelled flows to average annual flows.

5.4.9. The results from TUBA will provide input into the following tables: Transport Economic Efficiency (TEE), Public Accounts (PA), Analysis of Monetised Cost and Benefits (AMCB) and Appraisal Summary Table (AST). The AMCB table provides a Benefit to Cost Ratio (BCR) for the scheme when all present value benefits (PVB) are compared with present value costs (PVC). The tables will be considered in relation to the results from each of the scenarios involved in the appraisal.

5.5 ACCIDENT BENEFIT ANALYSIS

BACKGROUND

5.5.1. One of the objectives of the Business Case is: "Make the transport network safer for all users"; therefore, it is expected that the implementation of the package will be beneficial with regard to the impact on safety.

5.5.2. In the description of the existing situation, the OAR presented an analysis of the accidents that occurred on the highway network.

5.5.3. Personal Injury Collision (PIC) data covering a five year period were sourced for the period 2014 to 2018 during which time 105 PIC accidents were recorded.

5.5.4. The analysis showed that the distribution of PICs are primarily 5 locations:

- M1 J22: 17/105 accidents;
- Hough Hill/A511 Stephenson Way/Ashby Road/Swannington Road/A511 Ashby Road Roundabout. 9/105 accidents;
- B591 Copt Oak Road/A511 Little Shaw Lane/Stanton Lane/ A511 Shaw Lane Roundabout. 9/105;
- A511 Bardon Road/A511 Shaw Lane/Bardon Industrial Estate Entrance Roundabout. 8/105; and
- A50/Markfield Lane/A50 Leicester Road/Leicester Road: 8/105.

5.5.5. The package of measures proposed (traffic signal improvements, new traffic signal installations and/or carriageway improvements) have the potential to provide major safety benefits along the corridor. It is estimated that a combination of such measures could provide 30% injury collision savings, equating to over £0.5m of collision savings.

METHODOLOGY

5.5.6. In line with WebTAG, DfT COBA-LT software will be used to derive the accident benefits of the scheme. COBA-LT compares the predicted numbers of accidents with and without the scheme, and converts them into monetary values by multiplying the numbers of accidents by their monetised costs. The benefits for each year are discounted to 2010 and summed over the 60-year assessment period. COBALT uses nodes and links to represent the Base, Do Minimum (without scheme) and Do Something (with scheme) highway networks.

5.5.7. The COBALT network for the scheme will cover all roads and junctions where the model predicts a significant change in flow between Do Minimum and Do Something scenarios (taken to be a change in flow of 10% or more). **Table** 5-3 provides a summary of key assumptions that will be adopted as part of the analysis.

Table 5-3 – Accident Benefits Analysis

Item	Assumptions/Notes
Software	COBA-LT Version 2013.2 (current version)
COBALT Network	The COBALT network will be constructed in GIS and will comprise of a series of links and junctions. The network construction will be carried out in accordance with the COBALT guidance. The node-link structure will be based directly on the traffic model; however, the COBALT network will include only roads where the traffic model predicts a significant change in flow (taken to be a change in flow of 10% or more).
Accident data	▪ STATS 19 Personal Injury Accident (PIA) data for ▪ The accidents will be plotted in GIS and be ▪ As stated in Paragraph 3.1.1 of the COBALT User ▪ Checks will be made that the accidents have been correctly assigned to the links and junctions by

Item	Assumptions/Notes
	cross-referring the location with the accident ▪ If a link has no observed accidents over the five ▪ All new Do Something links and junctions will use the default accident rates.
Traffic flow data	Annual Average Daily Traffic (AADT) traffic flows from the traffic model with expansion factors applied derived from traffic counts.

5.6 TRANSPORT ECONOMIC EFFICIENCY – CONSTRUCTION IMPACTS

5.6.1. During the construction of the scheme, it is likely that some delays will be experienced by road users. These delays can be kept to a minimum through the use of effective traffic management and significant off-line construction but are unlikely to be removed all together. This results in travel time and VOC costs on the existing network that should be considered as part of the AMCB and TEE tables.

5.6.2. QUADRO is the industry-standard software and will be used to value the delays to road users using the standard economic parameters within the program.

5.6.3. Construction activities, traffic management arrangements and diversion routes will be coded into QUADRO, which will then be run to simulate the impact of the construction activities on travel times, VOC and accidents on the existing network.

Table 5-4 provides a summary of the key assumptions that will be adopted as part of the analysis of the Preferred Option scenario and the Next Best Alternative.

Table 5-4 – TEE Construction Delay Analysis

Item	Assumptions/Notes
Software	QUADRO Version R15 (current version)
Construction work profiles and durations	LCC/ Early Construction advice is expected to provide details on the following: ▪ Construction phasing; ▪ Construction programme; ▪ Traffic management details required for all the specific construction activities; and ▪ Diversion routes.

Item	Assumptions/Notes
	If required information is not available we will use professional judgement and examples from similar schemes to make suitable assumptions.
Modelling scenarios	▪ The roadworks will be modelled using QUADRO for the various ▪ Only significant construction activities will be coded into QUADRO. ▪ The number of QUADRO scenarios will depend upon the ▪ The Opening Year Without Scheme scenario will be used as the
Current year	2019 (defines the first year in which the discount rate is applied)
Appraisal period	QUADROs will be run for each construction period and the disbenefits summed in a spreadsheet for each modelled / construction scenario.

5.7 TRANSPORT ECONOMIC EFFICIENCY – MAINTENANCE IMPACTS

5.7.1. Delays will be experienced by road users during periods of maintenance both with and without the scheme. Without the scheme, delays and costs caused by maintenance are likely to be significant due to reduced capacity on approaches and through roadworks forcing some traffic to divert onto lengthy or less suitable routes.

5.7.2. Additional capacity provided by the scheme would reduce delays approaching and through the roadworks due to queueing and potentially reduce traffic diversion onto the existing road network.

5.7.3. Also, in the With Scheme scenario, less maintenance would be required because the scheme would have been newly constructed (i.e. the “maintenance holiday” effect).

5.7.4. QUADRO is the industry-standard software and will be used to value the delays to road users using the standard economic parameters within the program.

5.7.5. Maintenance activities, traffic management arrangements and diversion routes will be coded into QUADRO, which will then be run to simulate the impact of the maintenance activities on traffic on the proposed road and surrounding network. **Table 5-5** provides a summary of the key assumptions that will be adopted as part of the analysis.

Table 5-5 - Maintenance Delay Analysis

Item	Assumptions/Notes
Software	QUADRO Version R15 (current version)
Maintenance work profiles and durations	LCC is expected to provide details on the following:

Item	Assumptions/Notes
	■ Traffic management details required for all the specific maintenance activities; and ■ Diversion routes. If required information is not available we will use professional judgement and examples from similar schemes to make suitable assumptions. In the absence of available information maintenance works profiles and durations will default to the typical maintenance profiles and costs provided in Part 2, Chapter 4 of the QUADRO manual, designed for such assessment. Delays during bridge inspections/maintenance for the existing and proposed structures will be excluded.
Modelling scenarios	■ Roadworks will be modelled using QUADRO. ■ Only significant maintenance activities will be coded
Traffic Flows	The traffic flows for the modelled year closest to the year when maintenance is scheduled will be used in QUADRO: ■ Without Scheme AADTs for Opening Year/Design Year/Final Year ■ With Scheme AADTs for Opening Year/Design Year/Final Year
Current year	2019 (defines the first year in which the discount rate is
Appraisal period	60 years after scheme opening, in line with WebTAG requirements

5.8 ENVIRONMENTAL ASSESSMENT

5.8.1. The scale of the impact of the scheme on the environment is sub-divided into a range of environmental impacts, as required by WebTAG which will include:

- Air quality (nitrogen dioxide and particulates);
- Greenhouse gases (carbon);
- Noise and vibration;
- Landscape and townscape;
- Historic environment;
- Biodiversity; and
- Water environment.

5.8.2. An environmental constraints plan will be produced, showing any environmental designations within the vicinity of the scheme. There is an AQMA declared along the route of the proposed scheme at Coalville, within which a concentration of 43.2µgm3 was monitored in 2017, indicating an exceedance of the Air Quality Strategy Objective, which the proposed scheme would need to consider.

5.8.3. A detailed review of the baseline situation is to be undertaken to inform the business case. This will identify any further surveys that are required to support the environmental assessments. The proposed methodologies for the noise, air quality, greenhouse gases, landscape, townscape, historic environment, biodiversity and water environment assessments are discussed below.

AIR QUALITY AND GREENHOUSE GASES

5.8.4. A quantitative WebTAG air quality and greenhouse gas appraisal will be carried out and the outputs included within the Appraisal Summary Table (AST). The proposed methodology includes the following:

- Plan level appraisal – DMRB spreadsheet calculations with property counts;
- Regional appraisal – Regional emissions calculations of oxides of nitrogen (NO_x) and particulates (PM_{10});
- Air quality valuation – calculation of monetary values for PM_{10}, based on plan level calculations and NO_x taken from regional calculations and completion of valuation worksheet; and
- Greenhouse gases – emissions calculations using the Department of Environment, Food and Rural Affairs (Defra) emission factor toolkit (EFT) and completion of the Greenhouse gases worksheet with changes in CO_2 and monetary valuation.

5.8.5. Detailed Air Quality Modelling is also required, to be undertaken using the following methodology:

- Screening affected road network using criteria in DMRB Volume 11 Section 3 Part 1 - HA 207/07 - Air Quality;
- Digitising road network; and
- Detailed modelling using ADMS-Roads – Base (for verification), Do Minimum (DM - future base) and Do Something (DS – future with development) scenarios. This modelling assumes one DS scenario which is to be modelled at discrete hotspots e.g. Coalville AQMA, rather than across the full network in the interests of time. The locations to be modelled will be agreed in consultation with the Local Authority's Environmental Health Officer.

5.8.6. Some local authority air quality monitoring is available at Sinope and within the Coalville AQMA for model verification as such it is unlikely that a monitoring survey will be undertaken. Further it is noted that this would not be possible within the timescales available for submission of the OBC.

Air Quality Data Requirements

- Meteorological data are required for dispersion modelling.
- OS data for buildings as closed polygons, in ESRI shapefile GIS format, to include the OS toid reference for each building and OS MasterMap data (including ITN) covering a defined study area; and
- OS Address Base plus data, in csv format, to include the OS toid reference for each building, for the same extent as the OS buildings data.

Reporting

5.8.7. Outputs from the above scope of works would need writing up into an OBC Environmental Appraisal Report, and alongside the report we would provide the WebTAG environmental tables for Local, GHG and valuation. Information on the acceptability of the scheme for air quality will also be provided for inclusion in the AST.

NOISE

A WebTAG appraisal will be completed in accordance with the current DfT WebTAG guidance for noise and will include the following:

- Complete detailed road traffic noise modelling of the surrounding area for opening and future years;
- Input the results of the modelling exercise into the latest WebTAG analysis spreadsheets, to derive the noise impacts in monetised terms;
- Produce workbooks from WebTAG analysis except for the Social and Distributional Impacts (SDI) analysis (to be completed by the traffic team); and
- Completion of associated Appraisal Summary Tables (ASTs).

5.8.8. The study area will be defined in accordance with guidance given in Highways England's Design Manual for Roads and Bridges Volume 11, Section 3, Part 7, HD 213/11 Revision 1 (DMRB).

5.8.9. Daytime and night-time traffic noise levels at identified receptors will be generated using the SoundPLAN (v8.0) noise modelling software. The software implements the standard Calculation of Road Traffic Noise (CRTN) methodology. The model will be based on traffic data provided by a traffic model of the proposed scheme and surrounding area. The model will also include the ground topography, ground type and buildings to form a 3D representative of the study area. Residential buildings, and any other relevant sensitive receptors, will be identified using the OS AddressBase Plus dataset, and building heights defined using the OS building height dataset, which forms part of the OS MasterMap dataset.

5.8.10. Different façades of the same property can experience different changes in traffic noise level depending on their orientation to the noise source. WebTAG does not specify which façade should be used to characterise each receptor. Peer to Peer discussions with the NLCC Noise Advisor will be undertaken to establish a consensus to base WebTAG appraisal on the façade which experiences the highest Do Something $L_{A10,18h}$ traffic noise level in the opening year.

5.8.11. It is proposed that this approach is applied to these local authority proposals. The $L_{Aeq,16h}$ (façade) daytime and $L_{Aeq,8h}$ (free-field) night time noise levels for each residential receptor for the opening year and 15 years after opening, both with and without the scheme, will be inputted into the current WebTAG workbook. This calculates the monetised impacts on residential properties with and without the scheme in terms of amenity, sleep disturbance and a number of medical conditions.

Acoustics Data Sources

The above methodology will be undertaken using the relevant datasets for a minimum of 2km from the proposed scheme:

- OS MasterMap (including building heights);
- OS AddressBase Plus;
- 3d wider area ground heights;
- 3d scheme design;
- Details of existing/proposed road surfacing;
- Details of any existing noise barriers; and
- Road traffic data in the format 18 hour annual average weekday flows (AAWT), % HGV and average speed. Data is required for the baseline and with development scenarios for all the

surrounding roads included in the traffic assessment for both the opening and future year. The Highways England speed banding process set out in IAN 185/15 will not be applied.

The deliverables will be the completed WebTAG noise workbook and the relevant noise entries into the AST (Summary of key Impacts, quantitative assessment, qualitative assessment and monetary assessment). The distributional assessment entry in the AST will be completed utilising traffic noise predictions for residential and other sensitive receptors provided by the noise team. No other reporting is proposed.

The WebTAG appraisal will give an initial indication of any areas that may benefit from the consideration of additional noise mitigation (such as noise barriers). If required such mitigation would be considered in the Environment Statement (ES), in consultation with the wider team/client.

5.9 JOURNEY TIME RELIABILITY

5.9.1. There are three approaches to measuring journey time reliability in the guidance WebTAG Unit A1.3. These are tabulated in **Table 5-6**. The table also shows the rationale for the proposed approach.

Table 5-6 – Journey time reliability choices and suitability for the A511 Growth Corridor

Option	Constraints	Suitable for Scheme
Empirically derived models of Incident delays measured based Widening or traffic management changes alter the probability of incident and its impact. Reliability benefits calculated relative to whole route of traffic on motorway or dual carriageway.	Motorways and dual carriageways. Schemes limited to widening and traffic management measures. Demand is typically below capacity. Incident delay is separable from day to day variability. No readily available and suitable traffic diversion options.	No – A511 Growth Corridor is not a dual carriageway or motorway
Urban Variability Model Forecast coefficient of variation from distance and congestion index for each origin to destination flow in the urban area. Congestion index is ratio of mean travel time to free flow time. The model is rearranged to predict journey time standard deviation from forecast mean journey time and distance.	Urban areas with readily available alternative routes. Day to day variability across the network is susceptible to incident avoidance effects. Model derived from areas where average free flow speeds of 37kph to 47kph were observed. A locally calibrated model or at least a local validation is preferable. Guidance from DfT TASM may be required.	Yes. A511 Growth Corridor is adjacent to an urban area.

This then enables the reliability ratio to be applied. This is the value of standard deviation of travel time divided by value of travel time (0.4 for car journeys). This leads to an estimate of the value of reliability from the value of time which can be applied to the change in standard deviation and trips with and without the scheme to derive benefits.		
Stress Based Approach Change in stress (within the range Stress is the ratio of counted or measured annual average daily flow to the congestion reference flow. Applied on key links rather than whole length of road to avoid bottleneck effects from links and junctions operating close to capacity. Requires percentage stress on existing road with and without scheme and new road with scheme (if off line). Percentage stress is entered in quantitative column of AST. Stress change values (change in % stress x AADF) are qualitatively reported (>3 million = large beneficial/adverse, <200 thousand = neutral)	Single carriageways outside urban areas. Only appropriate where other approaches are not feasible. Takes account of improvements in reliability on both the existing route and new route in with scheme scenario such as a bypass. Modest improvements for large volumes of traffic may be more highly rated than those providing large improvements for small volumes. Stress is a proxy for reliability. Does not provide a direct quantification of changes in reliability or reliability benefits. It is not a precise or comprehensive method. It can only provide a very broad indication of the impact of a proposal on reliability. The performance of junctions is not included in the measure of stress. Not suitable for proposals affecting junctions alone. Not suitable for measuring reliability during construction and maintenance.	No. A511 Growth Corridor scheme is primarily a series of junction improvements.

5.9.2. The impact of the scheme on the journey time reliability will be assessed in-line with the relevant guidance from WebTAG Unit A1.3.

5.9.3. Reliability is defined in WebTAG as variation in journey time that transport users are unable to predict. It is expected that the A511will provide some journey time reliability benefits through alleviating congestion and a reduction in incidents on the A511.

5.9.4. It is proposed to use the urban variability model approach for quantified assessment developed by Hyder et al method (described in WebTAG Unit A1.3)

5.9.5. As recommended in the guidance, the reliability benefits will not be included in the Analysis of Monetised Costs and Benefits (AMCB) table and thus not be included in estimates of the initial Net Present Value (NPV) and Benefit to Cost Ratio (BCR) for the transport intervention, but will be included in the Appraisal Summary Table (AST), and be considered in the adjusted BCR and assessment of the overall value for money of the transport project.

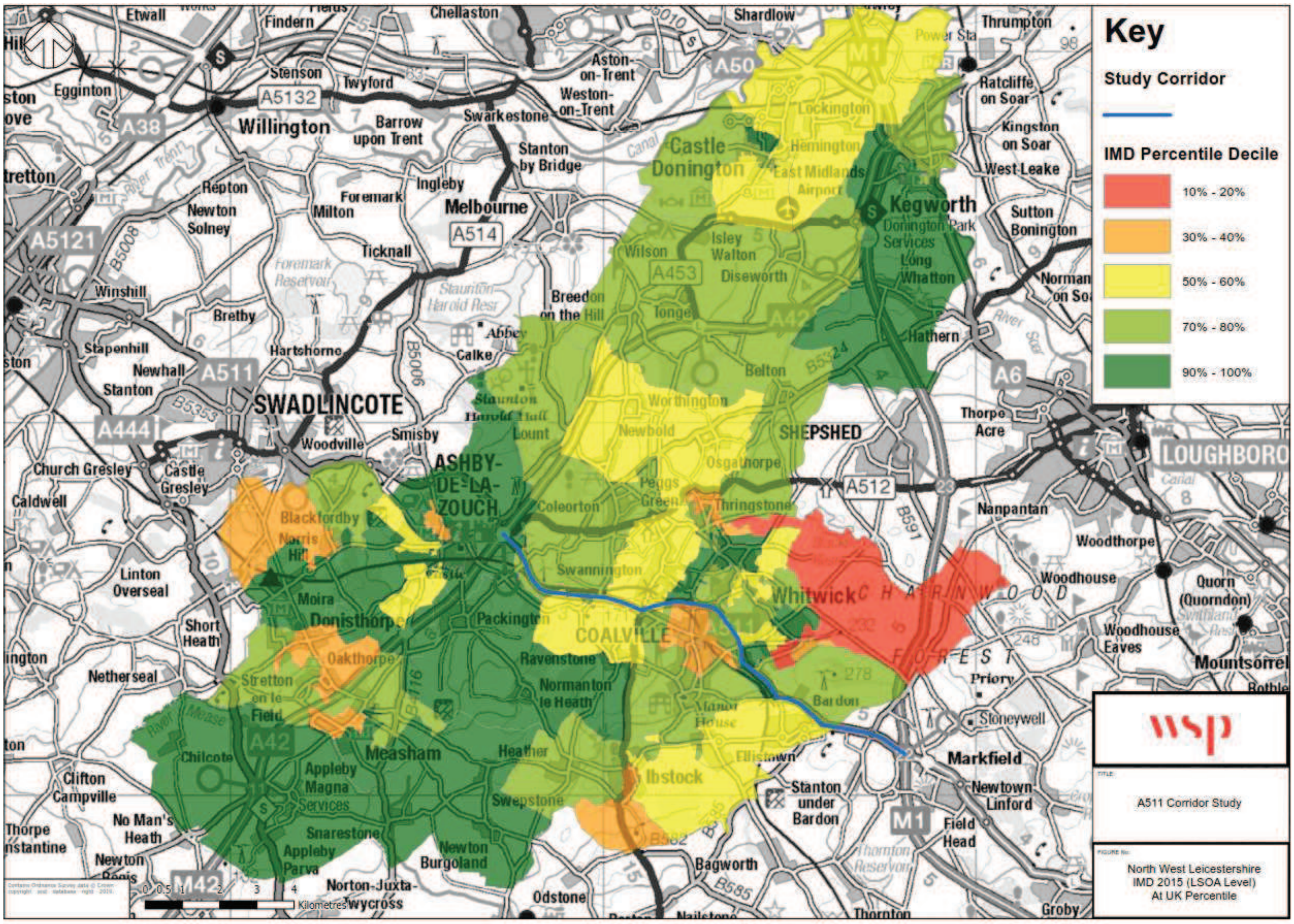
5.9.6. Reliability on roads not suitable for the urban variability model approach will be reported qualitatively only based on changes in delays and accidents due to the scheme.

5.10 DISTRIBUTIONAL IMPACTS

5.10.1. The assessment of Distributional Impacts (DIs) is designed to help understand the impacts of transport interventions on different groups of people, including those people that are potentially more vulnerable to the potential negative effects of transport schemes. The analysis of DIs is mandatory in the appraisal process and is a constituent of the Appraisal Summary Table (AST).

5.10.2. The assessment undertaken during the first stage of the appraisal (reported in the Option Assessment Report and SOBC) showed that the A511 upgrade is expected to produce benefits to the population living in Coalville area and the surrounding towns and villages.

Figure 5-1 – Index of Multiple Deprivation 2015



5.10.3. Whitwick, in the north east of the district and Greenhill in east Coalville are in 20% of most deprived areas in the UK. Coalville Town Centre, northwest Ashby-De-La-Zouch, Oakthorpe, South Ibstock and Thringstone are all in 40% most deprived. The more rural areas of the district are generally less deprived then the towns.

5.10.4. Improving transport accessibility to key locations is a key method of reducing employment deprivation and improving access to facilities.

5.10.5. The DI analysis will be undertaken in line with WebTAG Unit A4.2: Distributional Impact Appraisal (DfT, January 2014).

5.10.6. In full DI consideration is given to the following impacts:

- User Benefits;
- Noise;
- Air Quality;
- Accidents;
- Severance;
- Security;
- Accessibility; and
- Personal Affordability.

5.10.7. In line with WebTAG, screening proforma will be completed to provide justification for excluding any impacts from the analysis.

5.10.8. Details of the Distributional Impact Assessment will be documented in a separate report which will be one of the deliverables supporting the Business Case for A511 MRM Growth Corridor.

5.11 WIDER ECONOMIC IMPACT ASSESSMENT

5.11.1. There are three levels of analysis (outlined below), which are differentiated based on the maturity of the analytical techniques:

- Level 1 includes impacts which assume fixed land use excluding wider economic impacts.
- Level 2 includes wider economic impacts which assume fixed land use (connectivity impacts) or do not require land use change to be explicitly quantified.
- Level 3 includes analysis in which either land use change is explicitly quantified (structural impacts) or supplementary economic modelling has been conducted.

5.11.2. The assessment of the A511 assumes fixed land use at OBC stage, therefore only Level 1 and 2 analyses will be undertaken. The justification for including wider impacts will be outlined within the Economic Narrative.

5.11.3. It is considered the following impacts may be important:

- Output change in imperfectly competitive markets;
- Move to more / less productive jobs; and
- Agglomeration impacts.

5.11.4. The appraisal will be undertaken in alignment with WebTAG Units A2.1 - 2.4 and M5.3. This additional benefit would be added into the calculations for an adjusted BCR also including journey time reliability benefits. In undertaking the assessment WITA software will be utilised.

5.11.5. The approach to wider impacts will cover the following areas:

- Calculation of Agglomeration. The approach to calculating this is set out in WebTAG unit A2.1 paras 4.1.1 to 4.1.7;
- A calculation of the effect of output change in imperfectly competitive markets. This requires the Transport Economic Efficiency (TEE) analysis undertaken by the transport consultants. The approach to calculating this is set out in WebTAG unit A2.1 paras 4.1.8 to 4.1.10.; and
- A calculation of the tax revenue from labour market impacts. This requires calculating the labour supply impact and the move to more productive jobs impact. The approach to calculating this is set out in WebTAG unit A2.1 paras 4.1.8 to 4.1.25.

5.11.6. The wider economic benefits from the elements above will be captured over the 60 year appraisal period.

6 COMMERCIAL CASE

6.1 OVERVIEW

6.1.1. The Commercial Case of an OBC provides evidence on the commercial viability of a proposal and the procurement strategy that will be used to construct the scheme. It also presents evidence on risk allocation and transfer.

6.1.2. The Commercial Case will contain the following key elements:

- A proposed procurement strategy, including details of how different options have been assessed to arrive at the preferred procurement approach;
- An outline of the proposed payment mechanisms and pricing framework (e.g. linked to performance and availability);
- Identification of the commercial risks (based on the wider risk assessment) and how different types of risk might be addressed and shared between the parties involved (including whether the risk transfer is supported by any incentives that prompt the intended outcomes);
- Demonstration that the risk allocation is consistent with the cost estimate;
- Details of the contract timescales; and
- Details of the proposed contract management and implementation timescale.

6.2 PROCUREMENT OPTION ASSESSMENT

6.2.1. A key aspect of this task will to be to agree risk allocation in principle, namely, which party will be liable for cost overruns – for example, if the scheme is delayed (added inflation) or ground problems are identified once construction commences.

6.2.2. Different appropriate procurement options will be assessed at the OBC stage to support the rationale for selecting a preferred approach. Procurement options will be scored on the following broad criteria:

- Consistency with legal requirements. In particular, considering the OJEU thresholds and the need to follow certain OJEU procurement routes;
- Ability to ensure timely and cost effective procurement;
- Ability to ensure that contract requirements are delivered; and
- Ability to obtain an acceptable balance between cost certainty and risk exposure.

7 FINANCIAL CASE

7.1 OVERVIEW

7.1.1. The Financial Case provides evidence on the affordability of the proposal, how it is to be funded and any technical accounting issues. It includes the financial profile of the option and the impact of the proposed investment on budgets and accounts. The Financial Case will contain the following key elements:

- The expected whole life costs of the scheme, including the base cost and risk allowance in out-turn prices drawn from industry forecasts (optimism bias will not be included for this element);
- A cost profile showing year on year costs, and breakdown by cost type and parties on whom they fall;
- Details of key financial risks (including any risk allowance quantification) and the risk management strategy;
- Demonstration that sufficient funding is available to cover the identified costs in each year;
- Details of any sources of third party / alternative funding contributions, including associated conditions and consideration of the financial risks / contingencies that would result should any stream fail to materialise; and
- Consideration of the long-term financial sustainability of the scheme, including robust plans to ensure the affordability of any ongoing costs for operation, maintenance and major capital renewals.

7.2 SCHEME DEVELOPMENT WORK

7.2.1. Detailed scheme costs will be derived based on the more advanced design stage. Section 5 of this document covers the approach to design and costing for the scheme at the OBC stage. In general, scheme costs will incorporate construction costs, land purchase and associated legal costs, preparatory costs, supervision costs, maintenance / capital renewal costs and a risk allowance.

7.2.2. A key output of the Financial Case will be a proposed funding package for the scheme, setting out the year-on-year profile of funding required. This will include the funding source, including any third party contributions.

8 MANAGEMENT CASE

8.1.1. Clear and effective management arrangements are key to successful delivery of a major scheme. The Management Case ensures that the project is deliverable. It demonstrates that timescales and phasing are well established and realistic, that an appropriate governance structure is in place to oversee delivery, that risks have been identified and suitable management processes developed, and that there are robust plans for communications and stakeholder management. The Management Case also ensures that the benefits set out in the Economic Case are realised and will include measures to assess and evaluate this.

8.1.2. The Management Case will contain the following key elements

- A governance / organisational structure – joint governance arrangements identifying key roles and responsibilities (and their skills and experience), including a Senior Responsible Owner (SRO), defined through a suitable structure which includes arrangements for reporting and decision making. The scheme Project Board will continue to meet regularly for the duration of the OBC;
- A project plan for the further development, roll-out and implementation of the scheme – key outputs and milestones and critical path will be identified in the form of a GANTT chart;
- Details of the reporting, assurance and approval process (including key stage-gates in scheme development / delivery);
- A risk management strategy, setting out how risks have been identified, their likely impact, appropriate mitigation, and how the risks will be managed (and by who);
- A communications strategy – including identification of key stakeholders, their level of participation and the means of involving them. Joint communications to be agreed with developers;
- A benefits realisation plan setting out the approach to ensuring that the stated benefits are
- delivered; and
- A monitoring and evaluation plan - identifying suitable performance indicators to monitor progress against the identified scheme outcomes and the means of evaluating the overall effectiveness of the preferred option.

8.2 TIMESCALES AND PHASING

The OBC will present realistic and robust timescales for scheme development and implementation. In determining programme timescales for the scheme, the following will be considered:

- Time required for further scheme design;
- Key approval stages;
- Consultation with stakeholders and the public;
- Time required for obtaining planning permissions and statutory powers;
- Procurement process timescales; and
- Expected construction duration.

8.3 RISK MANAGEMENT

8.3.1. Risk management is a structured approach to identifying, assessing, and responding to risks that occur during a project. It will be important to identify key risks at an early stage in scheme development, to inform the risk budget included in the scheme costs. The approach to risk management for OBC development will be proportionate to the scale and complexity of the scheme.

A balance will be sought between the time and cost of assessing risks and reducing LCC exposure to risk to an 'acceptable' level.

8.3.2. The consideration of risk at the OBC stage will include:

- A risk assessment exercise (which will take the form of a risk workshop), to identify and assess the impacts of risk (e.g. in terms of programme delay or cost increase), and estimating the likelihood of risk impacts;
- Producing and maintaining a risk register;
- Identifying the means of responding to risks (i.e. mitigation); and
- Putting arrangements in place to review risks periodically and mechanisms for reporting / escalation.

8.3.3. Resources and effort will be focussed on identifying those risks that are likely to have the most significant impacts on scheme costs.

9 APPRAISAL SPECIFICATION SUMMARY TABLE

Impacts	Sub-impacts	Estimated	Level of uncertainty in OAR	Proposed proportionate appraisal methodology	Reference to evidence and rationale in support of proposed methodology	Type of Assessment Output (Quantitative/ Qualitative/ Monetary/ Distributional)
Economy	Business users & transport providers	Strong Positive	Low	TUBA analysis based on highway assignment model results	WebTAG Guidance and Previous Similar Work	Quantitative / Monetary
	Reliability impact on Business users	Strong Positive	Low	Reliability assessment based Journey Time reliability analysis using the highway model	WebTAG Guidance and Previous Similar Work	Quantitative / Monetary
	Regeneration	Slight Positive	Low	Scoping Study	WebTAG definition of 'Regeneration'	Qualitative
	Wider Impacts	Slight Positive	Low	Scoping Study	WebTAG definition of 'Wider Impacts'	Quantitative / monetary
Environmental	Noise	Assumed Neutral	Medium	Scoping study using flows from highway model to assess impacts based on determined thresholds	WebTAG Guidance and Previous Similar Work	Quantitative / monetary / distributional
	Air Quality	Assumed Slight Positive	Low	Scoping study using flows from highway model to assess impacts based on determined thresholds	WebTAG Guidance and Previous Similar Work	Quantitative / monetary / distributional
	Greenhouse gases	Assumed Slight Positive	Low	Emissions calculations using the Department of Environment, Food and Rural	WebTAG Guidance and Previous Similar Work	Quantitative / monetary

Impacts	Sub-impacts	Estimated	Level of uncertainty in OAR	Proposed proportionate appraisal methodology	Reference to evidence and rationale in support of proposed methodology	Type of Assessment Output (Quantitative/ Qualitative/ Monetary/ Distributional)
				Affairs (Defra) emission factor toolkit (EFT) and completion of the Greenhouse gases worksheet with changes in CO_2 and monetary		
	Landscape	Assumed Neutral	Low	Scoping Study	WebTAG Guidance and Previous Similar Work	Qualitative
	Townscape	Assumed Neutral	Low	Scoping Study	WebTAG Guidance and Previous Similar Work	Qualitative
	Heritage of Historic resources	Assumed Neutral	Low	Scoping Study	WebTAG Guidance and Previous Similar Work	Qualitative
	Biodiversity	Assumed Neutral	Low	Scoping Study	WebTAG Guidance and Previous Similar Work	Qualitative
	Water Environment	Slight Adverse	Low	Scoping Study	WebTAG Guidance and Previous Similar Work	Qualitative
Social	Commuting and Other users	Slight Positive	Low	TUBA analysis based on highway assignment model results	WebTAG Guidance and Previous Similar Work	Quantitative / monetary / distributional
	Reliability impact on Commuting and Other users	Slight Positive	Low	Reliability assessment based Journey Time reliability analysis using the highway model	WebTAG Guidance and Previous Similar Work	Quantitative / monetary
	Physical activity	Assumed Neutral	Medium	N/A	WebTAG Guidance and Previous Similar Work	Qualitative
	Journey quality	Slight Positive	Medium	Scoping Study	WebTAG Guidance and Previous Similar Work	Qualitative
	Accidents	Slight Positive	Medium	COBALT analysis based on highway	WebTAG Guidance and Previous Similar Work	Quantitative / monetary / distributional

Impacts	Sub-impacts	Estimated	Level of uncertainty in OAR	Proposed proportionate appraisal methodology	Reference to evidence and rationale in support of proposed methodology	Type of Assessment Output (Quantitative/ Qualitative/ Monetary/ Distributional)
				assignment model results and accident statistics		
	Security	Assumed Neutral	Low	Scoping Study	WebTAG Guidance and Previous Similar Work	Qualitative / distributional
	Access to services	Slight Positive	Medium	Scoping Study	WebTAG Guidance and Previous Similar Work	Qualitative / distributional
	Affordability	Slight Positive	Medium	Scoping Study	WebTAG Guidance and Previous Similar Work	Qualitative / distributional
	Severance	Assumed Neutral	Medium	Scoping Study	WebTAG Guidance and Previous Similar Work	Qualitative / distributional
	Option values	Assumed Neutral	Low	N/A	WebTAG Guidance and Previous Similar Work	Qualitative
Public	Cost to Broad Transport Budget	Moderate Negative	Low	TUBA analysis	WebTAG Guidance and Previous Similar Work	Quantitative / Monetary
	Indirect Tax Revenues	Slight negative	Medium	TUBA analysis	WebTAG Guidance and Previous Similar Work	Quantitative / Monetary

Appendix A

DISTRIBUTIONAL IMPACTS SCREENING

A511 GROWTH CORRIDOR DISTRIBUTIONAL IMPACTS: SCREENING PROFORMA

Scheme description: The preferred option for the A511 Growth Corridor consists of 12 junction improvements (as displayed in the Location Plan contained in Appendix A of the ASR) and a bypass situated to the south east of Coalville connecting the Bardon Link Road Junction (6) to the new developer delivered link road.

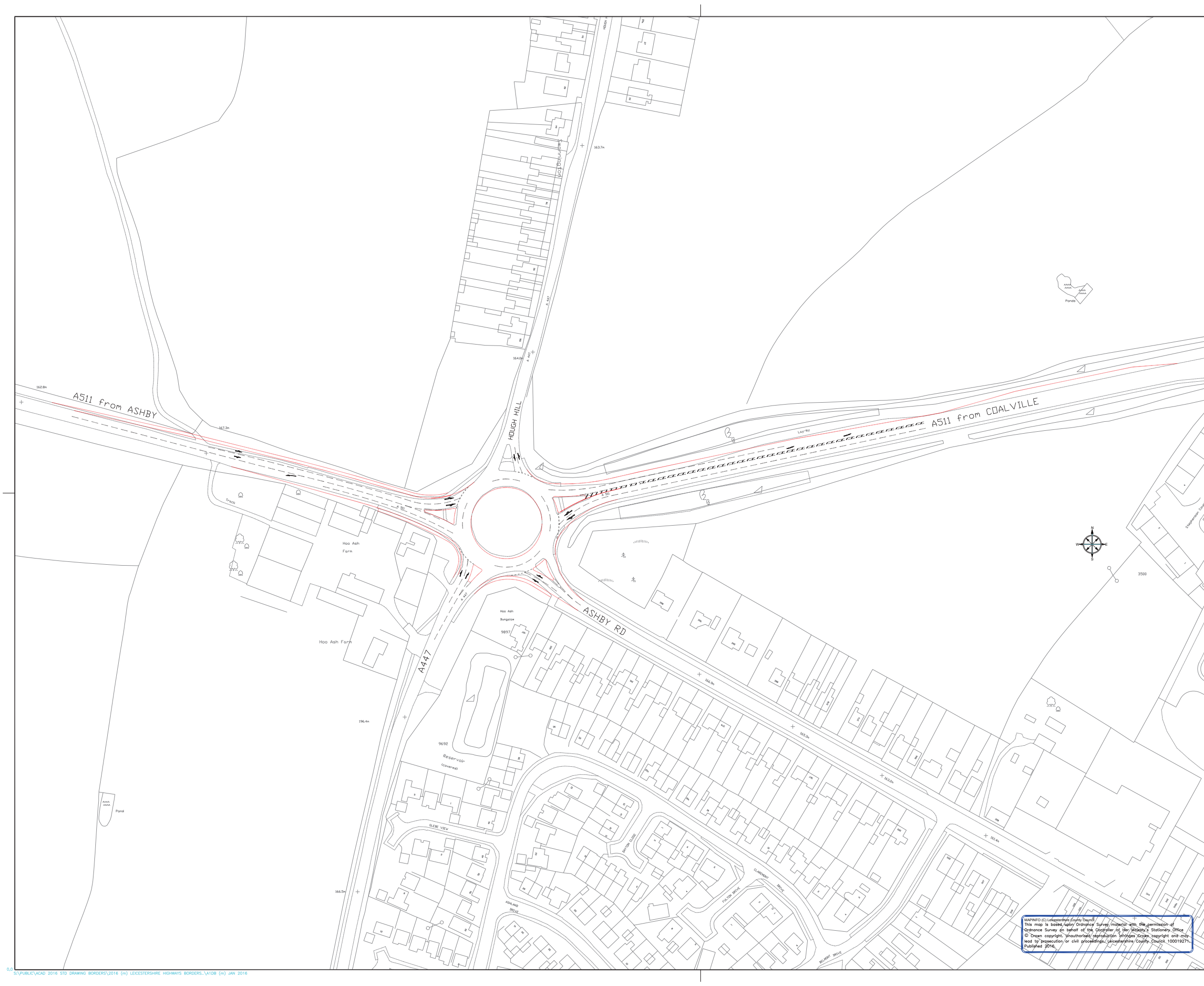
Indicator	Appraisal Output Criteria	Potential	Quantitative Comments	Proceed to Step 2
User Benefits	The TUBA user benefit analysis software or an equivalent process has been used in the appraisal; and/or the value of user benefits Transport Economic Efficiency (TEE) table is non-zero.	Yes.	The TUBA analyses indicate that there are user benefits with respect to journey time.	Yes
	Any change in alignment of transport corridor or any links with significant changes (>25% or <-20%) in vehicle flow, speed or %HDV content. Also note comment in TAG Unit A3.	Neutral.	It is expected noise levels will be deemed neutral as road traffic generated noise levels are expected to increase with and without scheme. The scheme aims to improve existing junctions and a short link road to permitted development site.	Yes
Air quality	Any change in alignment of transport corridor or any links with significant changes in vehicle flow, speed or %HDV content • Change in 24 hour AADT of 1000 vehicles or more • Change in 24 hour AADT of HDV of 200 HDV vehicles or more • Change in daily average speed of 10kph or more • Change in peak hour speed of 20kph or more • Change in road alignment of 5m or more	Yes.	The A511 passes though the urban area of Coalville. There is an AQMA around the A511 Stephenson Way/Bardon Road Junction at Coalville, within which a concentration of 43.2µgm3 was monitored in 2017, indicating an exceedance of the Air Quality Strategy objective, which the proposed scheme would need to take account of. AQMA overlaps the location of the scheme which may see an increase or decrease in vehicle volumes and speeds, and the associated changes in vehicle emissions due to the rerouting of traffic accessing the scheme. Therefore, there is potential	Yes

			for local air quality at	
	Any change in alignment of transport corridor (or road layout) that may have positive or negative safety impacts, or any links with significant changes in vehicle flow, speed, %HGV content or any significant change (>10%) in the number of pedestrians, cyclists or motorcyclists using road network.	Yes.	The scheme consists of a small section dualling and junction improvements along the A511 route. These are expected to reduce the likelihood of accidents by improving signal timings which reduce queueing and therefore shunt type accidents. Increased safety measures for pedestrians by improved crossing facilities. The scheme will likely have an effect on the surrounding local networks. The proportion of HGVs is not expected to change since, compared to the local roads, the A511 is the most suitable route for HGVs in the area travelling east to west between the SRN/MRN and so no change in the number of HGVs as a direct result of the scheme is expected.	Yes
Security	Any change in public transport	Yes	The scheme will provide improvements to pedestrian crossing facilities. There are no plans to provide public transport facilities. Pedestrian access is expected to be consistent but improved. The scheme does	No
	Introduction or removal of barriers to pedestrian movement, either through changes to road crossing provision, or through introduction of new public transport or road corridors. Any areas with significant changes (>10%) in vehicle flow, speed, %HGV content.	Yes.	The scheme is contained within the existing highway boundary, and includes a new infrastructure route to the south that could reduce severance. The scheme does not include the introduction or removal of public transport services. As a result of the scheme there will be changes to the routeing of vehicles, which may lead to some links	Yes

			exceeding the 10% change in vehicle flow threshold, which then determines that an assessment of severance is needed. Whilst the expected increase in vehicles on the A511 will not change the degree of severance at this location, the rerouting of vehicles away from some local routes should reduce traffic flow, and may improve severance conditions in these localities.	
Accessibili	Changes in routings or timings of	No.	The scheme is located within the existing highway boundary and does not require the relocation of any amenities. Changes to traffic flows on the wider network are not expected to be significant enough to affect access to amenities or public transport facilities located on the surrounding network.	No
	In cases where the following charges would occur; Parking charges (including where changes in the allocation of free or reduced fee spaces may occur); Car fuel and non- fuel operating costs (where, for example, rerouting or changes in journey speeds and congestion occur resulting in changes in costs); Road user charges (including discounts and exemptions for different groups of travellers); Public transport fare changes (where, for example premium fares are set on new or existing modes or where multi-modal discounted travel tickets become available due to new ticketing technologies); or Public transport concession availability (where, for example concession arrangements vary as a result of a move in service provision from bus to light rail or heavy rail, where such concession entitlement is not maintained by the local authority).	Yes.	The scheme will have an impact on car fuel and non-fuel operating costs, only. As a result of rerouting it is expected that there will be changes to these costs. For car fuel and non-fuel operating costs, the outputs from TUBA can be used, and indicate positive benefits. The remaining areas of affordability (parking charges, road user charges, public transport fares and concession availability) are not affected by the scheme.	Yes

Appendix B

PROPOSED SCHEME LAYOUT DRAWINGS



NOTES:

REVISION APPROVED	AMENDMENT	SIGNED/DATE	REV.

Leicestershire County Council

ENVIRONMENT AND TRANSPORT DEPARTMENT

ANN CARRUTHERS
DIRECTOR

LEICESTERSHIRE HIGHWAYS

FS 33973

CLIENT: ASSET AND MAJOR PROGRAMMES

TITLE:

A511 GROWTH CORRIDOR

FEASIBILITY LAYOUT - A511/HOO ASH

DRAWING NUMBER		SCALE	
0038.000/A1/1/1		1:1000	
PREPARED BY:	A. STINSON	DATE:	JUNE 2018
CHECKED BY:	P. VASDEWAN	SIZE:	A1
APPROVED BY:	F. BLOCKLEY	CORR. FILE:	0038.000

AUTOCAD PROJECT DIR:	K:\advdesign\0038\cad drawings
AUTOCAD FILENAME:	ALL LCC OPTIONS

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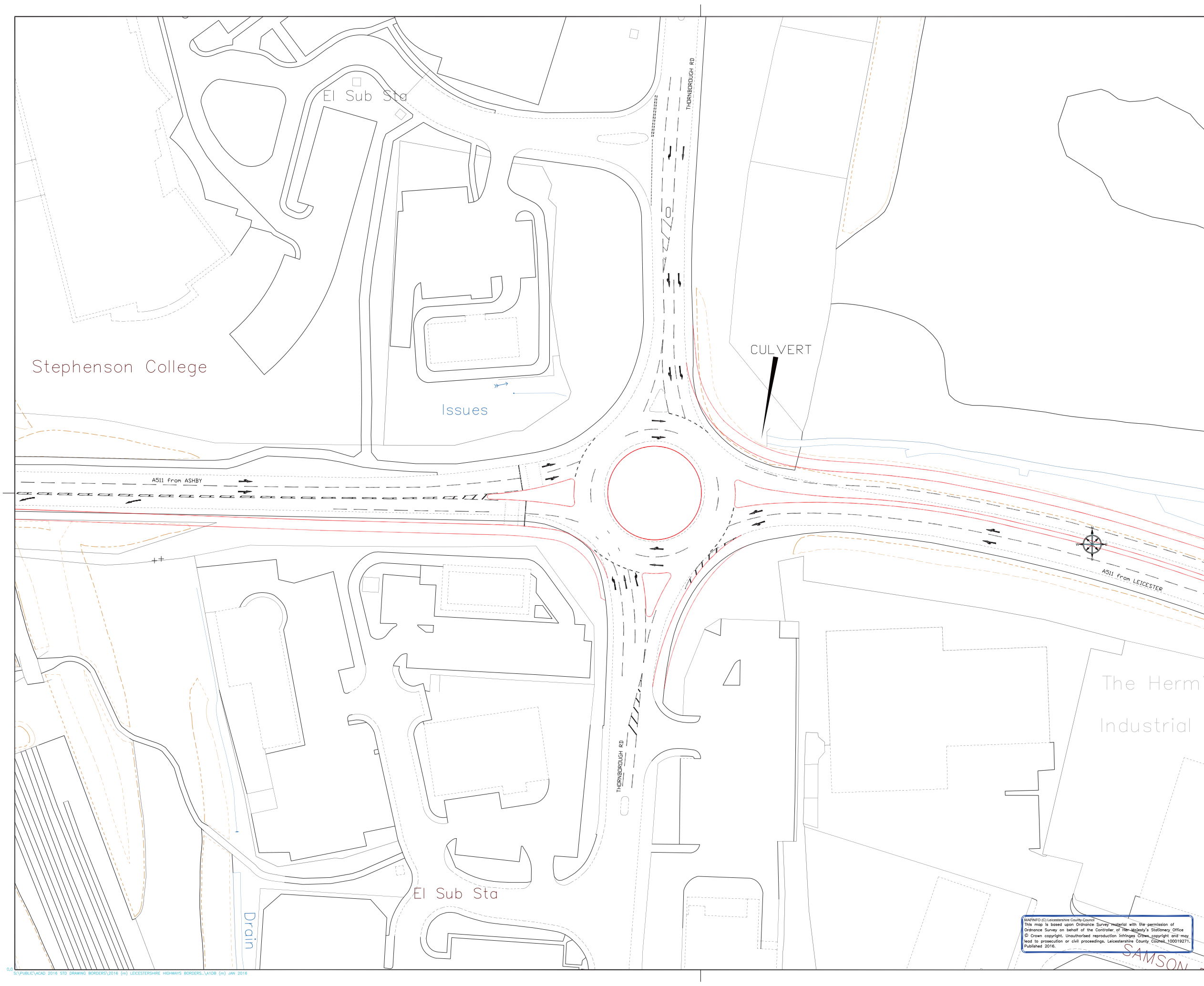
DRAWING 2 OF 9



NOTES:

REVISION APPROVED	AMENDMENT	SIGNED/DATE	REV.

Leicestershire County Council

ENVIRONMENT AND TRANSPORT DEPARTMENT

ANN CARRUTHERS
DIRECTOR

LEICESTERSHIRE HIGHWAYS

FS 33973

CLIENT:
ASSET AND MAJOR PROGRAMMES

TITLE:
A511 GROWTH CORRIDOR

FEASIBILITY LAYOUT - A511 / THORNBOROUGH RD

DRAWING NUMBER	SCALE
0038.000/A1/1/2	1:500

PREPARED BY:	A. STINSON	DATE:	JUNE 2018
CHECKED BY:	P. VASDEWAN	SIZE:	A1
APPROVED BY:	F. BLOCKLEY	CORR. FILE:	0038.000
AUTOCAD PROJECT DIR:	K:\advdesign\0038\cad drawings		
AUTOCAD FILENAME:	ALL LCC OPTIONS		

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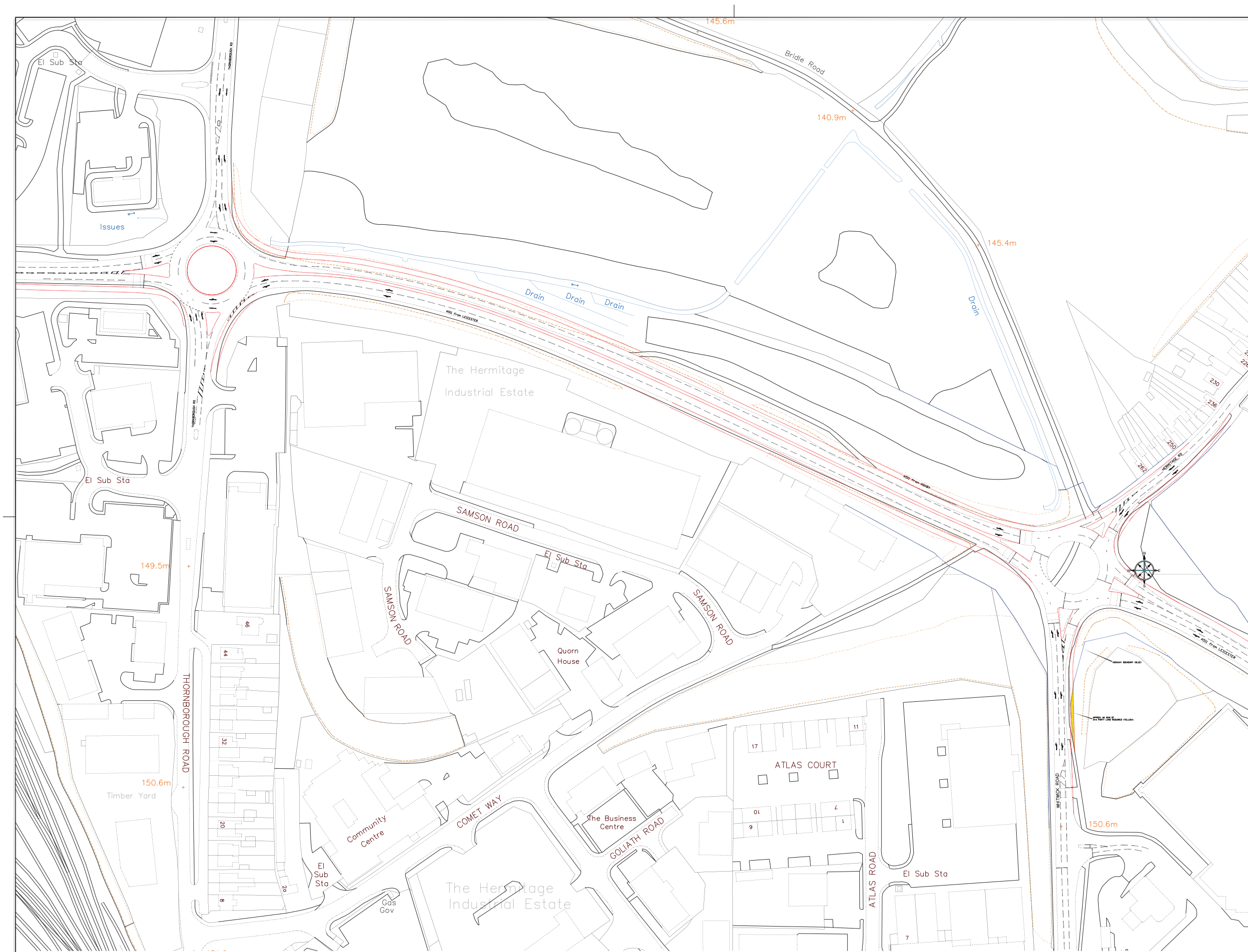

NOTES:

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Leicestershire County Council

ENVIRONMENT AND TRANSPORT DEPARTMENT

ANN CARRUTHERS
DIRECTOR

LEICESTERSHIRE HIGHWAYS

FS 33973

CLIENT:
ASSET AND MAJOR PROGRAMMES

TITLE:
A511 GROWTH CORRIDOR
Whitwick Rd to Thornborough Rd
Proposed Dual Carriageway Improvement

DRAWING NUMBER	SCALE
0038.000/A1/1/3	1:1000

PREPARED BY:	A. STINSON	DATE:	June 2018
CHECKED BY:	P. VASDEWAN	SIZE:	A1
APPROVED BY:	F. BLOCKLEY	CORR. FILE:	0038.000

AUTOCAD PROJECT DIR:	K:\advdesign\0038\cad drawings
AUTOCAD FILENAME:	ALL LCC OPTIONS

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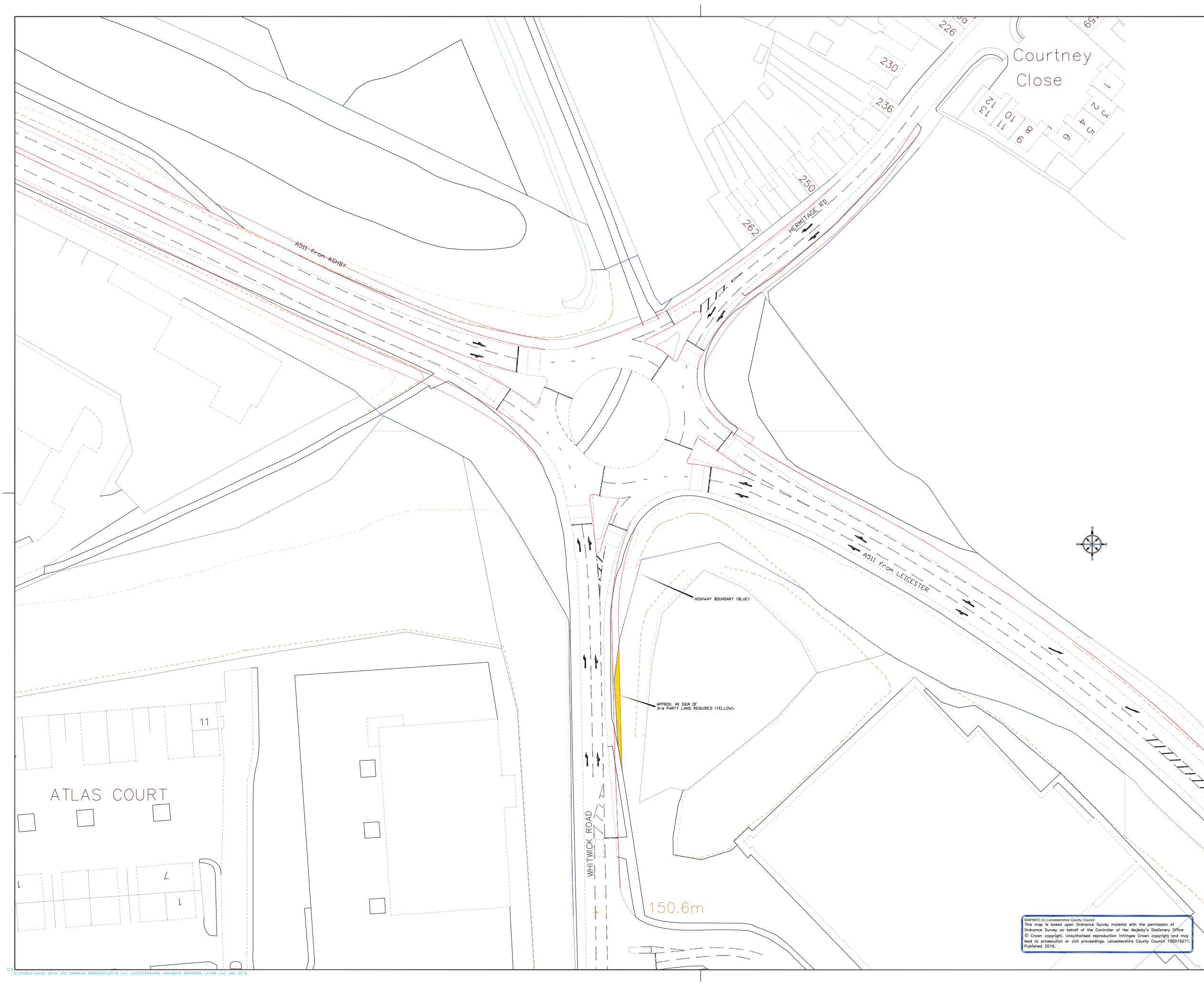
E.Mail address: astinson@leics.gov.uk | www.leicestershire.gov.uk



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FS 33973

CLIENT: ASSET AND MAJOR PROGRAMMES

TITLE:

A511 GROWTH CORRIDOR

FEASIBILITY LAYOUT - A511/WHITWICK RD

DRAWING NUMBER		SCALE	
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PREPARED BY:	A. STINSON	DATE:	JUNE 2018
CHECKED BY:	P. VASDEWAN	SIZE:	A1
APPROVED BY:	F. BLOCKLEY	CORR. FILE:	0038.000

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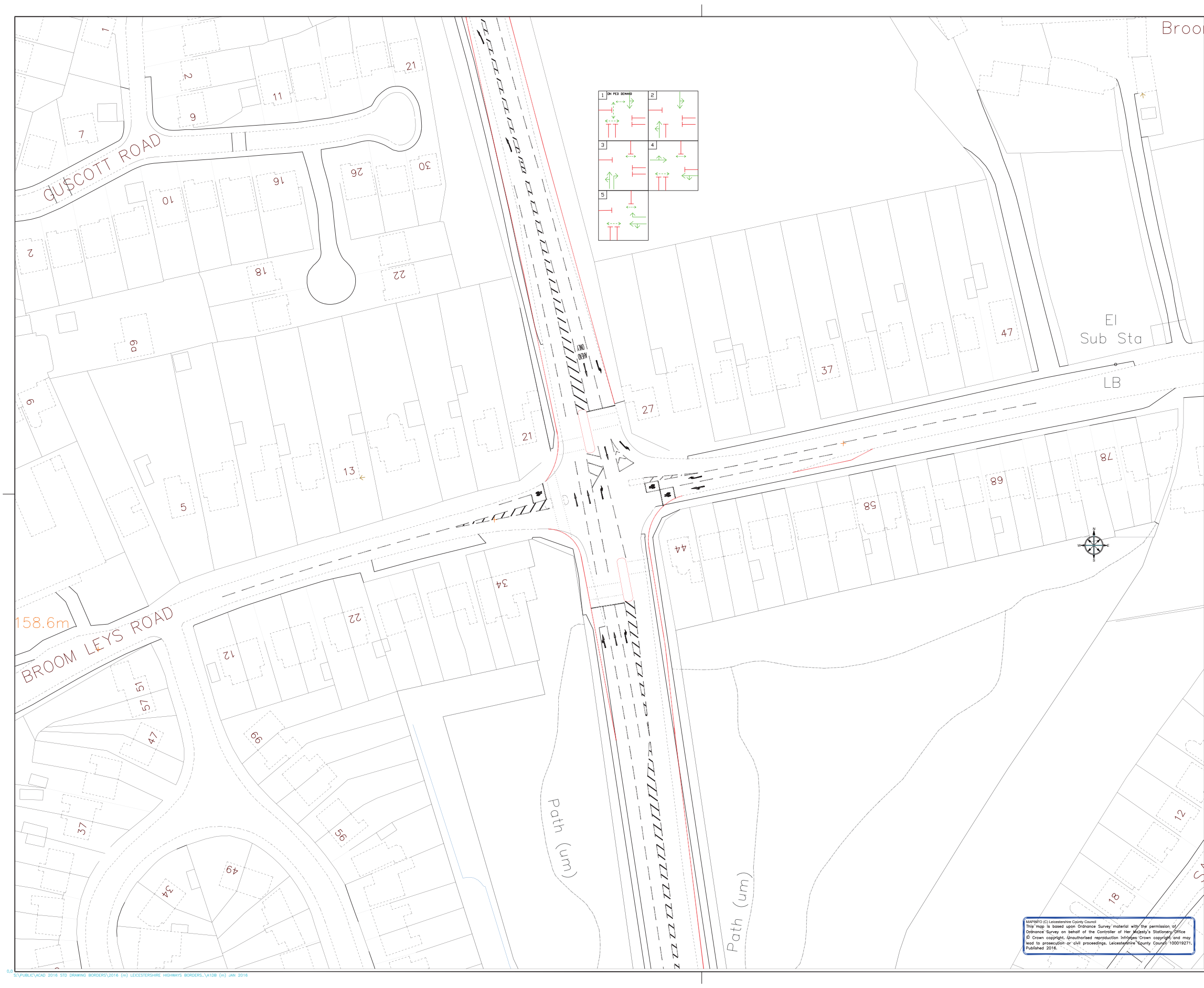
E.Mail address: astinson@leics.gov.uk | www.leicestershire.gov.uk



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CLIENT:
ASSET AND MAJOR PROGRAMMES

TITLE:
A511 GROWTH CORRIDOR
PROPOSED TRAFFIC SIGNAL IMPROVEMENT
A511/BROOM LEYS ROAD, COALVILLE

DRAWING NUMBER		SCALE	
0038.000/A1/1/5		1:500	
PREPARED BY:	A. STINSON	DATE:	JUNE 2018
CHECKED BY:	P. VASDEWAN	SIZE:	A1
APPROVED BY:	F. BLOCKLEY	CORR. FILE:	0038.000

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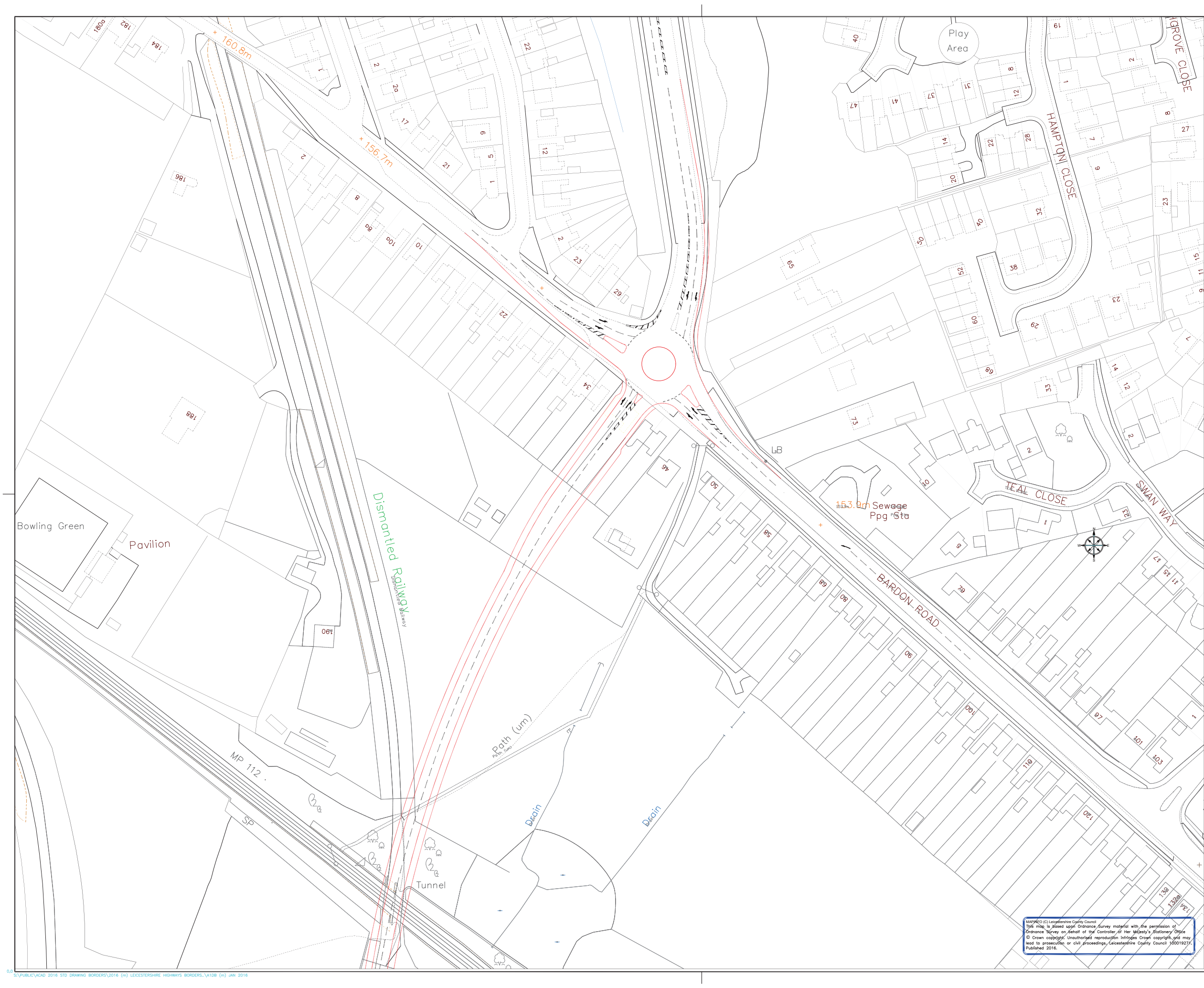

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TITLE:
A511 GROWTH CORRIDOR
PROPOSED ROUNDABOUT MODIFICATION
BARDON LINK ROAD JUNCTION

DRAWING NUMBER		SCALE	
0038.000/A1/1/6		1:500	
PREPARED BY:	A. STINSON	DATE:	SEPT 2017
CHECKED BY:	P. VASDEWAN	SIZE:	A1
APPROVED BY:	F. BLOCKLEY	CORR. FILE:	0038.000

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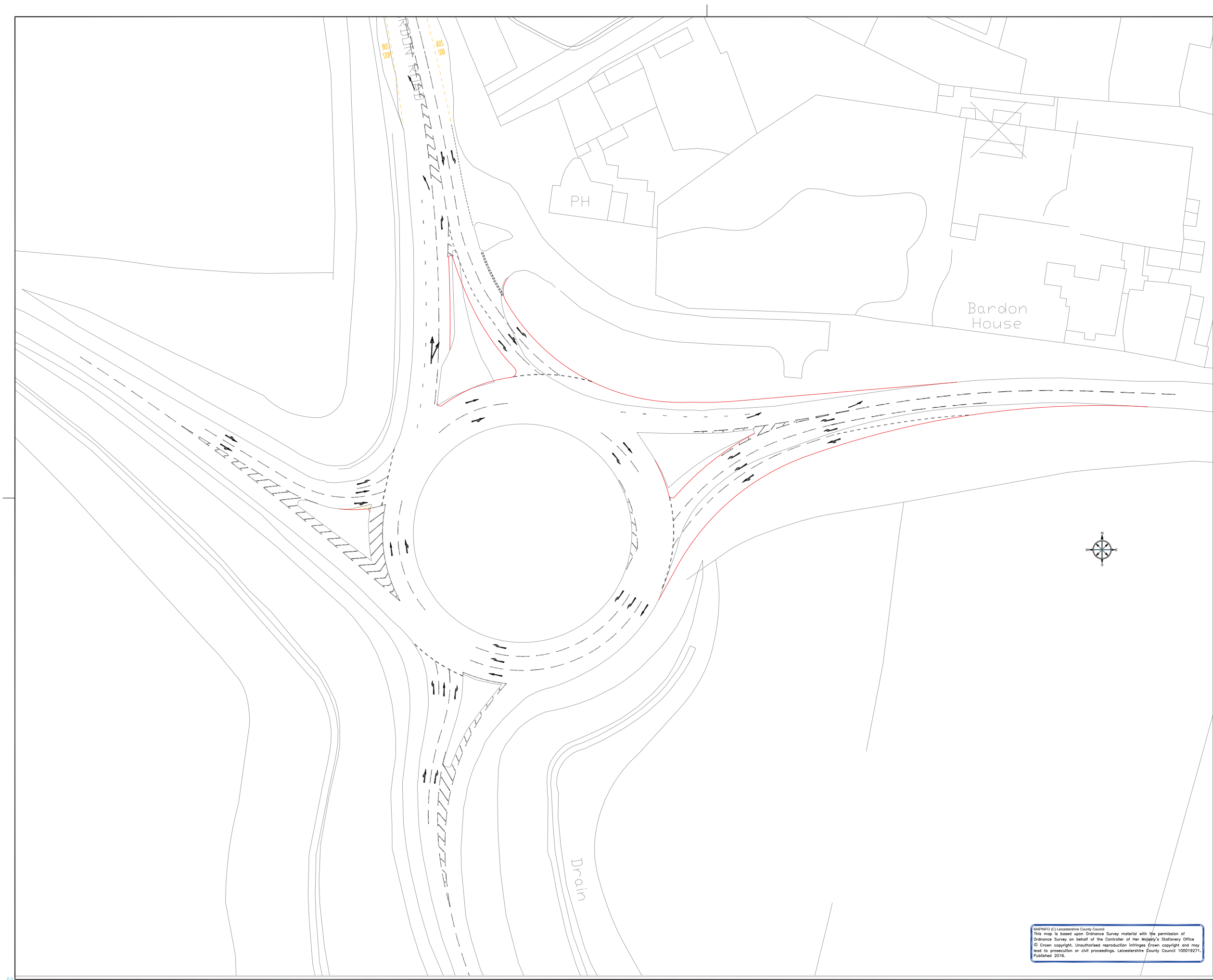

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FS 33973

CLIENT: ASSET AND MAJOR PROGRAMMES

TITLE:
A511 GROWTH CORRIDOR
PROPOSED ROUNDABOUT IMPROVEMENT
BIRCH TREE ROUNDABOUT, COALVILLE

DRAWING NUMBER		SCALE	
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PREPARED BY:	A. STINSON	DATE:	JUNE 2018
CHECKED BY:	P. VASDEWAN	SIZE:	A1
APPROVED BY:	F. BLOCKLEY	CORR. FILE:	0038.000

AUTOCAD PROJECT DIR:	K:\advdesign\0038\cad drawings
AUTOCAD FILENAME:	ALL LCC OPTIONS

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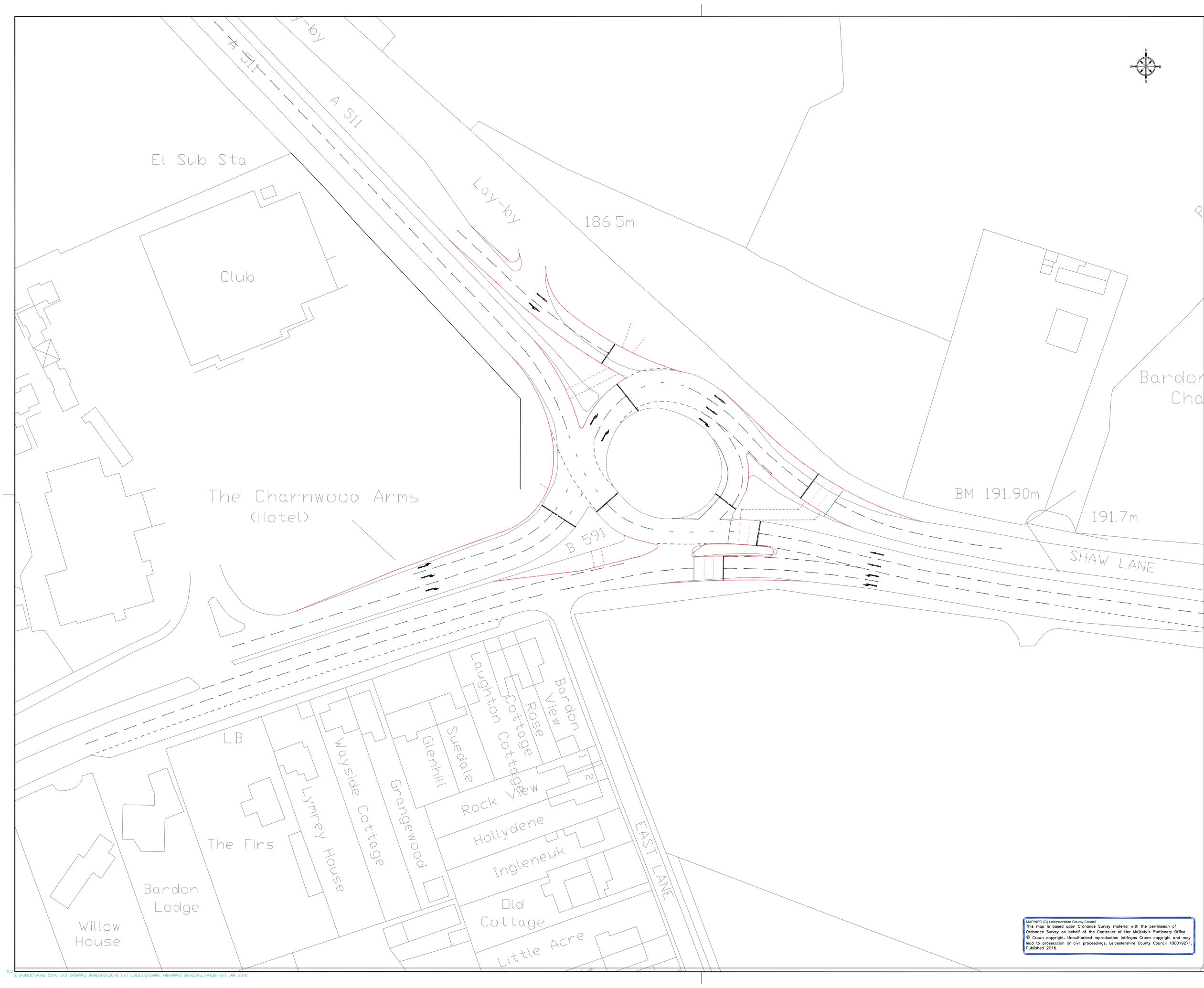

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ANN CARRUTHERS
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FS 33973

CLIENT: ASSET AND MAJOR PROGRAMMES

TITLE:
A511 GROWTH CORRIDOR
PROPOSED ROUNDABOUT IMPROVEMENT
A511 / BEVERIDGE LANE ROUNDABOUT, COALVILLE

DRAWING NUMBER	SCALE
0038.000/A1/1/8	1:500

PREPARED BY:	P. VASDEWAN	DATE:	JUNE 2018
CHECKED BY:	A. STINSON	SIZE:	A1
APPROVED BY:	F. BLOCKLEY	CORR. FILE:	0038.000

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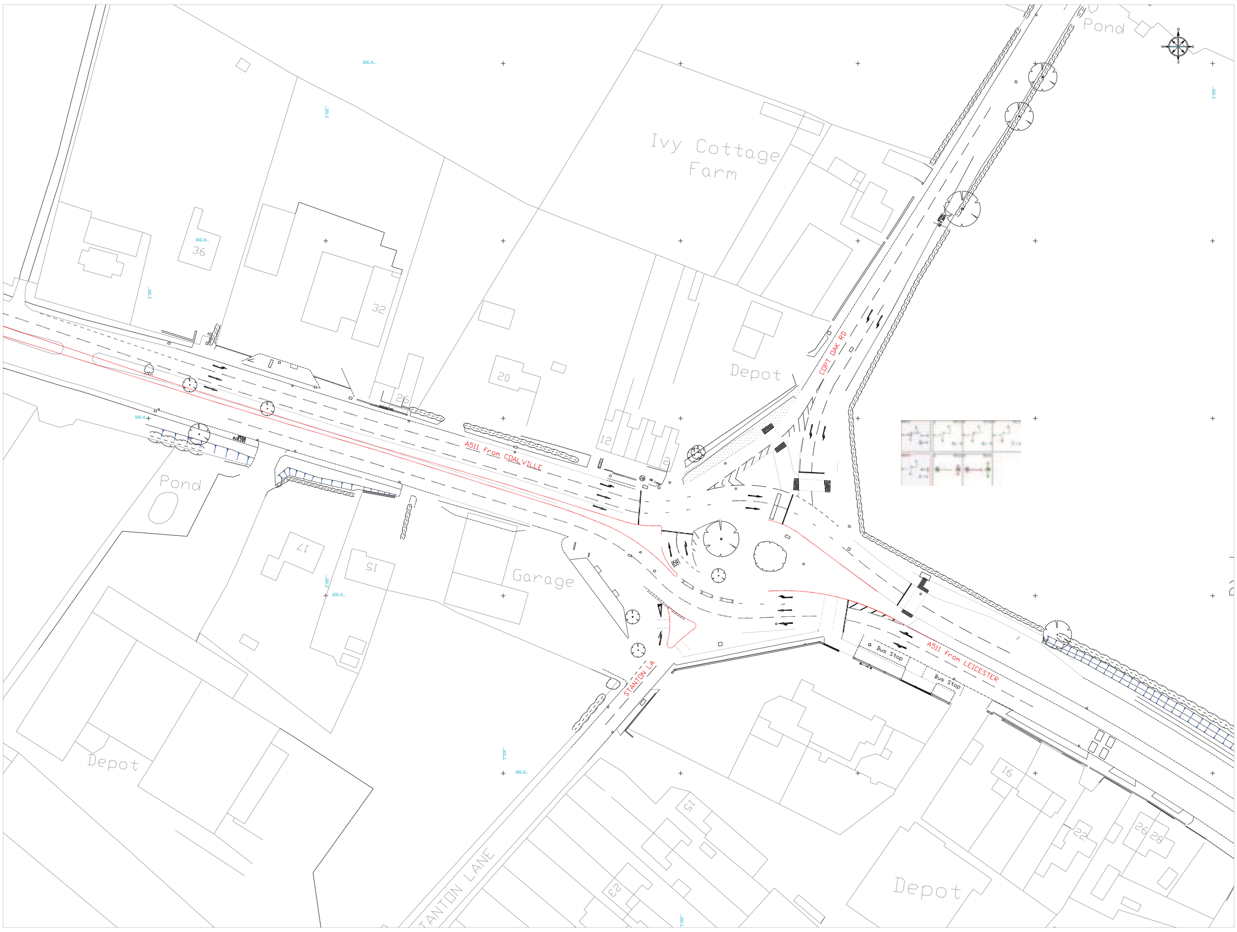

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Leicestershire County Council

ENVIRONMENT AND TRANSPORT DEPARTMENT

ANN CARRUTHERS
DIRECTOR

LEICESTERSHIRE HIGHWAYS

FS 33973

CLIENT: ASSET AND MAJOR PROGRAMMES

TITLE:
A511 GROWTH CORRIDOR
PROPOSED ROUNDABOUT IMPROVEMENT
A511 / FLYING HORSE ROUNDABOUT

DRAWING NUMBER		SCALE	
0038.000/A1/1/9		1:500	
PREPARED BY:	A. STINSON	DATE:	JUNE 2018
CHECKED BY:	P. VASDEWAN	SIZE:	A1
APPROVED BY:	F. BLOCKLEY	CORR. FILE:	0038.000

AUTOCAD PROJECT DIR:	K:\advdesign\0038\cad drawings
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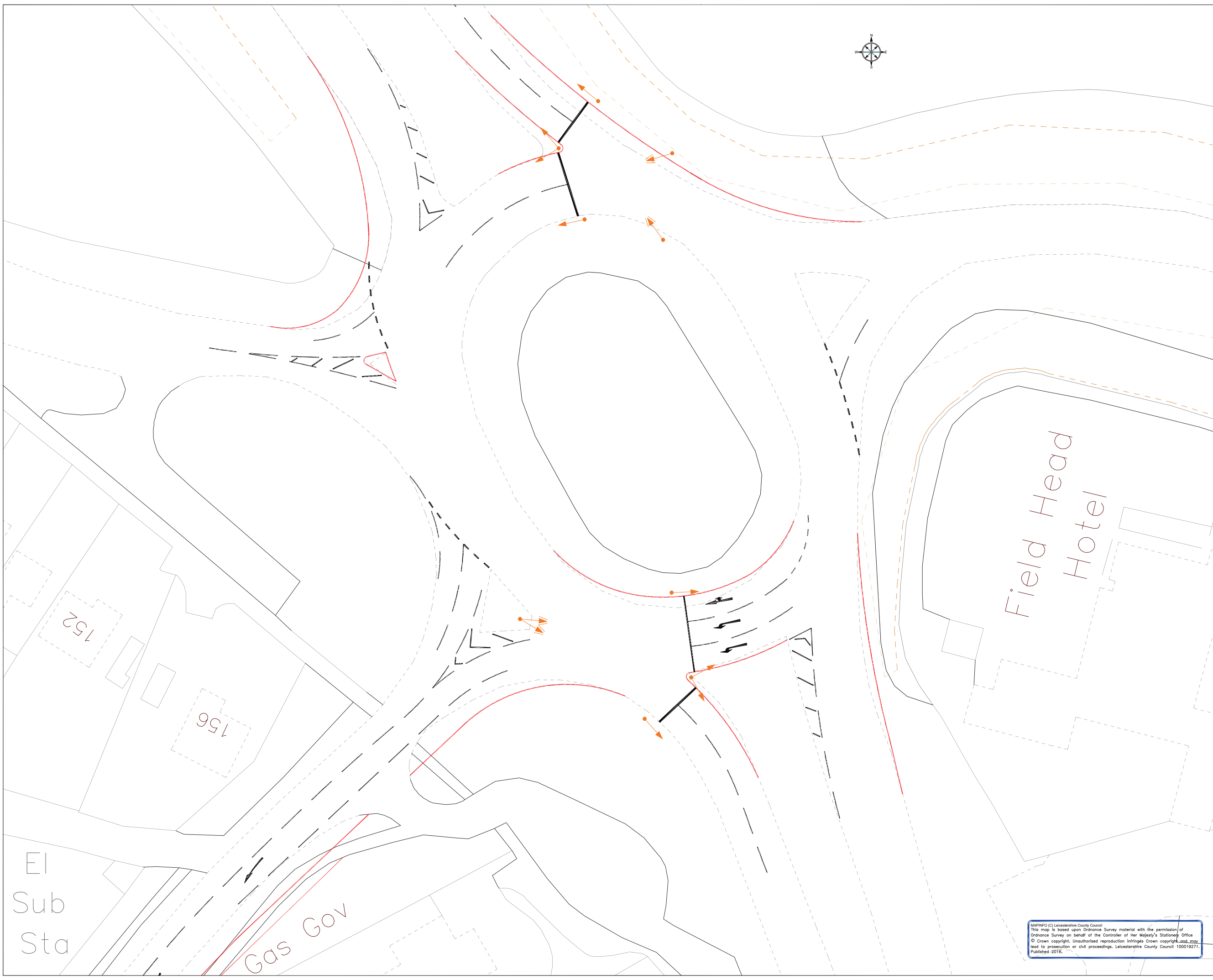

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ENVIRONMENT AND TRANSPORT DEPARTMENT

PHIL CROSSLAND
DIRECTOR

LEICESTERSHIRE HIGHWAYS

FS 33973

CLIENT: NAME OF CLIENT

TITLE:
COALVILLE GROWTH STRATEGY STUDY
FIELD HEAD ROUNDABOUT
FEASIBILITY LAYOUT

DRAWING NUMBER		SCALE	
DRAFT		1:250 @ A1	
PREPARED BY:	A. STINSON	DATE:	MARCH 2019
CHECKED BY:		SIZE:	A1
APPROVED BY:		CORR. FILE:	0038.000
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AUTOCAD FILENAME:	ALL LCC OPTIONS		

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Appendix C

V1.0LLITM-PRTM MODEL SPECIFICATION REPORT V1.0

CONFIDENTIAL

A511 MRN Growth Corridor OBC

LLITM 2014 Base / PRTM Model Specification Report

Quality Information

Prepared by	Checked by	Approved by
Ian Stanness	Andrew Currall	Mark Dazeley
Associate Director	Principal Consultant	Regional Director

Revision History

Revision	Revision date	Details	Authorised	Name	Position
v1	2019-06-05	Draft for Issue	Yes	Mark Dazeley	Regional Director

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Table of Contents

List of Tables

List of Figures

Section 1 – Introduction

1.1 Preamble

1.1.1 This document presents a specification for the Leicester and Leicestershire Integrated Transport Model (LLITM) which was updated in 2016/2017 using the latest available data. Since this time, a derivation of LLITM has been developed, called the Pan-Regional Transport Model (PRTM), which is identical to LLITM, but with some additional detail in the highway model in the Midlands Connect area, outside Leicestershire.

1.1.2 With this provenance, this document discusses the specification of the LLITM model; a final section then sets out the differences introduced in the refined PRTM.

1.2 Context

1.2.1 In 2007, Derby City Council, Derbyshire County Council, Leicester City Council, Leicestershire County Council, Nottingham City Council and Nottingham County Council received Transport Innovation Funding (TIF) to undertake a congestion management study. This work was completed and published in April 2008 as the 6Cs Congestion Management Study. The study examined the extent and severity of traffic congestion over the next 20 years. It examined options for managing and reducing traffic congestion over the medium to long term across the sub-region.

1.2.2 To build on this initial study, further investigation, development, refinement and appraisal of options was required. To this end, Leicestershire County Council, in partnership with Leicester City Council, developed a transport and land-use modelling suite named the Leicester and Leicestershire Integrated Transport Model, or LLITM.

1.2.3 This model represented a base year of (September) 2008, and was developed over the course of 2009 and 2010. During the model's lifetime a number of updates were made, mainly enhancing the performance of the highway assignment model included in the model suite. During this time the model was used for major scheme business cases, the development of local Core Strategies and the assessment of proposed major developments within the county.

1.2.4 Given the age of the data underpinning the LLITM suite, Leicester City and Leicestershire County Councils require a new model to incorporate newly collected observed data, such as mobile phone data and new roadside interview data, and including the recent 2011 Census data. This new model, named LLITM 2014 Base, (and now built) represents a neutral month within a base year of 2014, making use of updated observed datasets and following the latest WebTAG.

1.2.5 This Model Specification Report sets out AECOM and David Simmonds Consultancy's (DSC's) methodology for developing this model in response to the requirements of this new model as set out in LCC's brief for the LLITM 2014 Base model suite.

1.2.6 It is expected that this model will be required to assess land-use and transport changes from the base year of 2014 to an ultimate forecast year of 2051.

1.2.7 As with the previous LLITM (v5.2), we assume that the LLITM 2014 Base model will be required to provide evidence for the development of local Core Strategies and major proposed developments within the county, and potentially for any major scheme business cases that the City or County Councils wish to develop.

> This Model Specification Report has been produced to discuss the specification of the overall model suite. The model has been specified with the evaluation of schemes such as the proposed A511 MRN Growth Corridor scheme in mind. This version of the Model Specification Report includes a section discussing the application of the specified model structure with the assessment of the proposed A511 MRN Growth Corridor scheme in mind. This discussion is included within Section 13.

1.2.8 Blue boxes like the one above are used throughout this document to give additional context or to link to other relevant documentation related to the A511 MRN Growth Corridor Outline Business Case.

1.3 Report Structure

1.3.1 This Model Specification Report contains a number of sections detailing AECOM's and DSC's methodology for developing the LLITM 2014 Base model. Following this introduction, this report contains the following structure:

- Section 2 – Specification and Zoning: this section details the specification task for the LLITM 2014 Base model, and in particular considers the development of the model zone system which is a key task at the start of the proposed programme of work.
- Section 3 – Data Sources: this section discusses the known data sources that are available for developing the LLITM 2014 Base model. These include data expected to be used for the development of the highway demand matrices such as roadside interview data and traffic counts, and data required for the development of the land-use model.
- Section 4 – Model Suite, Scope and Interfaces: this section considers an overview of the model suite, and the likely interactions between different components of the model, including the iteration between these components during the running of the model.
- Section 5 – Highway Travel Demand: this section discusses the proposed methodology for developing the highway prior matrices.
- Section 6 – Highway Traffic Supply Model: this section considers the development of the highway modelled network, and the subsequent calibration and validation of the model given the highway prior matrices developed for this model.
- Section 7 – Public Transport Passenger Demand: as with the development of highway travel demand matrices, this section considers the development of prior matrices for the public transport model based on the available data sources.
- Section 8 – Public Transport Passenger Supply Models: this section details the development of the public transport, both rail and bus, network, including the representation of service patterns and frequencies in the model, the derivation of fare assumptions within the model, and the development of access / egress walk links required within the public transport model to access services.
- Section 9 – Demand and Trip-End Models: this section details the proposed structure and functionality of the demand model and trip-end models to be included in the LLITM 2014 Base model suite. This includes both the proposed segmentation of demand within the demand model and the representation of parking within the model suite.
- Section 10 – Land-Use Model: this section details the development and functionality proposed to be included in the land-use model to be included within the LLITM 2014 Base model suite.
- Section 11 – Forecasting, Analysis and Handover: this section discusses the proposed forecasting processes within the model, and also details the demonstration testing included in this proposal and the handover process of the model to LCC.

As the LLITM 2014 Base suite has now been produced, this Model Specification Report should be

Section 2 – Specification and Zoning

2.1 Introduction

2.1.1 The project will begin with a detailed specification exercise for each component of the model. This report outlines the overall project scope in full and the major project tasks, but the precise methodologies are not specified in full detail as they will rely, in part, on a review of the available data. The specification, scope, budget and programme will be kept up-to-date in consultation and agreement with LCC before and during the model development work. More in-depth task-specific specification notes will be prepared prior to each major task and agreed with LCC before work begins.

2.2 Model Development Principles and Guidance

2.2.1 LLITM 2014 Base will be developed with reference to national guidance, particularly the Department for Transport's Web Transport Analysis Guidance (WebTAG), and will seek to accord with this guidance where possible in all modelling principles, as well as using the guidance to obtain economic parameters (such as fuel prices and values of time) and elasticities for benchmarking the demand model performance.

2.2.2 Other relevant guidance documents include some parts of the Design Manual for Roads and Bridges (DMRB), although most of this advice has been superseded by WebTAG; and Traffic Appraisal Manual (TAM) on highway matrix building. Some rail-specific advice is available from PDFH; this may be referred to where WebTAG lacks detail.

2.3 Specification

2.3.1 The specification will result in a series of technical notes which we will start to produce early in 2014. Priority will be given to specifying tasks that are required to start early in programme; the notes relating to less time-critical tasks, such as the demand model, may be undertaken later in the year.

2.3.2 The first step will be the preparation of a scoping note defining clearly what the objectives, purpose and scope of the LLITM 2014 Base model are. This is critical to all subsequent work, and should be agreed and circulated in draft before the zone system work begins. It will specify what interventions and policies LLITM 2014 Base will be required to test, what outputs are expected to be obtained from it and for what purpose, the degree of detail required, and the expected run times and usability of LLITM 2014 Base as a tool.

2.3.3 Many of the technical notes will draw on material produced for the initial development of the existing LLITM model or as part of updates to it. Some areas are not covered by existing notes, and some existing notes are no longer relevant, so significant new material will be required.

2.3.4 Other reports, not related to specification, such as model validation reports, coding manuals and a user guide, will of course also be produced as part of the project. These are described later under model component chapters and in Section 11.3.

2.4 Zone System

2.4.1 The zone system for LLITM 2014 Base will be based upon 2011 Census geography. This is primarily formed of output areas (OAs), but to address issues experienced with the existing LLITM, large employment zones will be disaggregated using employment zones (EZs). Thus, most zones will be aggregations of 2011 output areas, but in urban centres output areas will sometimes be split into a number of zones using the 2011 employment zones.

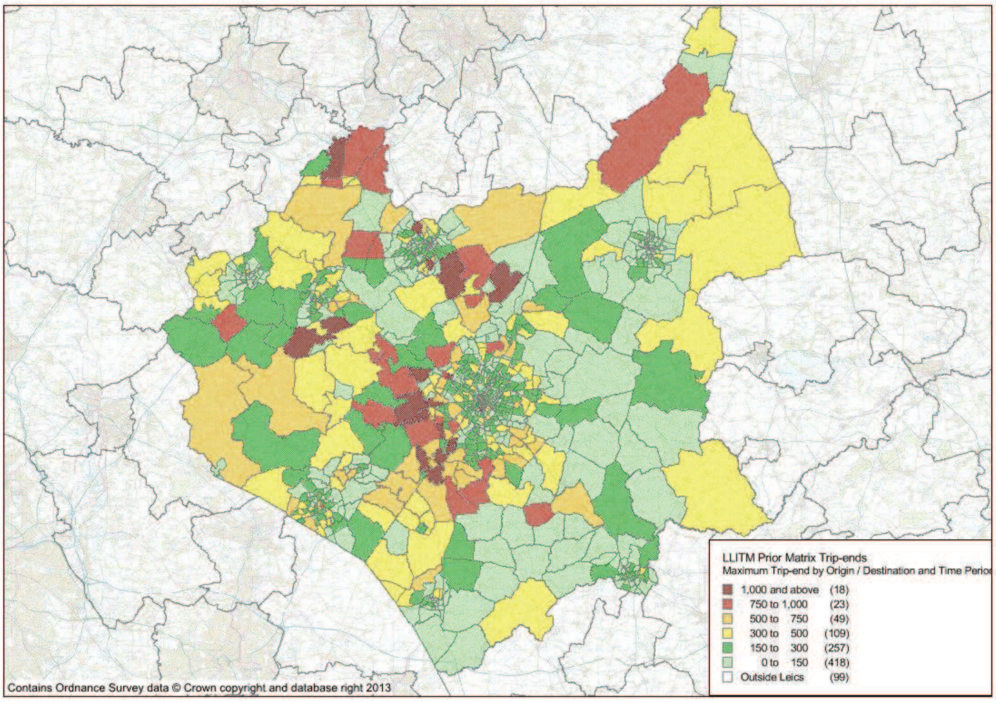
2.4.2 In defining the zoning, consideration will be given to the level of detail required for a ring of zones outside the intended simulation area (broadly speaking the county boundary). The existing LLITM contains relatively large zones in this area, and greater zonal detail in this area will help provide better routeing decisions in these areas of the highway network. This additional detail may address localised oddities in the existing LLITM v5.2 land-use forecasts (e.g. Melton), may better represent (spatially) forecast land-use change where major impacts are expected (e.g. south Nottinghamshire), and would better future-proof the model if further extension of the simulation network is required.

2.4.3 We expect that all components of the model will share the same zoning system; this will make data transfer between components much easier. Consideration will however be given, in consultation with LCC, to more detailed zoning for the public transport model to enable more precise modelling of bus stops.

2.4.4 The general level of detail in the zoning will initially be derived from the existing LLITM, with boundaries converted to the new 2011 OAs / EZs. However, this will be comprehensively reviewed, with both increases and decreases in zoning detail considered across the network. Particular attention will be paid to the following areas:

- Consultation with LCC regarding the locations of major development sites in the county will be used to future-proof the zoning system to be usable in forecasting. A suitable number of zones will be put in place to model these development sites at an appropriate level of detail. In addition, some spare zones (for discussion, but likely around 20) will be retained for use in forecasting land-use developments not foreseen during model development.
- The zone system immediately outside Leicestershire was not specified at a level of detail in the existing LLITM; it is considered that finer detail in this area, especially in Nuneaton, Nottingham and Derby, would be beneficial to the model forecasts.
- A review has been undertaken of the levels of base traffic loaded per zone (see Figure 2.1). This has demonstrated both some areas, especially in rural Melton and Harborough, where zonal traffic is low enough to consider aggregating zones, and areas where zonal traffic is higher than preferred, especially west of Leicester (WebTAG suggests that a few hundred vehicles per zone per hour is a sensible target in the area of detailed modelling). The existing planning data will also need to be critically reviewed as part of this exercise, as traffic levels will depend on these (e.g. previously identified anomalies in the north east of the county, suggesting errors in the base planning data).

Figure 2.1: Trip-Ends by Zone, Existing LLITM Model



2.4.5 Some key principles to be followed in designing and reviewing the zone system are outlined as follows. These principles will inform and prioritise choices in developing a practical zone system. It will be necessary to be proportionate in defining the zones, with as few zones as is necessary, but meeting the following constraints.

- Generally each zone should be as homogenous as possible, i.e. it should represent similar groups of people, premises and land-use.
- Zones internal to the area of detailed modelling should ideally be roughly equal in terms of trip generation. They may become larger as they move away from the boundary of the study area (as the proportion of trips accessing the study area declines). External zones are necessary to enable the modelling of trips which start or end outside the study area.
- Zones should be consistent with geographical boundaries to be used in obtaining zonal data; in this case 2011 Census output areas and employment zones are most relevant. For external zones distant from Leicestershire, districts and counties may also be used as zones, and internal zones should not cross district or county boundaries.
- Zones should anticipate, where practicable, future significant changes in land-use, so reducing the reliance on development zones.
- From the perspective of the supply models, zones should be spatially defined around a convenient and realistic loading point, that is, land-use within a zone should have reasonably homogeneous access to the transport networks.
- The zoning should take account of model size and run times, and also of likely increases in computing power over the next few years.

The development of the adopted zone system for LLITM 2014 Base is detailed within Section 4.3 of

Section 3 – Data Sources

3.1 Overview

3.1.1 We outline here the data sources we are aware of and intend to use as part of the development of LLITM 2014 Base, including both currently existing data, and data the collection of which is currently programmed by LCC. This section is not a detailed data collection specification (we have prepared this separately for LCC, see the technical notes *'Consideration of Public Transport Model Matrix Build Data Requirements'* and *'Consideration of Highway Model Matrix Build Data Requirements'*), or report of data collection, but simply a summary of the available data.

3.2 Roadside Interview Data

3.2.1 Approximately 110 new roadside interview surveys (RSIs) are due to be collected during 2013 and 2014, and will be available for use in the development of LLITM 2014 Base. These are based on the locations of the existing RSIs, as used for the development of the existing LLITM, but with the survey locations refined to intercept traffic with fewer sites where possible, and to provide better spatial detail in some urban areas to increase the proportion of observed sector-to-sector movements within the partially observed RSI matrix.

3.2.2 RSI data will be collated into a single database for ease of analysis, and a thorough checking and cleaning programme conducted. Origins and destinations will be checked graphically by RSI site to identify illogical records, and sense checks on data columns (such as high vehicle occupancies) will be put in place. Illogical records will in general be deleted from the analysis, and the remaining records expanded to the full count.

3.2.3 The data from these 2013/14 RSI surveys will be a key observed dataset for use in developing the highway demand matrices. Where appropriate, consideration will be made to make some limited use of the older RSI data, if appropriate.

3.2.4 In developing demand matrices for SRN through traffic (that passing through Leicestershire), we will consider the use of available OD data, such as the use of demand data from Highways England's J16-J19 M1 model, if available. This will be considered in a highway matrix development specification note, which will be one of the higher priority notes to be drafted early in the project.

3.3 Mobile Phone Data

3.3.1 The use of mobile phone positioning data (mobile data) is a data source that is starting to be used by the transport planning community to try to develop demand matrices, which are one of the key components of the LLITM 2014 Base suite.

3.3.2 AECOM has experience of both using and auditing mobile data, and based on this experience, the knowledge of the problems encountered by other consultants, and the lack of formal DfT guidance, a view was formed in 2013 that there was too much technical and programme risk associated with using mobile data as the primary source of new observed data, including risks associated with:

- disaggregating mobile data into mode, vehicle types and trip purposes;
- bias associated with the expansion of the observed mobile data records; and
- bias associated with a possible tendency for mobile data to under-report short trips.

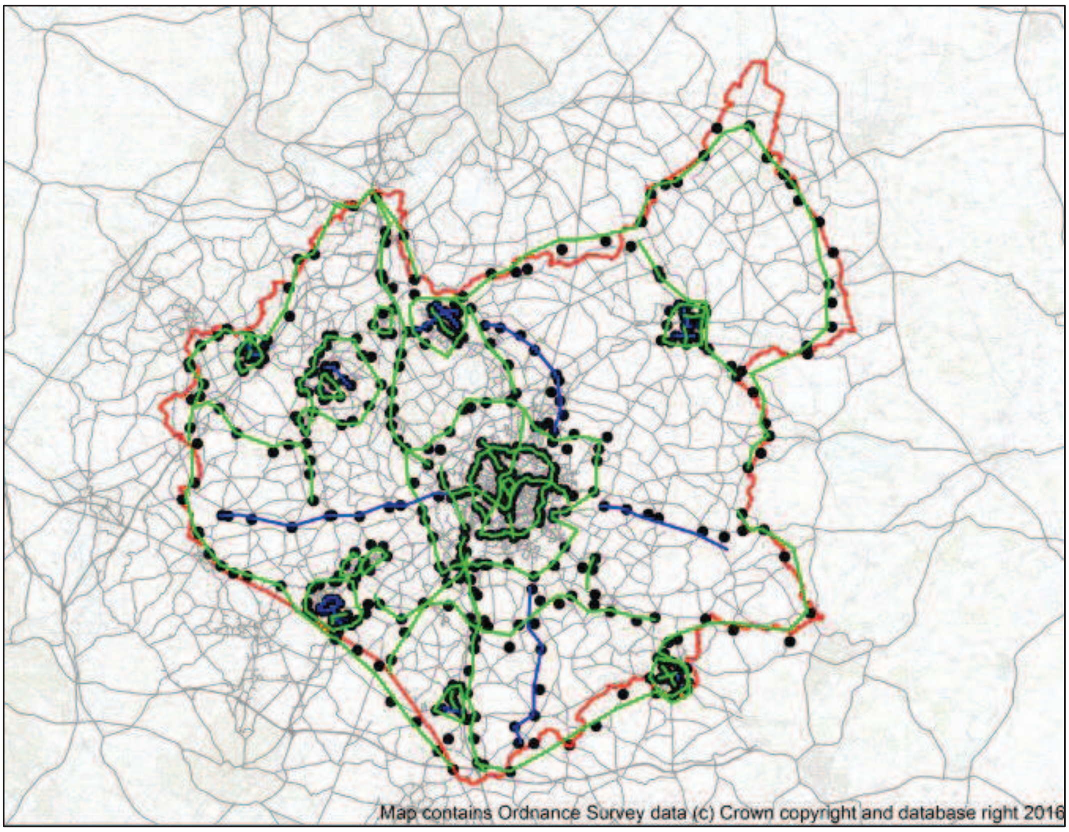
3.3.3 In recent months [in 2014], AECOM has become involved in exclusive discussions with one of the large mobile phone operators to work in partnership to take mobile data and develop the required data processing and assumptions to a point at which the data are useable in transport models; i.e. a verified 'proof-of-concept'. This 'proof-of-concept' will use the RSI data to undertake a verification process of the developed mobile data to understand the strengths and weaknesses of the two data sources for highway demand matrices, and to use the data sources accordingly.

3.4 Traffic Count Data

3.4.1 Traffic count data were collated for the LLITM model, covering around 30 cordons and screenlines around Leicestershire and Leicester incorporating around 400 sites. Most of these data were collected for the development of the existing LLITM model, and date from 2009 or earlier.

3.4.2 An extensive new programme of traffic counts will be undertaken in the first half of 2014, covering the count sites required for the calibration and independent validation of the new model. We assume that these sites will be defined by AECOM and LCC, and commissioned by LCC. The indicative count locations and their associated cordon and screenline definitions are shown in Figure 3.1.

Figure 3.1: Indicative Highway Screenlines and Cordons in Leicestershire



3.4.3 LCC now uses a cloud server to host its traffic counts, making maintenance and end-use easier. We assume that this portal will be used to provide the county traffic counts, making batch processing easier.

3.4.4 In addition to these Leicester and Leicestershire data, the Highway's Agency's TRADS data will be available, and used, for counts on the strategic road network.

3.5 Highway Journey Time Data

3.5.1 The existing LLITM model used a journey time data hierarchy of locally collected GPS data, HATRIS data, and Trafficmaster data to validate the highway model network speeds. The GPS data were collected as part of LCC's TIF congestion monitoring data collection programme, and will not be updated for use in LLITM 2014 Base.

3.5.2 Of the remaining two datasets, recent analysis of Trafficmaster journey time data has resulted in discrepancies being identified between this data and the locally collected GPS data, which with limited investigation have not been explained. We therefore suggest an evaluation and comparison of alternative journey time datasets, such as TomTom data, with the aim of providing confidence in one or more of these data sources; however we are aware of similar comparisons undertaken elsewhere (for example an AECOM analysis for Highways England) which have shown a good correlation between Trafficmaster journey time data and other observed data sources. All journey time data will be checked for plausibility by considering speed limits and available knowledge of congestion.

3.6 Highway Network Data

3.6.1 In terms of the required information on network links, this is predominantly information on link lengths, the number of lanes and the standard of road, or link type. The link lengths, number of lanes and speed limits can be determined through use of aerial photography, such as that available within Google Maps or Bing Maps, or from LCC's GIS data. Use of information available through these services also provides details on speeds limits and road classification, which will be used to determine the link type within the highway network.

3.6.2 Similarly information is also required for the junctions represented within the model. Again, use of aerial photography will be the primary source of information on junction type and standard. This includes information on the major / minor arms of priority junctions, the presence of flared approaches to junctions and 'right-turn' lanes, and the quality of the junction. The standard, or quality, of a given junction will take account of the turning radii and other factors such as visibility at each junction represented in the model.

3.6.3 One limitation of using aerial photography for this purpose is that the date of the images available on these online services is generally not known. Therefore information on network changes within Leicestershire over the past five years will be sought to ensure that the developed highway network represents the situation in the defined base month within 2014.

3.6.4 Recent LLITM model updates have highlighted a need to produce a standardised format for signal timing data, which is the main source of network data not available from aerial photography. This will enhance transparency of the signal timing assumptions in the model, and will make the coding of these data more straightforward.

3.6.5 The extent of the signal timing data are unknown, and for the purposes of this proposal, it is expected that AECOM defines a standardised format for signals data, and that LCC will complete the pro forma for the signals for which there are data available.

3.6.6 Signals data for the SRN will be sought from Highways England.

3.7 Public Transport Ticket Sales Data

3.7.1 Electronic ticket machine (ETM) sales data for both bus and rail travel will be available for LLITM 2014 Base. LENNON data for rail will be used to build the rail matrices. It is intended that recent (2013 or 2014) LENNON data be used; however the availability of these data has not yet been confirmed. 2008 LENNON data were used for the previous LLITM model, and these will be used if no recent data can be obtained. LENNON data contain origin and destination stations, time and day purchased, and ticket types.

3.7.2 Bus ticket sales data will be available from the major bus operators, covering the majority of bus services in Leicester and Leicestershire. These are likely to be less complete than the LENNON data; it is expected that full destination information will not always be available from these sources of data.

3.8 Public Transport Passenger Interview Data

3.8.1 A programme of passenger interviews for bus services is expected in early 2014. This will cover the bus stops in the centres of Leicester and the market towns, as well as Loughborough University and the bus stops near the major railway stations.

3.8.2 It is expected that these interviews will intercept the majority of passenger movements. Boarding and alighting counts will be collected together with the interviews so that they can be expanded to total passengers.

3.8.3 These passenger interview data will then be combined with the ETM data to produce a bus matrix that maximises the value available from each of these data sources.

3.8.4 No interviews are anticipated for rail passengers, due to the higher quality of the ticket data expected and the higher quality of alternative sources of information. Nevertheless, rail interview data are available from the existing LLITM model, from 2008 and 2003. These cover the five largest railway stations in Leicester and Leicestershire.

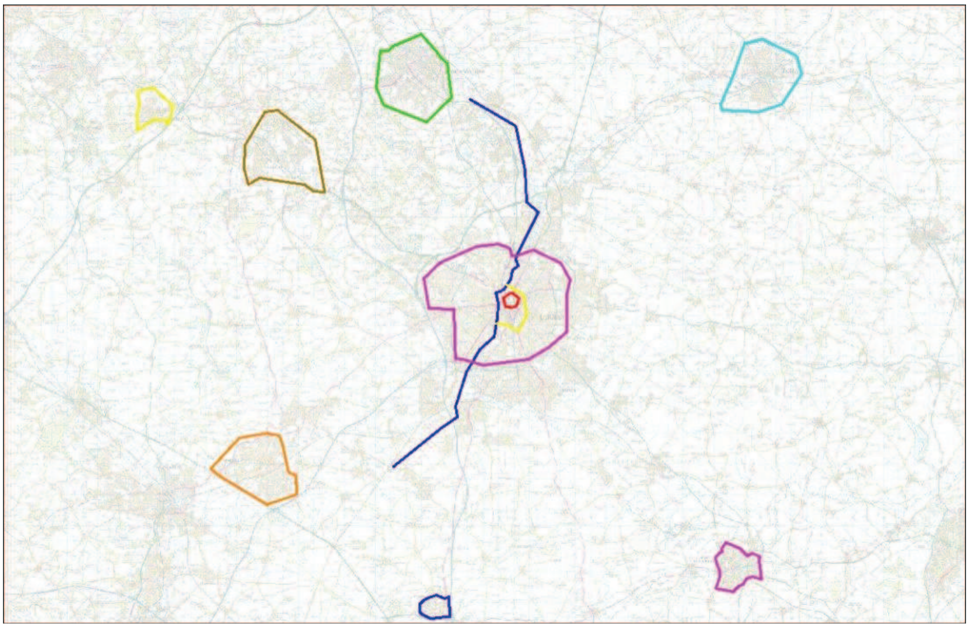
3.8.5 In addition, the National Rail Travel Survey (NRTS) was conducted in 2005, covering all of England and Wales, and provides very detailed information for rail travel, but has not been updated since. It is possible that useful information can be extracted from this source, and we will request access to it. These sources, combined with National Travel Survey data, will be used to obtain information (such as journey purposes) not available from the ticket data.

3.9 Public Transport Passenger Count Data

3.9.1 In addition to the boarding and alighting counts to be collected as part of the bus interviews, counts will be made of passengers boarding and alighting trains at the largest railway stations over a day.

3.9.2 Link passenger flow data (collected via one day on-board surveyor counts) will be available on buses at cordons around each major urban area and across screenlines in Leicester, as shown in Figure 3.2. Data in Leicester are collected annually as part of a monitoring programme; data around the market towns were collected in 2013 and will be used for this project. Where older (duplicate) data are is available, these will be used as a sense check on any newer available counts.

Figure 3.2: Bus Passenger Flow Count Cordons



3.10 Public Transport Service Pattern Data

3.10.1 CIF or XML-format data of all bus journeys made each year are available from LCC and / or the Traveline FTP server. Data for a suitable neutral month will be extracted and used to build service patterns for the model.

3.10.2 The National Public Transport Data Repository has previously been used to provide the data for service patterns; this dataset is no longer maintained. However, there is a new dataset, the Traveline National Dataset (TNDS) that contains the same type of bus data as used in LLITM v5.2, but does not include national coach services or heavy rail. However, the data format is different (xml-based), and so refinements to the process will be required before the data can be converted to a format that can be used in LLITM 2014 Base.

3.11 Household Interview Data

3.11.1 A household interview survey was conducted in Leicestershire in 2009 for the development of LLITM. While it is not proposed to repeat this for LLITM 2014 Base, the data will be available and of use in developing and validating the LLITM 2014 Base demand matrices.

3.11.2 In addition to this, the National Travel Survey (NTS) is carried out every year, and will also provide useful data for developing LLITM 2014 Base, most notably the demand matrices; we will obtain access to NTS.

3.12 Land-Use Data

3.12.1 Deriving suitable 2014 land-use data is essential for both the land-use and transport models (this derivation is discussed in Section 10). When finalised, the 2014 land-use data will be used to develop all day trip-ends (via a customised version of the DfT's CTripEnd model) by mode and purpose, which in-turn will be used as constraints in developing the 2014 highway, public transport and active mode demand matrices.

3.12.2 A number of sources of land-use data will be used in preparing the land-use model's base year database. These will include the Council Tax Register (for the numbers of dwellings), Land Registry data on house prices, Valuation Office Commercial Floorspace and Rateable Value Statistics, as well as Census data (discussed below).

3.12.3 Information on the scale and distribution of planned development across the land-use model's Fully Modelled Area will also be required for model forecasting; this will be supplied by LCC and the district councils in Leicestershire and Leicester.

3.13 Census Data

3.13.1 The 2011 Census will be a key source of information on households, population, levels of car ownership, journey-to-work flows, workforce characteristics, migration and workplace employment and will be used in creating a revised base year database within the land-use model.

3.13.2 The preparation of the 2014 base year database will draw upon both 2011 Census outputs and other published information that captures change in population, households and employment, in the period from 2011 to 2014. The Census outputs provide comprehensive and consistent small-area information on the number of households and people employed. It also travel to work data that are used, within the land-use model, to create the base year travel to work data base, which in turn is a key input to the land-use model's employment status model.

3.13.3 If there is a delay in the release of travel-to-work data then we would look to alternative sources when preparing this part of the 2014 base year database. Specifically use can be made of the 2014 travel to work matrix in the current version of LLITM v5.

3.14 Parking Data

3.14.1 Parking supply data (i.e. number of spaces by zone, by parking type) will be required for the area to be covered by the parking model, discussed in Section 9.7. Where 2014 data are not available, then estimates will be required, either from the existing LLITM, from local surveys, local knowledge, or through a rules-based estimate.

3.14.2 Estimates from the existing model or a rules-based estimate will primarily be undertaken by AECOM; we assume that LCC will facilitate the provision of actual parking spaces data.

3.14.3 It is noted that there has been a significant increase in the number of residents' permit parking zones in recent years, which, depending on the timing of the parking restrictions, may act to reduce the available supply of on-street parking. A definition of the residential parking zone areas will be required.

3.14.4 Parking demand (occupancy) data will also be required. The existing LLITM uses observed ins and outs to calibrate park-and-ride sites, and end of time period occupancy for all other parking zones.

3.14.5 The calibration of the model is more accurate if ins and outs data are available, so that modelled 'churn' of the car park better reflects reality. We therefore recommend that ins and outs be collected wherever possible. These data should be readily available for the larger barriered off-street car parks with electronic data. For other types of parking, either end-of period estimates may have to be used, either from local spot surveys, the existing LLITM, or from new rules-based estimates.

3.14.6 Estimates of parking demand from the existing model or a rules-based estimate will primarily be undertaken by AECOM; we assume that LCC will facilitate the provision of actual parking demand data.

3.15 Freight Demand Data

3.15.1 The Continuing Survey of Road Goods Transport (CSRGT) is a domestic data source for GB registered Heavy Goods Vehicles, consisting of ~120,000 vehicle records and ~1 million trip records. These HGV demand data will be used in the derivation of freight demand matrices (the data provide district-based trip-end estimates for HGVs).

3.15.2 There is less information available specifically for LGVs; the DfT publish some data such as average trip length, which will be combined with the LGV records from the RSI surveys to yield estimates of LGV demand. There are some ageing van surveys[1] which may be of use; these will be considered.

3.15.3 A report[2] by the Independent Transport Commission on Van Travel in Great Britain will also be reviewed and considered.

3.16 Economic Data

3.16.1 Economic assumptions will largely be obtained from the refresh of the Department for Transport's WebTAG advice (https://www.gov.uk/transport-analysis-guidance-webtag). Some information about income distributions will be derived from the LLITM household survey, discussed in Section 3.11.

3.16.2 We recognise that LLITM 2014 Base may have wider application then purely transport appraisal. Other stakeholders, such as the LEP may wish to make use of the model for economic appraisal. It may be that for this they would require economic assumptions that are consistent with their own economic forecasts (and not necessarily apply WebTAG derived forecasts). The land-use model is capable of running with different scenarios. We will provide an option for the provision of a second scenario.

The data collated for use in the development of the LLITM 2014 Base suite are detailed within the

[1] http://webarchive.nationalarchives.gov.uk/+/http:/www.dft.gov.uk/pgr/statistics/datatablespublications/freight/sourcesofroadfreightinfo.pdf
[2] http://www.theitc.org.uk/docs/111.pdf

Section 4 – Model Suite, Scope and Interfaces

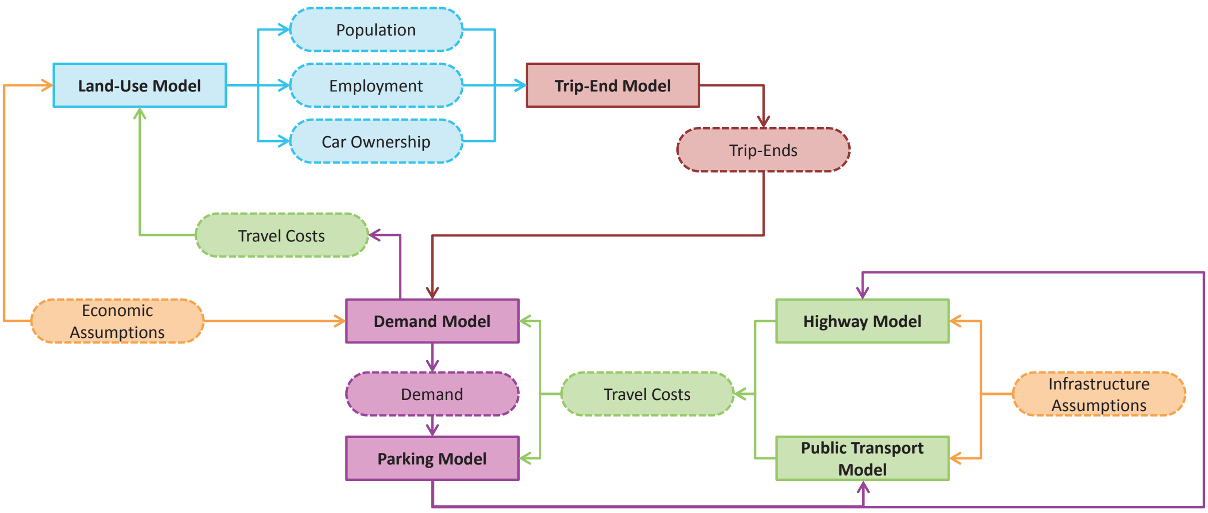
4.1 Overview

4.1.1 LLITM 2014 Base will be an integrated land-use-transport-interaction (LUTI) model. It will comprise six main modelling components:

- A land-use model, which forecasts future land-use, including population, households and employment by detailed categories. This depends upon a range of inputs, including transport costs / accessibility by area.
- A trip-end model, which forecasts future trip-making as a function of future land-use.
- A variable demand model, which uses forecast trip-ends combined with transport network / cost information, to estimate patterns, modes and times of day for travel, iterating with the supply models.
- A highway traffic supply model, which routes traffic on the road network, and forecasts traffic flows and highway travel times and costs.
- A public transport passenger supply model, which routes passengers on the public transport network, and forecasts patronage and public transport travel times and costs.
- A parking and park-and-ride model, which estimates parking search times and costs and allocates highway traffic to park-and-ride sites and other parking types.

4.1.2 The latter five components constitute the “transport model”, and will be developed by AECOM. The land-use model will be developed by David Simmonds Consultancy (DSC). The broad interaction between these components is illustrated below. Model components are illustrated as rectangles, while data passed between them are shown as ovals.

Figure 4.1: LLITM 2014 Base Model Suite Interactions



4.1.3 Many of the model components will be practically usable in isolation or with a limited number of components of the overall suite, and this enables the testing of certain scenarios more quickly. For example, minor network changes could be assessed in the highway model alone.

4.1.4 The three modes of operation will be:

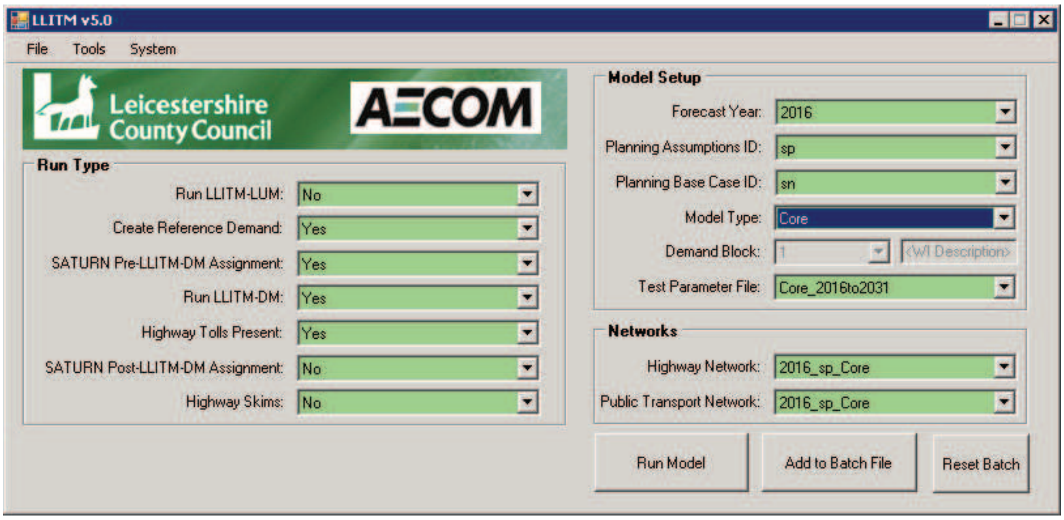
- using the full transport and land-use model;
- using the transport model only; and
- using the assignment models only.

4.2 Software Platforms and Interfacing

4.2.1 The various components of LLITM 2014 Base will be built using different software packages. The overall suite will be controlled by DOS batch files, which will enable the entire suite to be run automatically, without any user intervention during a scenario run. These batch files will be operable from a graphical front-end, which will enable the user to select inputs and set up tests or series of tests without the need to edit batch files or understand the detailed workings of the model.

4.2.2 The existing LLITM v5.2 front-end is illustrated below; for LLITM 2014 Base it is expected that a similar interface will be used. The front-end will enable tests using the full LLITM 2014 Base suite, and the transport elements without the land-use model using NTEM or user-defined planning inputs.

Figure 4.2: LLITM Front-End



4.2.3 The land-use model will be built in DSC's DELTA software. The trip-end model will be based on the Department for Transport's National Trip-End Model (NTEM); implemented in Microsoft Access and Visual Basic. The demand model and public transport model will be implemented in INRO's Emme transport modelling software, and the highway model will be based in the SATURN traffic assignment package.

4.2.4 The land-use and trip-end models carry out specialised tasks that standard transport modelling software does not generally support, hence their construction externally. Emme does not support detailed congestion or quasi-dynamic traffic modelling, so SATURN is preferred for this purpose, but SATURN does not have Emme's matrix manipulation, public transport assignment, or general transport modelling capabilities, being specialist traffic assignment software.

4.2.5 At many points in a LLITM 2014 Base run it will be necessary to run a process for a number of different categories; for example, the demand models will need to be run for different travel purposes and the highway model for different time periods. To minimise run times, we will use AECOM-developed software to exploit whatever multi-core processing is available to the software; the LLITM 2014 Base model will be primarily developed on a 12-core rack server of a similar specification available to LCC.

4.3 Consistency of Assumptions

4.3.1 It is highly desirable that the assumptions underpinning the various components of the LLITM 2014 Base suite be as consistent as possible, to ensure the overall model results and conclusions are robust. Two key issues are discussed below.

4.3.2 Consistency of demand data between the demand and supply models is desirable. The demand data in the demand model will be (as discussed in Section 9) tour-based, that is, outbound and return legs will be linked. These tours can be converted to trip-level for the supply models, but matrix estimation in the supply models will in general make it hard to reconcile the resulting trips with the original tours.

4.3.3 Consistency of economic assumptions, including public transport fare growth, vehicle operating costs, values of time and other elements of generalised cost, across all models will also be required. A master spreadsheet will be developed to calculate all economic data, derived primarily from WebTAG, for all component models.

4.4 Model Segmentation

4.4.1 The various components of LLITM 2014 Base will use different methods for segmenting people and travel into categories. In general, the land-use and demand models will use more detailed segmentation than the highway and public transport models. It is, however, essential that the segmentation in the model components is compatible as it will be necessary to convert data between each.

4.4.2 Segmentation is discussed in detail in the individual model component chapters. However, the modelled time periods will be broadly consistent across the transport models, anticipated as follows:

- Off-peak (Night-time, 19:00 to 07:00);
- AM Peak (07:00 to 10:00; the highway model will also consider the peak hour 08:00 to 09:00);
- Interpeak (10:00 to 16:00); and
- PM Peak (16:00 to 19:00; the highway model will also consider the peak hour 17:00 to 18:00).

4.4.3 The exact definitions of hours and periods will be reviewed, primarily using highway traffic count data.

4.4.4 The land-use model will not consider time periods as it does not represent travel. The parking / park-and-ride model may need to distinguish morning from evening off-peak to build up car park usage across the day.

4.4.5 The LLITM 2014 Base highway model will represent single peak hours in the AM and PM Peaks, and the travel costs generated by these models will relate to these single peak hour demand patterns. The LLITM 2014 Base demand model will represent whole time periods, rather than peak hours, and as such, the costs used by the demand model ought to be representative of average period hour demand.

4.4.6 In order to better represent the travel costs that are representative of an average peak period hour, we will assign average 3-hour period demand during the iterative demand-supply loop (see Section 9.8), rather than the peak hour demand used in the main highway model. Following convergence of the demand-supply loop, the final peak hour assignments will be performed for reporting and analysis.

4.4.7 The public transport assignment model, since it will not depend on the level of public transport demand to estimate travel times, will model an average period hour throughout, so this issue will not apply. An average period hour is preferred, as the modelling of crowding in the public transport model is not proposed, and generally public transport demand is relatively low. Also public transport services can be irregular and the definitions of what exactly is in the modelled hour can have a marked effect. It is therefore much more difficult to establish a peak hour rather than period hour public transport model.

4.5 Highway and Public Transport Model Interaction

4.5.1 The highway model network will be used to provide a basis for the bus network as well, with node numbers and links consistent between the two. The two networks will not be entirely identical, because rail and walk links will also be needed by the public transport model, but they should remain similar and highly compatible.

4.5.2 Two forms of interaction are sometimes modelled between highway and bus model networks. Firstly, bus routes may be transferred from the bus to the highway model to take account of the impact of buses upon road congestion. Secondly, traffic congestion may be transferred from the highway to the bus model to allow bus journey times to be reflective of road conditions.

4.5.3 Implementing these processes robustly and consistently at a detailed network link level requires that the two model networks remain entirely consistent in all forecasting. This is a potentially onerous requirement, making it harder for highway and public transport coding to be accomplished in parallel and potentially slowing down all forecasting tasks.

4.5.4 Some degree of representation of the effect of changes in congestion on bus travel times, as well as some representation of the effect of bus vehicles on congestion, are considered to be necessary in the LLITM 2014 Base suite. However, the level of detail required for each of these processes will require further thought and discussion; one of the proposed specification technical notes will be on this subject.

4.6 Iteration and Convergence

4.6.1 There will be four levels of “loop” in the LLITM 2014 Base forecasting process, whereby outputs from one process feed a second process that feeds back into the first process, as follows:

- The highway model assigns traffic to routes based on the route travel times. These travel times of course depend on the level of traffic, which depends on the routes.
- The highway model also simulates junction performance as a function of turning flows. These turning flows depend on the assignment results, but the assignment results depend on travel times which depend on junction performance.
- The demand model estimates demand patterns as a function of the "generalised cost” (including travel time) of travel. The highway supply model forecasts travel times and other components of generalised cost, but these forecasts depend on the demand supplied by the demand model.
- The land-use model estimates land-use as a function of travel costs. However, travel costs are produced by the transport models and depend on the demand, which depends on the population and employment data that are output by the land-use model.

4.6.2 The latter two loops are illustrated graphically in Figure 4.1.

4.6.3 All but the last of these loops will be resolved by repeatedly running the two halves of the loop and passing data between them until the data produced stops changing significantly. This requires a measure of convergence: the degree to which the data are consistent between iterations of the loop. LLITM 2014 Base model convergence will be consistent with WebTAG. These measures are discussed in more depth in Section 6 and Section 9.

4.6.4 The land-use / demand model loop is processed by feeding the model results back into each other over model years, as described in Section 11.1.

Section 5 – Highway Travel Demand

5.1 Overview

5.1.1 The highway matrix development process for LLITM 2014 Base will be built using a combination of MS Excel, MS Access and Emme transport modelling software, and will be controlled by macros to ensure transparency and repeatability.

5.1.2 All data collection is, by its nature, subject to error. This includes sampling error resulting from expanding an observed sample to be representative of all travel, and measurement error, miscounting or recording survey responses incorrectly. Best practice in developing demand matrices is designed to minimise the residual error in the demand matrices.

5.2 Data Availability and Use

5.2.1 There is no single source of data which would, of itself, provide all the information required for satisfactory highway trip matrices. We therefore need to maximise the quality of the trip matrices by integrating information from a range of data sources:

- mobile phone data for trips intercepting a cordon containing Leicestershire;
- roadside interview (RSI) surveys, there will be RSI data available from ~110 sites with older RSI data available for reference as appropriate;
- traffic counts for trunk and motorway networks and for local authority monitoring sites;
- planning data in the form of trip-end estimates from the LLITM 2014 Base land-use and trip-end models;
- National Travel Survey (NTS) data for the East Midlands; and potentially
- demand data from other models.

5.2.2 We have not included the 2011 Census Journey to Work (JTW) tables in this list as we have significant reservations relating to their use for the development of highway demand matrices (though they are considered suitable for use within the land-use model). The 2001 Census is more than a decade old, and 2011 JTW data may not be available in project timescales[3].

5.2.3 Furthermore, there are inconsistencies between the definitions used in the Census data and the measure of travel on an average weekday we will require for our modelling. In particular, the definition of 'usual' mode used and 'normal' workplace used in the Census differ appreciably from the average day in travel models as well as including only commuting trips, and result in inconsistencies with the observed trip pattern on an average working day. We do not, therefore, expect to make use of these data for the highway matrix development.

5.2.4 However, and bearing the limitations of the dataset in mind, the 2011 Census Journey to Work tables may be used at a high level to provide a measure of verification of the highway demand matrices.

5.3 Demand Matrix Requirements

5.3.1 The highway matrices for LLITM 2014 Base will be developed as two-legged tour matrices for home-based purposes, stored in production-attraction (PA) format, and as trip matrices for non-home-based purposes and freight demand, stored in origin-destination (OD) format. A "tour" is assumed to be a pair of journeys, from home and then back to home again, linked together.

5.3.2 The representation of tours and PA format has no direct relevance for the SATURN highway model, which will assign OD vehicle matrices. The PA tours for home-based purposes are of importance for the demand model, their use having the following key properties:

[3] The land-use model requires JTW data from the Census at a later stage in the programme, and so depending on the release of the 2011 Census JTW data this data will be included within the land-use model if possible.

- ensuring that the representation of home and non-home related land-use patterns are appropriately represented in the demand model, through the linkage of homes to trip productions rather than origins;
- the enabling of from-home and to-home legs of individuals' daily travel to be linked, ensuring that both legs of the tour will be sensitive to the travel costs of each direction of travel; and
- ensuring that the from-home and to-home legs use the same main mode(s) of travel.

5.3.3 The tour matrices will be formed of 15 time period pairs defining the time of the from-home and to-home legs of the tour constituting a 24-hour average neutral weekday in 2014 (assuming the time periods as defined in Paragraph 4.4.2, noting that these are subject to review).

5.3.4 Table 5.1 shows the time period pairs to be modelled, based on the assumption that a to-home leg will not occur in an earlier time period than the from-home leg; hence the return leg is assumed to occur within the same day. This assumption removes 10 permutations (shaded grey), which will reduce data storage and run time requirements by ~40%.

Table 5.1: Time Period Pairs for Matrix Building

Outbound \ Return	Off-Peak E	AM Peak	Interpeak	PM Peak	Off-Peak L
Off-Peak Early					
AM Peak					
Interpeak					
PM Peak					
Off-Peak Late					

5.3.5 Since non-home-based trips and freight demand cannot so easily be classified into simple tours, these will be represented as single-leg trip matrices for each of the five time periods, stored in OD format.

5.3.6 The demand matrices will be developed for the journey purposes shown in Table 5.2.

Table 5.2: Journey Purposes

Representation	Purpose
Home-Based (Tours)	Commuting
	Education
	Employers' Business
	Shopping
	Other
Non-Home-Based (Trips)	Employers' Business
	Other
	LGV
	OGV

5.3.7 The matrices will then be further segmented by household income, using income data from the land-use model, rather than the illustrative WebTAG assumptions (WebTAG encourages the use of local data in models where available). However, since this information will not be available from the roadside interview data or mobile data, the split will be applied following the main process to create matrices by purpose and time period.

5.4 Verification of Mobile Data

5.4.1 There are known issues with mobile data that will need to be resolved. For context, a comparison of the characteristics of RSI data and mobile phone data is provided in Table 5.3, focussing solely on the use of mobile data for deriving motorised highway demand. The key strength of the mobile data is the large sample of all travel.

Table 5.3: Key Characteristics of Mobile Data and RSI data for Matrix Building

Attribute / Consideration	RSI Data	Mobile Phone Data
Type of raw data	Cross-sectional (a sample from a single day)	Longitudinal (cross-sectional data collected over a period of time)
Sampling approach	Specified locations for selected roads; Random sample of drivers at these locations	Full population of Operator's subscribers
Sample rate (for a given road)	10% to 20% (individual sample)	~30% (repeated sample over several days)
Variation of trips observed in the data	Spatial variation	Spatial and temporal variation
Data bias	Potential for response bias, this could be minimised through careful survey design and sampling strategy	Potential for bias towards the profile of 'subscribers' if different, bias could be corrected largely if identified properly
Expansion of data	Relatively straightforward using count data and statistical analysis where journeys traverse more than one sample site.	More complicated, requiring information on how the mobile phone users relate to total population
Identify trip purposes	Straightforward; survey question	Need to be inferred through assumptions/rules/other data sources (including RSIs if available).
Identify vehicle type	Straightforward; survey observation	Need to be inferred through assumptions/rules/other data sources (including RSIs if available).
Identify vehicle occupancy	Straightforward; survey observation	Need to be inferred through assumptions/rules/other data sources (including RSIs if available).
Geographical scope of data	Only those movements intercepted by screenlines / cordons	In theory all movements, though short trips may be omitted
Proportion of unobserved OD trips in the matrix	Relatively large, depending on number of RSI sectors	None or very low (short trips)

5.4.2 Given these key characteristics of the two datasets, a series of verification tasks will be defined to understand the strengths and weaknesses of the two sources of demand data. These will be defined, in part, during the verification stage responding to the outcomes of the investigations; however we would expect the verification to include:

- checks on the trip-rates implied within mobile data compared with independent sources (such as NTEM and NTS);
- checks on the trip-length distribution within mobile data compared with the RSI data and other data sources (such as NTS);

- checks on the location of trip origins and destinations within mobile data against independent data sources; and
- checks on the pattern of trip movements at a sector level between the mobile data and the RSI records.

5.4.3 The approach to deriving the base year highway demand matrices will then be developed based on the outcomes of this verification exercise of mobile phone data and the known strengths and weaknesses of the available data sources. This may result in mobile phone data being used for all movements where trips have been reliably observed (i.e. excluding external-external and short distance trips), mobile data being used for movement unobserved by the RSI records, or mobile data not being used within the base year matrices.

5.5 Development of Partially Observed Matrices

5.5.1 Depending on the adopted methodology for building the base year highway matrices, it may or may not be necessary to build partially observed matrices based on the collected RSI data. If partially observed matrices are required, these will be built using a variance weighting approach as discussed below. Some of these tasks and process will be required for the verification of mobile phone data, and will be undertaken whether or not a partially observed matrix is required.

Expanded Site and Cordon Demand

5.5.2 The roadside interview data, both old and new, will have already undergone a checking and cleaning process. We will make our own logic and consistency checks before committing the data to the matrix-building process, following up any identified data anomalies.

5.5.3 RSI survey data will be processed using standard rules and methods. We will review the raw data to identify implausible trip origins and destinations given the direction and location of the survey site. These data will be excluded and the surveys re-expanded to the MCC totals for three vehicle groups (car, LGV, OGV) and then across groups using ATC totals.

5.5.4 The RSI surveys will have been undertaken in one direction only, but will generally contain some information on the timing of reverse direction trips. It will sometimes be necessary to deduce or estimate the time period in which the reverse trip is made, where this information is not available. These assumptions will be made based on a combination of household survey data, NTS outbound-return proportions by time period pair, directionality information from the RSI survey, which will indicate at least whether a trip is outgoing or returning home, and the profile of traffic counts in the reverse direction.

5.5.5 Expansion factors will be calculated to match the count data for the reverse direction for the three vehicle groups. These will be recalculated for any previously expanded RSI data, to take account of the 2014 traffic count data to be used, and to build the matrices at the tours level. Non-home-based trips will be dealt with separately, as directional trips rather than tours.

5.5.6 Given the 12-hour span of the RSI surveys, there will be no observed OD data for OP_{early}-OP_{early}, OP_{late}-OP_{late} or OP_{early}-OP_{late}. We will therefore make estimates of this demand, again deriving suitable factors from household surveys and assumed patterns of travel from other time periods.

5.5.7 There will be a need to rebase some count data to 2014. Traffic counts will therefore be adjusted to take account of local growth between the time of each survey and the LLITM 2014 Base year. The growth factors will be based on count data at the survey site or at nearby sites. Newer data will be prioritised over older data.

5.5.8 Where there are gaps in the survey data, consideration will be given to infilling missing information, for example, using data from other time periods at the same site together with information on purpose mix at that time of day from other sites, and, for minor unsurveyed routes, information from adjacent sites, expanded to count data on the unsurveyed route.

5.5.9 Some holes in cordons and screenlines may be too large to justify infilling in this way. Of particular note is through trips on the major trunk roads and motorways (the M1 and M69). We plan to investigate use of mobile data (subject to verification) or Highways England's J16-J19 M1 Model (the matrices for which were built using mobile data) to obtain most of this demand.

5.5.10 The matrices will be built for both observed people (all vehicle occupants) and vehicles, as vehicles are required by the highway assignment model, and people by the demand model.

Observed Partial Matrices

5.5.11 Matrices across cordons and screenlines will be merged using a variance weighting method. This approach uses estimates of the statistical accuracy of the surveys where trips cross multiple screenlines or cordons, and is therefore more robust than simpler approaches.

5.5.12 The sample variance of RSI data is a measure of the uncertainty in the expanded observed matrix obtained from an RSI screenline (or site). This ensures that, other things being equal, larger samples will be treated as more reliable than small ones. The variance for records crossing a given RSI screenline will be calculated as follows:

$$\sigma_{ij}^2 = O_{ij}\left(\frac{E_{ij}}{O_{ij}}\right)^2$$

where:

- σ_{ij} is the variance of observed vehicles between zones i and j;
- O_{ij} is the number of observed vehicles between zones i and j; and
- E_{ij} is the number of expanded vehicles between zones i and j.

5.5.13 Variances will be calculated separately for car, LGV and HGV trips at each RSI screenline so that the different sample rates (and hence variances) obtained for different vehicle types are taken into account.

5.5.14 The variance for transposed trips will be increased to reflect the increased uncertainty in these data, using factors previously derived by AECOM for this purpose, subject to review. Consideration will be given to applying other variances based on age of data and other characteristics if this is felt significant.

5.5.15 The final merged matrices will be created by weighting individual estimates of a given trip movement by the inverse of the variance squared. Estimates with high variance will thus have less weight. The process will be capable of merging any number of estimates. Many movements, for example, will be available from only a single cordon (meaning there is no weighting to do), while some long distance movements may cross several screenlines and cordons and the overall estimate will be a robust merge of them all.

5.6 Gravity Modelling

5.6.1 Whichever process is adopted for the development of the base year highway matrices, synthetic demand will be required for some movements. No source of data available for LLITM 2014 will have reliably captured short distance trips for example, and therefore synthetic demand is likely to be the source of data for these movements.

5.6.2 With a set of 2014 planning data from the land-use model, and having tested the customised model, we will apply the trip-end model (discussed in Section 9.3) to estimate car driver and passenger trip productions and attractions in the LLITM 2014 Base zone system.

5.6.3 There is no such data source for freight trip-ends. The DfT’s national model has drawn on national survey data, and we will consider the use of the information from Great Britain Freight Model as aggregate (sector) constraints.

5.6.4 The gravity models will also need indicative generalised cost data from the SATURN highway model. Some interim demand, probably derived from the old LLITM model, will be used for this. It is intended to have a suitable LLITM 2014 Base network, albeit not finalised, available for assignment. Generalised costs will be built using WebTAG economic assumptions as they will be used in the final LLITM 2014 Base demand model (see Section 9.4).

5.6.5 The period-specific OD generalised costs will be combined to establish all-day purpose specific costs in PA format, obtained using conversion factors derived from RSI data and NTS. These cost estimates will be verified against costs derived from the final model to ensure consistency.

5.6.6 The all-day PA cost data will be used to estimate deterrence functions, constrained to trip-ends separately for each purpose, of the following form:

$$Demand_{ij} = k_i P_i A_j Cost_{ij}^{\beta} exp^{\alpha Cost_{ij}}$$

where:

- P_i is the production trip-end for zone i;
- A_j is the attraction trip-end for zone j;
- k_i is a factor to control the total production demand to the production trip-end, equal to a sum over j of the right-hand side of the equation from A_j onwards; and
- α and β are calibrated parameters.

5.6.7 By fitting the synthetic, purpose-specific, trip length distribution in observed movements to that observed in the RSI surveys, the synthetic matrix provides an unbiased basis to extrapolate travel patterns to unobserved trip cells. Household survey data and local East Midlands NTS data will be used to validate this extrapolation, as they contain complete distributions of trip-lengths, unlike the RSI data.

5.6.8 Having created the all-day synthetic PA demand matrices, we will apply conversion factors (discussed below) to disaggregate all day PA person tours between individual time period pairs. The total OD period specific trips will be accumulated by adding to-home and transposed from-home trips to create OD demand for assignment. Finally, vehicle occupancy factors will be applied to estimate period-specific vehicle trips.

5.6.9 Both the creation of generalised costs in PA form and the conversion of synthetic demand back to OD assignment format require conversion factors; some of these will also be needed by the demand model in forecasting. They will be obtained primarily from RSI data (although data from NTS may be used to infill missing data), and will be of three kinds:

- factors to split all-day demand into time period pairs (home-based tours) and time periods (non-home-based and freight trips);
- factors to convert from person to vehicle trips by applying group size (vehicle occupancy); and
- factors to convert between AM and PM three-hour peak periods and the AM and PM peak hours.

5.6.10 In principle the conversion factors are simply defined by the observed demand. For example, average car occupancy for home-to-work in the morning peak, is defined by the total (expanded) number of surveyed individuals divided by the total (expanded) number of vehicles, for the given period and purpose. It will be necessary to assume factors for unobserved movements based on the observed data available.

5.6.11 The output of this process will be a set of factors used to disaggregate all day synthetic production-attraction trip matrices to period specific origin-destination vehicle matrices. Separate factors will be derived for each purpose.

5.7 Matrix Estimation

5.7.1 Following the development of the base year highway prior matrices, we will apply highway matrix estimation techniques, if necessary, to draw upon accurately measured data from traffic count sites. The steps will be to:

- validate the original prior matrix against counts, and adjust the network or assignment where discrepancies appear to relate to the network or assignment process;
- undertake matrix estimation by short screenlines (these will generally be disaggregated from the RSI cordons and screenlines and will include traffic count data not used in the RSI build);
- formally validate the estimated matrix against independent sites excluded from the initial estimation;
- undertake a further estimation using, in addition, the independent sites; this maximises the use of information and accuracy of the model; and
- undertake final validation demonstrating the extent of changes that the final estimation made to the trip matrix.

5.7.2 The matrix estimation and assessment of its impact will be done in accordance with guidance detailed in WebTAG Unit M3.1.

The adopted approach to developing the base year highway trip matrices is detailed within Section 7

Section 6 – Highway Traffic Supply Model

6.1 Overview

6.1.1 The SATURN highway network for LLITM 2014 Base will be based on the existing LLITM network. This was partially reviewed in depth as part of an update for LLITM in 2013.

6.1.2 While the LLITM network will be used as the basis for the LLITM 2014 Base network, the following tasks will be undertaken to further enhance the network:

- Centroid connectors in LLITM were coded in an inefficient way, using four nodes and five links. This will be revised to a simpler two node and two link approach, significantly reducing network complexity, making analysis easier, and shortening run times. As part of this process, all centroid connector loading points will be reviewed to ensure that traffic is loaded at the most logical points by zone.
- Over half of simulation junctions in the LLITM model were reviewed for the 2013 update to ensure they were coded accurately and consistently. The same process will be applied to the remaining junctions so that all network coding is consistent.
- The external buffer network, a long way from Leicestershire, has substantially more complexity, particularly in terms of unnecessarily long "chains" of links, than necessary, which slows run times and makes converting the network between software packages harder. This complexity will be removed. However, link shape will be retained for graphical purposes, using functionality in SATURN to allow a single link to be plotted as a series of straight lines, rather than a single line. Some buffer network is likely to be removed altogether.
- The network immediately outside Leicestershire requires additional detail and junction modelling to ensure that route choice between Leicestershire and routes immediately outside are modelled accurately. The focus of effort is expected to include Nuneaton and Rugby, but the areas will be discussed with the client.
- The 2008 network will be updated to 2014 by reviewing and coding schemes implemented between 2008 and 2014. The existing 2014 LLITM forecast networks will be used as a starting point.
- A check on the network topology will be conducted by comparing the network against GIS data or aerial photography to ensure that all strategic and connection routes are included. The model will not in general represent residential streets or very minor roads.
- All available signal timing data will be incorporated into the model in the coding of signalised junctions; it is assumed for the purposes of this proposal that these data will be provided using an agreed signals data pro forma that is specified by AECOM and agreed with LCC.
- Banned network movements for car and freight will be reviewed and updated; we assume that LCC will provide GIS layers containing these data.
- Approximate demand for the year 2041 will be prepared and assigned on the network to perform a "stress test" and identify any likely areas of significantly poor performance in the future. Where these result from likely coding errors, the issues will be addressed as appropriate.

6.2 Coding Principles and Quality Assurance

6.2.1 A SATURN model coding manual, *'TN101 - LLITM SATURN Coding Manual'*, was prepared as part of the 2013 LLITM update. This document will be reviewed and updated as appropriate, and will form the basis of further coding. Any refinements to the coding approach will need to be considered with respect to the network that was updated as part of the 2013 update. The coding approach will accord with industry best-practice, and will be reviewed by an experienced SATURN modeller separate from the model development team.

6.2.2 We envisage the SATURN coding task for the new 2014 base year model to be undertaken by one person over approximately 6 months. This will ensure consistency of approach and removes the practical complexities associated with multiple coders working in parallel.

6.2.3 An experienced SATURN modeller, separate from the model development team, will spend 0.5 days per week during this coding period independently reviewing and checking a sample of the coded network. This peer review will focus on areas of the network that are considered to be more critical / sensitive to LCC. Findings and remedial action from this review will all be documented.

6.2.4 Some of the more detailed requirements of the brief (such as coding methodology for motorway merges) will be addressed in the coding manual.

6.3 Buffer Network Congestion

6.3.1 LLITM will contain SATURN “buffer” network outside the main simulation area which will cover Leicester, Leicestershire, and some surrounding area. In the buffer network, junctions will not be modelled and the network will be skeletal. It will be necessary to ensure boundary effects between simulation and buffer (potentially resulting in spurious route choice, demand model, or land-use effects) are minimised.

6.3.2 We plan to do this by using buffer links speeds that are fixed in any given model run, but reduce over time in line with national congestion trends, derived with reference to both the internal model and to published National Transport Model trends. In this way, congestion will affect simulation and buffer areas similarly, and yet the model will not need to forecast capacities and demand precisely a long distance from Leicestershire.

6.4 Road Charging and Tolls

6.4.1 There are no road tolls or user charges in Leicestershire or Leicester currently, so the LLITM 2014 Base model will not contain any charges. However, it will be set-up appropriately to allow charges to be tested in forecasting.

6.4.2 Road user charges could take a number of forms, including, in approximate order of likelihood:

- workplace parking levies; these would be modelled in the LLITM 2014 Base demand model, rather than the highway model;
- cordon charges around urban areas; these would be represented by charges on links in the highway model, and will be able to vary by time of day;
- new tolled roads; also would be represented by link-based charges, however, some consideration of external choice modelling might be required depending on location and context; and
- marginal social cost (MSC) charging; this would require a more complex external process to calculate charges, but would also be modelled at a link-based charge level.

6.4.3 The highway model will allow charges to be specified within the network, by time period, and ensure that monetary costs are able to be extracted for journeys and passed to the demand model.

6.5 Flow and Journey Time Validation

6.5.1 With the development of the coded highway network and the prior matrices (as discussed in Section 5) the assignment of these matrices onto the network in the three modelled hours can be assessed against observed data. This observed data will consist of both link counts and journey times along defined routes.

6.5.2 The assessment of the assignment results against observed data will follow WebTAG, and will consider both the comparison of modelled screenline and individual count locations flows against observed data and the comparison of modelled and observed journey times. In addition to this, if matrix estimation is required as part of the calibration of the highway model, the changes to the prior matrices due to this process in terms of individual cell values, sector-to-sector values and trip-ends will be assessed.

6.5.3 It should be noted that current WebTAG places particular emphasis on minimising the changes to the prior matrices above link and journey time performance against observed data. With that said, it is acknowledged that a key requirement for the highway model is to get as close to WebTAG acceptability criteria in terms of link and journey time validation, given the type of scrutiny that the model is expected to undergo (Core Strategies, AAPs, EIPs etc.). The balance of weight to be placed on the matrix changes and the assignment performance will be discussed with LCC prior to and during the calibration process.

6.5.4 An additional complexity within the calibration of the highway model is the application of the parking model. In the base year this will influence the routeing in and around the areas included within the parking model; however the parking model can only be realistically applied after the base year highway model has been calibrated. Running and calibrating the parking model during each run of the matrix estimation process would add significant time to the programme for this task.

6.5.5 In order to account for this effect within the highway model calibration, the expected change in modelled flows due to the application of the parking model will be applied to the counts used within the calibration and validation process. With the final base year model having been run, including the application of the parking model, these adjustments will be removed and the reported calibration and validation will be based on these post-parking model results.

6.5.6 It is anticipated that these adjustments to the observed counts to account for the likely effect of the parking model will initially be taken from the existing LLITM highway model. However, providing that the base year demand model is operational during the calibration of the highway model, these adjustments will be updated from interim versions of the base year demand model where possible.

The development of the base year highway networks is detailed within Section 6 of the LLITM 2014

Section 7 – Public Transport Passenger Demand

7.1 Overview

7.1.1 The public transport matrix development process for LLITM 2014 Base will be built using a combination of MS Excel, MS Access and Emme transport modelling software, and will be controlled by macros to ensure transparency and repeatability. Separate and different processes will be developed for bus and rail trips.

7.1.2 There is little available guidance or consensus regarding the best methods for building public transport matrices. We will seek to use all available data as well as possible, placing higher confidence in data with less survey error and data with larger sample sizes.

7.2 Data Availability and Use

7.2.1 The following data sources are or will be available for constructing public transport matrices:

- bus passenger interview data in urban centres collected in 2014;
- bus passenger counts, boarding and alighting in urban centres and flow exiting and entering main urban areas, collected in 2013 and 2014;
- bus passenger ticket sales data, collected in 2014;
- National Travel Survey (NTS) data for the East Midlands and National Rail Travel Survey (NRTS) data for Leicestershire. NTS is for 2002 to 2012 and NRTS from 2005;
- rail ticket sales data, LENNON, for Leicestershire, for 2008 or 2013, depending on availability;
- rail passenger boarding and alighting counts, collected in 2014, at major railway stations in Leicestershire; and
- Leicestershire household survey data, collected in 2009.

7.3 Demand Matrix Requirements

7.3.1 The bus and rail matrices for LLITM will be developed as two-legged tour matrices for home-based purposes, stored in production-attraction (PA) format, and as trip matrices for non-home-based purposes, stored in origin-destination (OD) format. A “tour” is defined as a pair of journeys, from home and then back to home again, linked together.

7.3.2 The representation of tours and PA format has no direct relevance for the public transport assignment model, which will assign OD people. The PA tours for home-based purpose are of importance for the demand model, their use having the following key properties:

- ensuring that the representation of home and non-home related land-use patterns are appropriately represented in the demand model, through the linkage of homes to trip productions rather than origins;
- the enabling of from-home and to-home legs of individuals’ daily travel to be linked, ensuring that both legs of the tour will be sensitive to the travel costs of each direction of travel; and
- ensuring that the from-home and to-home legs use the same main mode(s) of travel.

7.3.3 The tour matrices will be formed of 15 time period pairs defining the time of the from-home and to-home legs of the tour constituting a 24-hour average neutral weekday in 2014 (assuming the time periods as defined in Paragraph 4.4.2, noting that these are subject to change).

7.3.4 Table 7.1 shows the time period pairs to be modelled, based on the assumption that a to-home leg will not occur in an earlier time period than the from-home leg; hence the return leg is assumed to occur within the same day. This assumption removes 10 permutations (shaded grey), which will reduce data storage and run time requirements by 40%.

Table 7.1: Time Period Pairs for Matrix Building

Outbound \ Return	Off-Peak E	AM Peak	Interpeak	PM Peak	Off-Peak L
Off-Peak Early					
AM Peak					
Interpeak					
PM Peak					
Off-Peak Late					

7.3.5 Since non-home-based trips cannot so easily be classified into simple tours, these will be represented as single-leg trip matrices for each of the five time periods, stored in OD format.

7.3.6 The demand matrices will be developed for the journey purposes shown in Table 7.2.

Table 7.2: Journey Purposes, Public Transport

Representation	Purpose
Home-Based (Tours)	Commuting
	Education
	Employers' Business
	Shopping
	Other
Non-Home-Based (Trips)	Employers' Business
	Other

7.3.7 The matrices will then be further segmented by household income and car availability. Income data may not be available from the passenger interviews or ticket sales data, so the split will be applied following the main process to create matrices by purpose and time period using NTS and NRTS data. Car availability data may be taken from the passenger interviews, but this is likely to be applied at a more aggregate level as a post-build process rather than the matrices being built separately by car-availabilities.

7.4 Rail Demand Matrices – Overview

7.4.1 The process for constructing rail demand will be as follows:

- Create origin-station to destination-station rail matrices for the whole country using LENNON data.
- Use the LLITM survey data and / or NRTS, along with zonal population and employment data to run an access / egress model to adjust the LENNON trip-ends within Leicestershire so that they represent ultimate trip-ends rather than stations. This will distribute trip-ends within station "catchment areas" as a function of access costs and population / attraction factors.
- Apply NRTS data to derive splits by time period pairs and purpose, and NTS data to derive splits by income and car availability.

7.4.2 A synthetic gravity model is considered unnecessary, as both LENNON and NRTS are in principle complete representations of rail demand. A matrix estimation process is also thought to be unnecessary, as the matrix build process should ensure that total passengers using each station are broadly correct. Any failure to reproduce patronage would suggest that either the assignment needed adjusting or that the catchment areas used for the access / egress model were poorly chosen, and would therefore be corrected by adjusting one of these processes.

7.5 LENNON Data

7.5.1 It is intended to obtain LENNON data for 2013 or 2014 for the LLITM 2014 Base rail demand. If this is unavailable, the original 2008 LENNON data will be expanded to account for rail growth between 2008 and 2014, subject to agreement that this data source is appropriate for use in LLITM 2014 Base.

7.5.2 LENNON ticket data for the whole country for September and October 2008 were available previously. These comprised 1,649,052 records (a record contains all tickets sold of a specific type between two specific stations, so there are many more trips than records), 652 different ticket types and 632,040 unique station pairs. These were a complete representation of all tickets sold and were used as the starting point for matrix construction. Should 2013 / 2014 data be available but more limited (e.g. Leicestershire only), we assume that 2008 data would be used to fill in the gaps.

7.5.3 Ticket sales must be converted to trips / tours made. In particular, it is necessary to estimate the number of trips made by season tickets. Estimates of total trips made per ticket issued, by ticket type, were required to create the matrices initially. For each ticket type in the LENNON database a decision will be made on whether this related to a single trip or a tour, and the number of trips that the ticket entitles the customer to over the duration of its validity. Most of these estimates will be acquired from databases that were already at our disposal; some may need to be filled in logically.

7.5.4 In order to produce average weekday trip and tour rail demand matrices, it will be necessary to allocate stations to model zones, before tabulating the data.

7.6 Rail Access / Egress Model

7.6.1 As LENNON data represent trips from station to station, and the demand matrices must represent travellers' ultimate origins and destinations (and subsequently productions and attractions), it will be necessary to distribute demand over access / egress zones. It will be assumed, principally on the basis of zone size, that for trip-ends outside of Leicestershire, the station zone and the actual origin / destination zone are the same. For trip-ends within Leicestershire, a gravity model will be constructed as follows to distribute trip-ends:

$$D_{ijab} = D_{ab} k_{ab} P_i A_j * \left(d_{ia}^{(\lambda_{l1}-1)} e^{\mu_{l1} d_{ia}} \right) * \left(d_{jb}^{(\lambda_{l2}-1)} e^{\mu_{l2} d_{jb}} \right)$$

where:

- i is the origin zone;
- j is the destination zone;
- a is the origin station zone (from LENNON data);
- b is the destination station zone (from LENNON data);
- D_{ab} is the demand (from LENNON data);
- P_i and A_j are the production and attraction factors, equal to population plus employment (persons plus jobs) by zone. P_i and A_j are assumed to be the same, as we are distributing an all-purpose matrix;
- d_{ia} is the distance from origin zone i to origin station a;
- λ_{l1} and μ_{l1} are calibrated parameters for access, by trip length (from a to b) band l;
- λ_{l2} and μ_{l2} are calibrated parameters for egress, by trip length (from a to b) band l; and
- k_{ab} are factors to control total demand from a to b to the total in the LENNON matrix.

7.6.2 Demand will then be aggregated over i and j: the final demand matrices will not be stored by origin and destination station, so:

$$D_{ij} = \sum_{ab} D_{ijab}$$

7.6.3 i and j will be considered for a given a and b only if they fall into a defined "catchment area" for each station. In the case of external zones, a stations catchment area will be its own zone only; in the case of Leicestershire zones, it will be a larger area around the station. All Leicestershire zones will be within the catchment area of at least one station.

7.6.4 λ and μ parameters for distance will be calibrated, by length of rail trip, using NRTS data.

7.7 Rail Matrix Splitting

7.7.1 LENNON data contain tickets sold by type, issuing station, origin station and destination station but lack the following:

- trip purpose; and
- time periods of outgoing and return trips.

7.7.2 NRTS data will be used to apply splits by time period pair and journey purpose. These will be calculated by trip length bands, and by production sector within Leicestershire.

7.8 Bus Demand Matrices – Overview

7.8.1 The bus matrix build process for LLITM 2014 Base will be as follows:

- Electronic Ticket Machine (ETM) data will be processed to create a series of stop to stop matrices of demand for each service. This will involve estimating alighting points for ticket types that lack this information, which will be done with reference to the distribution of alighting points for those tickets for which this information is available.
- These will be converted to zones using catchment areas for each stop, estimated based on a typical maximum walk distance of a few hundred metres to a bus stop. The distribution among zones will be based on land-use/ trip-end data.
- The data will already be by time period. They will be split based on returning periods and purpose of travel using the passenger interview data and the National Travel Survey.
- Passengers travelling on services operated by operators for which no ETM data exist will be estimated using counts and passenger interview data.

7.9 Bus Passenger Interviews

7.9.1 Bus passenger interviews are expected to contain almost all information required to create transport model matrices, including origins, destinations, travel times, return times, journey purpose and car availability. They may lack income data which may have to be filled in using NTS data as a final step at the end of the process.

7.9.2 However, the interviews will only cover a portion of bus trips in Leicester and Leicestershire. It is expected that a slight majority of tours will be intercepted by the interviews (clearly the interviews will be only of a sample of the intercepted journeys, however), due to their location in urban centres, to and from which most bus travel occurs.

7.9.3 However, the sample size is expected to be very low by comparison with the ETM ticket sales data, and the sample that is interviewed will be biased in favour of longer trips. Interviews often lack reliable (or at least precise) geographic details for at least one end of the trip as interviewees understandably are often unable to supply a postcode for the non-home end of their trip.

7.9.4 The precise methodology for building the bus demand matrices will need to be refined following further work, as Leicester and Leicestershire ticket sales data have not been used for this purpose previously. A detailed specification note will be provided.

7.10 ETM Ticket Data

7.10.1 ETM data are expected to be available from the major bus operators in Leicester.

7.10.2 It will be necessary to match boarding points and services in the ETM data to surveyed boarding stops, stop clusters and services to enable it to be used in expanding interviews. Services in the ETM data will need to be mapped to services in the bus network. Boarding and alighting points will need to be matched to model zones or groups of zones. These mapping tasks will consume considerable time; automated processes will be considered to reduce this, but it is likely that complete manual checking of each mapping process will be required.

7.11 Unobserved Bus Trips

7.11.1 Any wholly unobserved movements (found in neither the ticket sales nor the interview data) will be infilled using a synthetic model. Bus service occupancies by time of day and other characteristics considered relevant will be estimated either from ticket data for other services, or, where available, from link count data. Trips will then be distributed using suitable functions, calibrated to the considerable quantity of observed data available, and making use of trip-end and cost data.

7.12 Matrix Estimation

7.12.1 As the rail matrices will be relatively simple to produce, representing, at a service level, movements between a small number of railway stations in Leicestershire, we do not expect to require matrix estimation techniques to improve the matrix quality. The observed boardings and alightings will be compared with those modelled, and any discrepancies considered individually and adjustments made to the matrix building process if considered appropriate.

7.12.2 Matrix adjustment is expected to be necessary for the bus matrices; to reconcile the matrices and the observed link flow counts. A tours-based matrix estimation is proposed, carried out using the 'gradient method' documented in *"A Gradient Approach For The O-D Matrix Adjustment Problem", Spiess, 1990*. The process can be adapted so that it estimates tour matrices rather than trip matrices (in effect estimating all time periods simultaneously). This will ensure that the estimated matrices remain wholly compatible with the original prior tour demand, and that no reconciliation step is required and no inconsistency between the supply and demand models is created.

The development of the base year demand matrices for rail and bus used within the model's

Section 8 – Public Transport Passenger Supply Models

8.1 Scope

8.1.1 The public transport supply model will represent four periods for an average neutral weekday in 2014, assumed to be, subject to confirmation:

- an AM peak period (07:00 to 10:00);
- an interpeak period (10:00 to 16:00);
- a PM peak period (16:00 to 19:00); and
- a four-hour off-peak period (06:00 to 07:00 and 19:00 to 22:00), with this period reflecting an absence of services at night.

8.1.2 It should be noted that the off-peak period will not be formally validated. It will be used solely to provide representative costs to the demand model for night-time (19:00 to 07:00) public transport demand.

8.1.3 The model will have several modes of transport, including public transport modes of 'bus', 'park-and-ride bus', 'coach' and 'rail', and access / egress / interchange modes 'walk' and 'car'. It will model three "user classes" with varying modes of travel enabled, as follows:

- bus passengers, who can use bus, park-and-ride bus, coach and walk;
- no-car-available rail passengers, who can use rail, bus, park-and-ride bus and walk; and
- car-available rail passengers, who can use rail, walk and car.

8.1.4 Allocation of demand among user classes will be undertaken by the demand model.

8.1.5 Consideration will also be given to distinguishing concessionary travellers from those who pay for bus fares. This decision will depend upon the foreseen applications for the model, as well as on the degree to which fares are considered to influence route choice. If adopted, the split will be a relatively simple one; we will not model entirely separate demand model segments for concessionary bus passengers, but split them relatively globally prior to the sub-mode choice model.

8.2 Networks and Services

8.2.1 The public transport supply representation will include several network components:

- a road network, taken directly from the SATURN highway model, which includes bus-only links and bus lanes, and converted to Emme format;
- a rail network, coded for LLITM 2014 Base using appropriate GIS data;
- a selection of walking routes, connecting the road network to the rail network and providing additional connectivity in urban centres; this will be coded for LLITM 2014 Base, with reference to the LLITM network; and
- zone connectors, for assigning public transport passengers to the network; these will be coded manually with reference to GIS and land-use data.

8.2.2 It will also include a representation of public transport services on these networks:

- all bus services that pass through Leicester and / or Leicestershire, derived from TransXChange-format data provided by LCC for a suitable period in a neutral month in 2014;
- all rail services that pass through Leicester and/or Leicestershire, derived from inspection of the National Rail Enquiries website or published timetables for 2014;
- a representation of coach services passing through Leicester and Leicestershire; this will be derived from 2011 National Public Transport Data Repository (NPTDR) data, unless some more recent source can be acquired; and
- a strategic representation of rail service frequency on rail corridors immediately outside Leicestershire and on main strategic routes throughout Britain.

8.2.3 The coding of many of these components is discussed in more detail in the following sections. A public transport model coding manual will be prepared in advance of the work to specify how the services and network will be coded in Emme and to ensure consistency.

8.3 Public Transport Fares

8.3.1 Estimates of fares paid will be required in LLITM 2014 Base. These will probably be modelled at a network level, such as to influence route-choice; they will certainly be required for the demand modelling.

8.3.2 We will develop new fare functions for LLITM 2014 Base. Three functions will be prepared, for rail, bus, and park-and-ride bus. The fare functions will be based on average fares actually paid per trip, including all forms of concession and discount.

8.3.3 The appropriate information should be available from ticket sales data for rail and bus trips. For park-and-ride bus, we will consider using specific information to the Leicester park-and-ride services if it is suitably detailed. If not, we will assume the same function as ordinary buses; the functions will still be distinguished to allow different assumptions about fare changes over time to be represented.

8.3.4 For coach services, ticket sales data are not expected to be available. A suitable function will be estimated based on operator website searches, including consideration of available discounts.

8.3.5 We expect to create functions based on service boardings and distance travelled. The function of distance is not expected to be linear; longer distance trips are generally cheaper per unit distance than shorter distance trips.

8.4 Assignment Principles

8.4.1 The LLITM 2014 Base public transport model will be a frequency-based model, incorporating fares in the assignment (and demand model). That is, it will represent the frequencies or headways of each service, but not the precise timetables, arrival and departure times. Like the highway model, it will be a static model, not taking account of the passage of time over the course of a passenger journey. For example, in a long journey, the time period and consequently running service patterns or frequencies could in principle change over the course of the journey.

8.4.2 A timetable approach, where each service has its precise timetable coded, is possible in Emme, but requires substantially more detailed data regarding desired departure times and is much more time-consuming to calibrate; given the relatively high frequencies of urban buses which are the focus of the model, it is not considered useful.

8.4.3 Assignment will be conducted on an “optimal strategy” basis, where the model calculates an optimal strategy for each destination at each node in the network, choosing services that take the traveller closer to their goal either representing the quickest service or providing a sufficient reduction in expected wait time to offset any increase in expected travel time.

8.4.4 This approach results in the creation of single optimal strategies for each journey and does not explicitly allow for any variation in personal preferences or level of information. However, it does not in general assign each traveller to a single path, as their strategy may result in boarding from a set of services, divided among them by the service frequency.

8.4.5 The approach makes the following implicit assumptions:

- that all travellers have complete knowledge of the service routes, interchange points, and frequencies;
- that travellers are, however, unaware of the precise arrival and departure times, and must decide as they encounter a service whether to board it or not (this is generally quite realistic in a congested urban context, as buses often do not adhere precisely to timetables, especially in peak periods);
- that at each network “node”, it is possible to observe service arrivals at that node only and not at any nearby nodes;
- that travellers seek to minimise their “generalised cost”, which includes walking times, in-vehicle times, waiting times, fares and boarding penalties, all with appropriate weights; and

- that services are, and that travellers know them to be, evenly spaced, so that if, for example, there are two services going in one direction, they will not always arrive together, but arrive half way between the intervals between each other.

8.4.6 This is an appropriate methodology for a relatively high frequency urban bus situation such as LLITM 2014 Base will be primarily modelling. It is generally poorer at assigning passengers to very low frequency services, such as long-distance coaches, but even here may perform suitably if there is no route choice anyway.

8.4.7 The approach requires assumption of weights and values for the various components of generalised cost:

- walking time;
- car access and egress time;
- waiting time;
- in-public-transport-vehicle time;
- fares; and
- boarding of services / interchanging.

8.4.8 These will largely be derived from WebTAG advice, though some of them, such as boarding penalties, can be adjusted as part of the model validation and calibration. The values may differ by the user classes discussed in Section 8.1.

8.4.9 The LLITM 2014 Base public transport model will not represent passenger crowding, that is, the discomfort associated with travel on crowded services, inability to get a seat, or inability to board a service through overcrowding resulting in increased waiting times. These are not generally considered significant for bus travel, and are typically only modelled on very busy rail services.

8.4.10 Assignment of rail passengers will require the model to favour rail over bus for these so that rail trips do actually use rail services in preference to bus where they are available. This will be achieved using suitable boarding penalties and / or in-vehicle time adjustments.

8.5 Rail Network

8.5.1 The rail network will be coded using GIS data showing rail lines in Britain. It will not include every railway line, only public passenger-serving railways in Leicester, Leicestershire and the immediate surroundings and the most strategic routes elsewhere. This is likely to include:

- the Midland Mainline from London to Derby, Nottingham and Sheffield, through Market Harborough, Leicester and Loughborough;
- Nuneaton to Peterborough, going through Hinckley, Leicester, Melton Mowbray and Oakham;
- Tamworth to Derby;
- Nottingham to Peterborough;
- the West Coast Mainline from London to Glasgow;
- the East Coast Mainline from London to Edinburgh; and
- other significant strategic movements required to ensure zone connectivity in the external network.

8.5.2 Key railway stations will be identified based on the zone system. This will include all 10 railway stations within Leicester and Leicestershire; outside the county more minor stations will not be included.

8.5.3 All services running through Leicestershire will be coded as accurately as possible with reference to the timetables and stopping patterns. Outside Leicestershire we will merely seek to ensure that connectivity and broad service frequencies are correct; the coding will not attempt to reproduce the stopping patterns precisely.

8.6 Bus Service Supply Data

8.6.1 TransXChange-format (or similar xml-format) data will be taken from the Traveline FTP server. These will cover all bus journeys Leicester and Leicestershire in 2014, detailing all timetabled arrival and departure times and stops for every service. We will select a suitable neutral weekday in the year and extract services for that day.

8.6.2 An automatic process will be applied, based on an updated process as used for the LLITM model, to process these data and convert them to a suitable format for use in the public transport model. This has three key steps:

- extract relevant services, during weekdays for the day selected, not specific to bank or school holidays, and allocate these services to model time periods;
- remove duplicate journeys, and combine journeys into modelled "transit lines", where the latter is a combination of service number, direction of travel, and stopping pattern; and
- allocate bus stops to nodes in the model network, and build travel times between nodes.

8.6.3 From previous experience in working with similar data, considerable effort will be required to remove duplicates and to ensure that services are not represented multiple times. An approach considered robust is to consider services duplicates where they share service numbers and have at least three identical stops with identical arrival times.

8.6.4 The allocation of bus stops to model nodes will involve finding the closest points of stop coordinates on model links, with reference to direction of travel where one-way links are modelled. The process may depend to some degree on the specified approach to modelling interaction between the bus and highway models.

8.6.5 TransXChange data do not explicitly record bus routes as such, but only the stops called at and their order. We will use Traveline East Midlands routeing data to check the allocated routeing in the public transport model if these can be obtained in GIS format; the checks will be prioritised according to the likelihood of there being routeing problems (for example, infrequent stopping services are more likely to need amending as there are fewer routeing data points in the TransXChange data.

8.6.6 Travel times will be derived from the published timetables. Some degree of congestion feedback over time, whereby increases in highway congestion are taken account of in the bus model, is required. We plan to adopt a matrix-based approach, where origin-destination movements by bus experience a comparable increase in delay to that observed in the highway model.

8.6.7 A network-based method, where highway congestion on links feeds directly into the bus model, while clearly more precise, has large implications for model complexity and development costs. It forces complete consistency between highway and public transport network models, which is both difficult to establish and still more difficult to maintain in scheme coding and model application. It is considered not be worth the development cost, unless specific appraisal of bus priority schemes such as bus lanes was desired, in which case it would be necessary.

8.7 Connectors, Walk Links and Access / Egress

8.7.1 Zone connectors will be required to load passenger demand onto the network. These will in general be fed into the centre of population in each zone. Connectors in external zones will be linked to the main railway station in the zone. One connector will be used per zone. Longer distance access and egress will be modelled on the road and limited pedestrian network itself.

8.7.2 Travel times on connectors will be estimated by zone type. Internal urban zones will be assigned a suitable short walk distance (of the order of 300 metres). External zones will have static connector times of the order of half an hour. These times and distances will be derived with reference to survey data where possible (household survey, NTS, possibly passenger surveys); they are of limited importance to the model as such since they cannot affect routeing or demand model choices.

8.7.3 Walk-only links will be added in urban centres; these will be coded with reference to the LLITM model and to GIS mapping as available. LCC will be consulted on the coverage.

8.7.4 Access to and egress from public transport services will be modelled using two modes: walk and car. Car will be available, to car-available rail passengers only, on all non-bus-exclusive road links, respecting one-way roads, and walk on all non-rail links, ignoring one-way allocations. Suitable fixed average speeds will be used, for example, 4 kph for walk and 30 kph for car. The walk mode will still be available for car-available rail passengers, who will use it to walk from the road network to the rail network (as in walking from the car park to the platform).

8.8 Network Checking and Validation

8.8.1 Two levels of checking will be carried out on the public transport networks, as follows:

- Service Validation: The coded services will be checked against existing services and timetables to ensure they are represented accurately.
- Assignment Validation: Route choices through the network will be checked to ensure that the assignment actually allocates passengers to realistic routes and services.

8.8.2 The service checking for bus services will be carried out by defining a structured checking procedure to check services converted from TransXChange data and comparing them to published online timetables. We assume that we will use Traveline East Midlands routeing data to check the allocated routeing in the public transport model if these can be obtained in GIS format; the checks will be prioritised according to the likelihood of there being routeing problems (for example, infrequent stopping services are more likely to need amending as there are fewer routeing data points in the TransXChange data). We will also seek local, independent checks on the coded services from LCC as part of this review.

8.8.3 This will serve as a check both on the accuracy of the TransXChange data and the robustness of our conversion of the data to Emme format. If any discrepancies are observed, we will attempt to correct these in a generic way (thus hopefully addressing any other similar errors), and a new set of services will be selected for checking. This process will be repeated until the random set of services contains no significant errors.

8.8.4 For rail services, the coding will be checked by a second, independent, staff member, not involved in the original coding, who will compare the coded services with the timetables. All services in Leicestershire will be checked, along with a sample of strategic routes outside the county.

8.8.5 Assignment validation will begin with of selection of a sample of plausible origin to destination journeys, ideally with reference to the demand matrices to ensure the validation focuses on trips that are actually made in practice. These journeys will be assessed in the model with reference to both an online journey planner and to broad plausibility.

8.8.6 In addition to checking the validity of modelled routes, the analysis will ensure that any journeys for which usage of rail is at all practical are assigned to rail usage for the "rail passenger" user classes, thus allowing the demand model to allocate demand between bus and rail where appropriate.

The development of the base year networks for the public transport model contained within LLITM

Section 9 – Demand and Trip-End Models

9.1 Overview

9.1.1 The LLITM 2014 Base demand model will forecast traveller demand based on three main inputs:

- the 2014 base year demand, developed from observed data, described in Section 5 and Section 7;
- trip-end data, supplied by the trip-end model (described in Section 9.3 below), derived from land-use data from the land-use model; and
- generalised costs of travel by each mode, produced by the highway and public transport supply models described in Section 6 and Section 8.

9.1.2 It will be an **incremental hierarchical logit model**, as described in WebTAG. By "incremental" we mean that it will forecast changes in base year demand derived from observed data based on changes in the cost of travel; this contrasts with an "absolute" model which forecasts demand from scratch based on the absolute costs of travel.

9.1.3 The demand model will be based primarily on two-legged "tours", linked outbound and returning trips, which will be processed as single entities. Thus outbound and returning travel responses will be linked, so for example, an intervention which penalises commuting traffic in the morning will also have an effect upon returning traffic in the evening. Freight demand will be modelled as single-leg trips.

9.2 Segmentation

9.2.1 The demand model will be more-heavily segmented than the supply models. Fifteen time-period pairs (where the pair represent the outbound and returning time periods), as shown in Table 5.1, will be used.

9.2.2 The demand model will consider six modes of travel:

- car;
- park-and-ride (car-bus mixed-mode);
- rail;
- bus and coach;
- active mode (walk and cycle); and
- freight: LGV and HGV.

9.2.3 It will model six person types, based on two categories of household car-availability (available or not available) and three categories of household income (banded into low, medium and high).

9.2.4 Finally, five travel purposes will be modelled, as follows:

- commuting;
- shopping;
- employers' business;
- education; and
- other.

9.2.5 Not all categories of segmentation will apply everywhere. Freight trips will be divided solely into Light Goods Vehicles (LGVs) and Heavy Goods Vehicles (HGVs), and not further segmented by purpose, mode or person type. Employers' business trips will not be segmented by income because they are already very price-insensitive. Car-availability will only be used in the mode-choice model, not in choosing a travellers' time period or destination.

9.3 Trip-End Model and Matrix Balancing

9.3.1 The trip-end model's purpose is to use land-use data, populations and employment by category, to estimate trips produced and attracted to each model zone by purpose, using suitable trip rates.

9.3.2 The LLITM 2014 Base trip-end model will be based on the DfT's National Trip-End Model (NTEM) software CTripEnd. This will be modified to work in the LLITM 2014 Base zoning system and to allow it to run automatically as part of the model suite. Land-use data will be taken from the LLITM 2014 Base land-use model in normal operation.

9.3.3 It will be necessary to estimate trip-ends for freight travel. CTripEnd only produces trip rates and trip-ends for personal travel, so this will require an additional process. Freight trip rates will be obtained from TRICS and applied to the employment data; this process will be incorporated into the trip-end model.

9.3.4 Explicit provision will be made in the trip-end model for East Midlands Airport. CTripEnd does not calculate demand separately for airports and consequently does not generally produce plausible trip forecasts for airport passengers and employment. A process will be put in place to ensure airport trip-ends are at an appropriate scale; they will remain functions of airport employment, but trip-rates specific to the airport will be used.

9.3.5 CTripEnd calculates trip-ends by outbound time period, by mode, by car-availability and by purpose. The outputs lack two required data for the demand model segmentation:

- income level; and
- returning time period (i.e. CTripEnd does not fully categorise trip-ends into tours).

9.3.6 Data will be extracted from CTripEnd at a 24-hour level, allowing the base year matrix proportions to split demand back to time periods, so the lack of a return time period does not concern us. The income band will be obtained by splitting the trip-ends with reference to the input land-use data (which do contain indicators of income based on socio-economic level, household size and employment status), taking account of differences in trip-rates by income. This will ensure that income and car-availability are forecast to vary sensibly over time.

9.3.7 Following derivation of trip-ends, "reference" demand will be produced for input to the demand models. The reference demand represents trips adjusted from the base year to account for increases in and changes in the makeup of population and employment, but not yet adjusted to account for any changes in the cost of travel.

9.3.8 Future year model trip-ends will be derived by calculating the forecast change in trip-ends from CTripEnd and applying to the trip-ends in the base year model (the LLITM 2014 Base trip-ends and CTripEnd trip-ends will not be the same due to local observed data that will be used in the model). Reference demand will be obtained by running a matrix balancing procedure on the base 2014 matrices using the future year model trip-ends. This consists of repeatedly factoring the matrix rows and columns until both match the required trip-ends.

9.3.9 New developments will require special treatment in deriving robust estimates of reference demand, since the base matrices will not necessarily contain reasonable initial distributions. Gravity models will be used for this purpose, to produce reasonable initial distributions of travel to and from developments based on travel times and distances and locations of nearby employment and population.

9.3.10 The trip-end model will be based on the most recent available release of NTEM and CTripEnd software at the start of project. It will be capable of forecasting up to 2051.

9.4 Generalised Cost

9.4.1 The demand models require forecasts of the "generalised cost" of travel to make adjustments to the patterns of travel. These costs include monetary costs, but also travel times and perceived penalties with appropriate weights varying by mode, purpose and person type. Generalised costs, despite the name, are usually presented in time units, minutes in the case of LLITM 2014 Base.

9.4.2 Generalised cost of travel will be built up as follows:

$$\mathrm{GenCost_{Highway}} = \mathrm{t_t} + \mathrm{t_s} + \left(\frac{\mathrm{M_F} + \mathrm{M_O} + \mathrm{M_T}}{\mathrm{V} * \mathrm{O}}\right) + \mathrm{f_a t_a}$$

$$\mathrm{GenCost_{Bus/Rail}} = \mathrm{t_t} + \mathrm{t_h} + \mathrm{f_w t_w} + \mathrm{f_a t_a} + \left(\frac{\mathrm{M_T}}{\mathrm{V}}\right)$$

$$\mathrm{GenCost_{Active}} = \mathrm{t_a}$$

$$\mathrm{GenCost^{ij}_{ParkRide}} = \mathrm{GenCost^{ip}_{Highway}} + \mathrm{GenCost^{pj}_{Bus}}$$

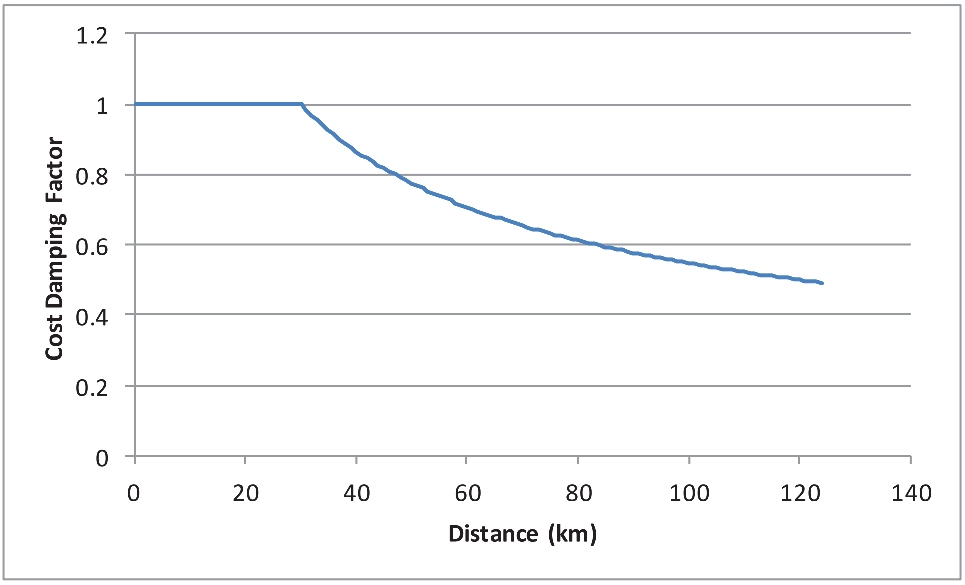
where:

- $M_F = p_F * l * i * \left(\frac{f_a}{v} + f_b + f_c v + f_d v^2\right)$ is the monetary cost of fuel, where:
  - P_F is the fuel price (pence per litre)
  - l is the assigned distance;
  - i is the fuel improvement factor, which reduces fuel consumption over time;
  - f_a, f_b, f_c and f_d are the fuel consumption parameters defined within WebTAG; and
  - v is the average assigned speed for the movement (in kph).
- $M_O = l * \left(n_a + \frac{n_b}{v}\right)$ is the monetary non-fuel costs, which is assumed to be non-zero for business and freight trips only, and n_a and n_b are non-fuel cost parameters from WebTAG;
- M_T is the monetary cost of all tolls and charges (including parking charges and public transport areas);
- t_t is the travel time, which is the timetables in-vehicle time for public transport;
- t_s is the search time for a parking space;
- f_a is the weighting factor for active mode legs of mixed mode trips, initially assumed to be 2;
- t_a is the walk time, derived approximately from a shortest path assignment of walk trips on the bus network with an assumed, fixed average walk speed;
- t_h is the delay time to (non-timetabled) highway congestion for bus and coach trips;
- f_w is the weighting applied to waiting time for public transport trips, initially assumed to be 2;
- t_w is the waiting time for public transport services;
- V is the value of time for a given demand segment (in pence per minute); and
- O is the average vehicle occupancy.

9.4.3 Generalised costs for long-distance trips will be reduced using “cost damping” procedures to reduce the sensitivity of long-distance trips to proportionally small changes in cost. This will be done following WebTAG advice. Two processes will be used; one to damp all components of generalised cost and one to increase values of time with distance (in effect to damp monetary components of cost only).

9.4.4 A function showing the factors that might be applied to generalised cost based on trip distance is shown below; this is illustrative only. The process will ensure that longer trips continue to experience larger costs; the damping process causes this relationship to be non-linear, but still increasing.

Figure 9.1: Illustrative Cost Damping Function



9.5 Active Modes

9.5.1 The demand model will forecast and require generalised cost for active mode travel- that is walking and cycling trips. We do not propose to build validated walking and cycling models using detailed observed data, as such data do not currently exist and is difficult to collect and routeing choices for pedestrians are not well understood.

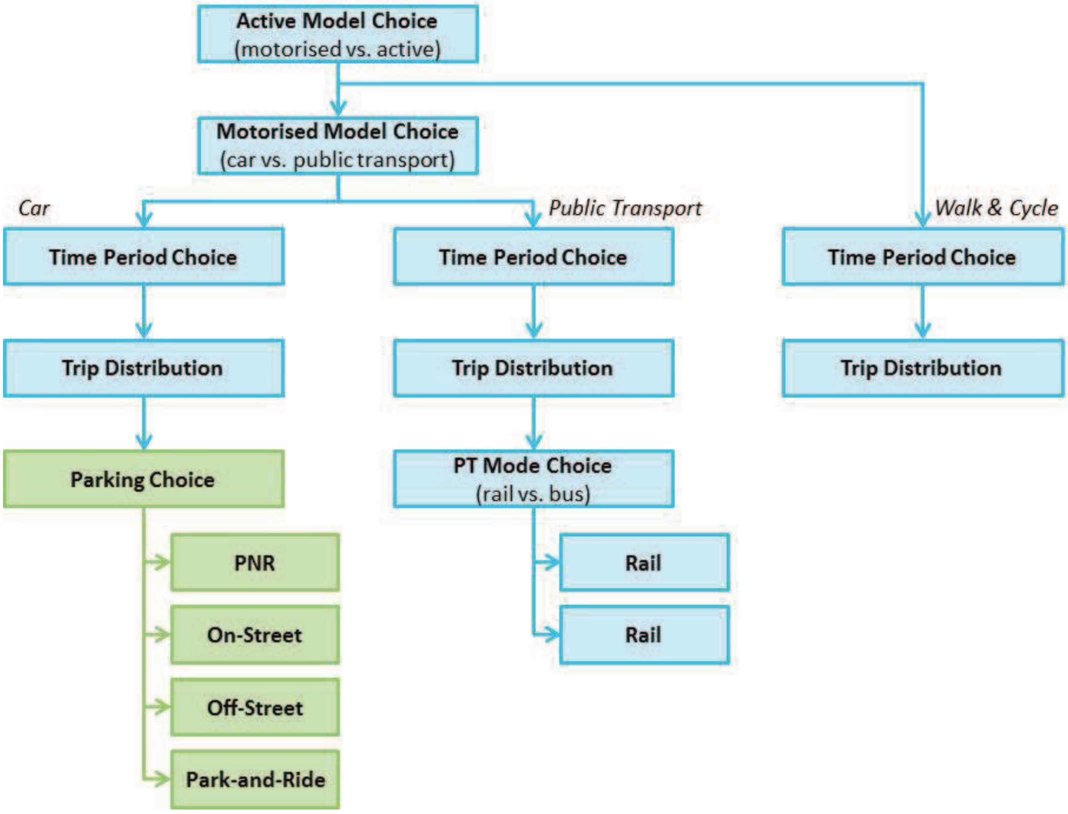
9.5.2 Accordingly, we will construct a simple walking model using the public transport assignment model with only the “walk” mode enabled. This will allow reasonable estimates of zone-to-zone walk times to be produced, which will be used to calculate generalised costs for active mode.

9.6 Choice Models

9.6.1 LLITM 2014 Base will be a hierarchical demand model, comprising several traveller choice models applied sequentially to transport demand. The hierarchy is illustrated in Figure 9.2. Two different forms of model will be used. Most choice models (blue) will be incremental, adjusting the reference matrices and proportions. The parking model will an absolute model (green), estimating proportions from scratch.

9.6.2 The scope of the parking model component is discussed in Section 9.7 below.

Figure 9.2: Indicative LLITM 2014 Base Demand Model Choice Structure



9.6.3 No-car available demand will not be permitted to choose a car mode, so the motorised mode choice for such persons will allocate all demand to public transport. Freight demand will use a significantly simplified structure with only time period choice and trip distribution.

9.6.4 All choice models will be logit-based, functions of the form:

$$\widehat{D}_{pmtui*} = \widehat{D}_{pm**i*} \frac{D_{pmtui*}e^{-\lambda_t \Delta C_{pmtui*}}}{\sum_{tu}\left(D_{pmtui*}e^{-\lambda_t \Delta C_{pmtui*}}\right)}$$

9.6.5 The example above is a model forecasting demand D for time period choice, allocating input demand ($pm ** i *$) among outbound and return time periods t and u based on the changes in generalised cost (ΔC). The lambda (λ) values are model sensitivities, derived from the LLITM household survey to represent as well as possible travellers' actual sensitivity to cost changes.

9.6.6 The mode choice models allocate demand among two options each; the time period choice models among fifteen time period pairs, and the distribution models among as many attraction zones as there are in the model zone system.

9.6.7 The models will make use of "composite costs", a form of average over options. For example, the time period choice model will use as inputs generalised cost changes by production zone, aggregated over all attraction zones. The expressions for calculating these (simple demand-weighted averages would not be correct), are of the form:

$$\Delta C_{pmtui*} = log_e\left(\frac{\sum_j D_{pmtuij}e^{-\lambda_d \Delta C_{ptmuij}}}{\sum_j D_{pmtuij}}\right)$$

9.6.8 This expression calculates "average" cost changes ΔC over all attraction zones j. The cost changes are weighted by demand D, but are not a simple weighted average.

9.7 Parking Model

9.7.1 LLITM 2014 Base will represent parking costs in major urban areas, namely the centres of Leicester and Loughborough. As part of this process, it will contain a choice model to divide travellers into a few types of parking, including Private Non-Residential (PNR), on-street parking, off-street parking and park-and-ride (P&R).

9.7.2 Park-and-ride travel will be modelled in a slightly more complex way, so that a park-and-ride tour in the demand model will generate both two trips in the highway assignment model (between the trip production and the park-and-ride site), and two trips in the public transport assignment model (between the park-and-ride site and the trip attraction). Similarly the generalised cost for park-and-ride travel will be an appropriate combination of the highway and public transport cost.

9.8 Iteration and Convergence

9.8.1 The highway and public transport supply models and the demand model will be run in sequence iteratively until LLITM 2014 Base is deemed to have converged (discussed below). The costs from the supply models and functions will be fed into the demand calculations, with the resulting demand used to recalculate the costs in the supply models. This process continues until model convergence has been achieved.

9.8.2 Demand smoothing will be used to ensure that LLITM 2014 Base and the network models reach a convergent state. Demand matrices are assigned in the supply models, which generate costs to be used in the demand model. Following choice model calculations, new demand is calculated, from which the **%Gap convergence** measure is calculated prior to the averaging process which is then applied to the demand matrices. These averaged demand matrices are reassigned in the supply models in the next iteration of the overall LLITM suite.

9.8.3 The demand smoothing will use the following function, a variation of the method of successive averages (MSA) algorithm that we have used in existing demand models:

$$\widehat{D}_{X+1} = \frac{2D_X}{X-1} + \frac{(X-3)\widehat{D}_X}{X-1}$$

where:

- X is the current iteration of LLITM;
- $\widehat{D}_X$ is the averaged demand matrix used as input to the supply models in iteration X.
- D_X is the demand matrix produced by the demand model in iteration X.

9.8.4 The measure of convergence of the demand and supply models is the demand-supply gap, as defined in WebTAG Unit M2. The %Gap is calculated as follows:

$$\%Gap = \frac{\sum_{pmtuij} C\left(D_{pmtuij}\right) * \left|D_{pmtuij} - D\left(C\left(D_{pmtuij}\right)\right)\right| * 100}{\sum_{pmtuij} C\left(D_{pmtuij}\right) * D_{pmtuij}}$$

where:

- D_{pmtuij} is the production-attraction demand;
- $C(D_{pmtuij})$ is the production-attraction generalised cost generated by the assignment of D_{pmtuij} on the network;
- $D(C(D_{pmtuij}))$ is the production-attraction demand generated by the demand model in response to the cost changes created from $C(D_{pmtuij})$; and
- p is the demand segment (purpose and person type), m is the mode, t and u are the outbound and return time periods, and i and j are the production and attraction zones.

9.8.5 The %Gap will be calculated across all of the person demand segments, as well as LGV and HGV, for each of the time periods and for all modes. WebTAG guidance suggests that a convergence gap of 0.1 is should be the target value. The value that is adopted will be influenced by the convergence of the SATURN highway models, but should be around this level.

9.8.6 We will evaluate the convergence gap for a subset of the demand matrix. Previous experience suggests that it is quite common for the external demand, which will constitute the vast majority of total demand, the matrix representing the whole country as it does, to stabilise very quickly, leading to a very low convergence gap, while the demand in the modelled area (which is what is really of concern) has not reached a reasonable level of convergence. We have previously used demand with a production end in the internal area as a sub-matrix for evaluation of convergence, and will use this in LLITM 2014 Base.

9.9 Calibration and Realism Testing

9.9.1 We will calibrate LLITM 2014 Base following WebTAG, such that its response to cost changes is at an acceptable and reasonable level. In particular, we will aim to achieve the following:

- an elasticity of car vehicle kilometres with respect to car fuel cost of around -0.3;
- an elasticity of car trips with respect to car journey time of more than -2, ideally much closer to 0 than -2;
- an elasticity of public transport trips with respect to fare of -0.2 to -0.9; and
- an elasticity of parking usage with respect to charges of the order of -0.2 to -0.6.

9.9.2 All of these tests will be conducted in the base year of 2014. Following WebTAG advice, the car journey time elasticity test will be carried out using a single demand-supply iteration; all other tests will be iterated to convergence; this is consistent with WebTAG.

9.9.3 In addition to the required WebTAG realism tests on the model's sensitivity to changes in cost, we will also undertake a series of sensitivity/demonstration tests of the model in forecasting mode. These demonstration tests will review the model's responses to changes in land-use, highway and public transport assumptions in forecast years. These demonstration tests are discussed in Section 11.2.

The implementation and calibration of the variable demand model contained within LLITM 2014 Base

Section 10 – Land-Use Model

10.1 Context

10.1.1 The LLITM 2014 Base land-use model will forecast population and employment by model zone and by household and employment type. It will be based on the existing land-use model used in the existing version of LLITM.

10.1.2 In preparing a set of model enhancements we are conscious that the model should be fit for purpose and that primarily it must meet both LCC and Leicester City Council's transportation planning needs. This includes the need to understand:

- the impacts of land-use developments upon the immediate transport networks; and
- the impacts of development strategies (for example, the LDF's Core Strategies) upon the wider transport network.

10.1.3 We note that the Department for Transport has recently said that it is considering an increased use of Land-Use and Transport Interaction models (LUTI models). We will continue to monitor Central Government guidance and identify any changes that are required to comply with DfT advice.

10.1.4 In addition we believe that the model is a powerful tool for policy appraisal and that it has wider application then just transport-related work. We recognise that governance structures are currently evolving and that things may change over the course of the next 5-6 years. However we believe there are several potential applications of the model, either as a free standing land-use model or as a LUTI model. For example:

- to support the policy and strategy development within the Local Enterprise Partnership;
- to inform prioritisation of infrastructure investment across land-use, regeneration, transport and other public-sector funded infrastructure; and
- to provide forecasts of housing need and employment land need to inform the land-use planning process.

10.2 Enhancements to the LLLUM Database

10.2.1 The existing LLITM is largely based upon 2001 Census data and assumptions on the change that took place between that Census and the model's 2008 Base Year. The 2013 update identified incompatibilities between forecasts for 2011, based upon that base year database, and the initial 2011 Census results. Specifically the mix of household types that were input, into the base year database was incompatible with the 2011 Census household mix.

10.2.2 We will undertake an update to the base year database, which will:

- take account of recently published data (including the 2011 Census); and
- create a new base year of 2014.

10.2.3 In effect there will be a two-stage process. We will first create a 2011 base year database. Then we will run the model forward to 2014 taking account of development 2011-2014, changes in employment, population etc. to create a 2014 database. This will be a similar process to that undertaken for the original LLITM model where a 2001 base was first created and then this was used as the base for a model run through to 2008 and the creation of a new base year.

10.2.4 Table 10.1 sets out the main tasks we have identified that are required to update the database.

Table 10.1: Updates to LLITM Land-use Model Base Year Data

Database	Description	Task
Activity	Information upon both households and employment by type, at zone level	Update this information drawing upon the 2011 Census, BRES and other published sources for the period 2011-2014 We would propose to review and revise the household activities. The current disaggregation of households is based upon 1981 definitions. We would propose to change these to ensure consistency with the disaggregation used in the 2011 Census2011 Census tables. We would also look to include additional categories of activity to represent student households and population not in households. Student households are not explicitly modelled within LLITM currently (they are included within other household categories). Non-resident population is not currently modelled within LLITM but are clearly significant within parts of the County We would explore options to disaggregate the employment activities so that they are consistent with LEP priority sectors.
Floorspace	Information on the amount of floorspace by land-use type, including amount of floorspace, vacancy rates and rents, by zone	Update this information drawing upon the 2011 Census, the Council Tax Database, Valuation Office Data and other sources
Car Ownership	Information on car ownership by household type by zone	Update this information drawing upon the 2011 Census
Distance	Distance between zones	Recalculation of distance matrix, if a new zoning system is introduced
Environmental	Information on the zone-level environment	Range of sources can be used including extracts from the Index of Multiple Deprivation and Open Space database
Travel to Work database	Information on zone-to-zone flows	The 2011 Census travel to work data are unlikely to be made available until 2015 or later. In the short term a TTW database based upon the 2001 Census will be necessary. Once the 2011 data are available then this matrix will need to be reviewed and a revised version implemented if appropriate

10.2.5 The current definition of DELTA areas is based upon the 2001 Travel to Work Areas. These in turn are based upon the 2001 Census travel to work analysis. The timetable for the release of 2011 Census travel to work data, and any subsequent review of Travel to Work Areas means that there are not likely to be any 'final' revisions to the TTWAs within the timescale envisaged for this model development. We do not therefore propose to review DELTA areas at this point.

10.2.6 It is recommended that as and when new TTWAs are published that a review be undertaken of the changes and their likely impact were they to form the basis of new DELTA areas, within the LLITM 2014 Base land-use model.

10.2.7 We would seek agreement with LCC, at the outset, as to the sources of data that will be used for the updating of the LLITM land-use base year database. If local sources are identified by LCC then these should be made available at the outset of this work.

10.2.8 Within the work programme we would differentiate between:

- the updating of the base year database with information that is also required as input to the transport model development (for example, information on the numbers of households, population and employment within each zone); and
- the updating of the base year database with information that is required internally to the land-use model (for example, land-use, car ownership, the DELTA travel to work matrix).

10.3 Planning Inputs

10.3.1 The planning policy inputs inform the scale and distribution of future modelled development within the land-use model. With the current model version, development may only take place in zones where there are planning policy inputs. Further the total development cannot exceed the quantity input within the planning policy inputs.

10.3.2 The planning policy inputs within the current version of the model are based upon:

- the information captured in 2009/10 as part of the development of the existing land-use model; and
- a partial refresh of the data in 2012 that was limited to the main development sites identified within the emerging and approved LDFs.

10.3.3 We recommend a regular update of the planning policy inputs at 18-24 month intervals. This ensures that model application continues to be based upon the latest understanding of future development and reflects both the policies and other strategies of the local planning authorities across the County, and the anticipated development in those areas where there is high pressure for development and new applications are approved.

10.3.4 Two of the model enhancements described in Section 10.5 (modelling development viability and modelling of redevelopment and intensification) would require additional data to be collected as part of the collection of planning policy inputs. The specification of what information will be required will be drawn up at the outset (following agreement of what, if any, enhancements are to be implemented).

10.3.5 Within the work programme we would differentiate between:

- information on completions for the period 2011 to 2014; and
- information on development for the period post 2014.

10.3.6 The first of these will be required at an early stage in the work programme as this will inform the process of moving from a 2011 base year database (based upon 2011 Census data) to a 2014 base year database (to be used in the LLITM 2014 Base model). The latter will be required at a later stage of the work programme.

10.4 Scenarios

10.4.1 The model's demographic and economic scenarios determine:

- for population and household's the 'top-down' level of growth across the Modelled Area; and
- for the economy the broad level of growth within each DELTA area. They currently are based upon NTEM v6.2.

The land-use model scenario will be updated as and when updated NTEM forecasts are issued, to ensure that the model continues to be compliant with WebTAG.

10.4.2 We also recommend an alternative scenario, based upon LEP and / or Planning Authority forecasts. This would enable the model to be used to inform the LEP or Planning Authorities strategy development in a way that was consistent with their assumptions on future growth.

10.5 Model Functionality and Calibration

10.5.1 In this section we consider first the zones and forecasting time horizon applied within LLITM 2014 Base. Then we consider the introduction of functionality that we believe would be beneficial for LLITM

2014 Base (in meeting the user needs identified in Section 10.2 above). Finally we consider recalibration of the model.

10.5.2 A review of the zones will be undertaken (see Section 2.4). Any significant change will require:

- the creation of a new base year database (as described above); and
- the defining of a new set of DELTA areas and some recalculation of the area databases.

10.5.3 The forecast time horizon for the land-use model will be extended to 2051.

10.5.4 As with the existing land-use model, the model run time for the land-use model is relatively short; it is the transport model that requires heavy processing resource. An extension of the forecast horizon would extend run times for the full LUTI model, but it would continue to be the case that in most applications, the model would only be run for five or ten years post the modelled intervention in order to gauge the land-use impacts.

10.5.5 Table 10.2 summarises the key improvements to functionality that are anticipated.

Table 10.2: Updates to LLITM Land-use Model Functionality

Functionality	Description
Modelling of development viability	This enhancement introduces a viability test into the development process. This takes account of the development costs associated with site preparation and relates it to the returns to the developer. Sites with high preparation costs are unlikely to come forward. **Application**: the modelling of regeneration schemes. **Data requirements**: additional data required on site preparation costs.
Modelling of redevelopment and intensification	This enhancement allows underused floorspace to be redeveloped for alternative use (consistent with planning policy) and floorspace in areas of high demand to be redeveloped at a higher level of intensity. It permits the better modelling of the re-cycling of the built environment. It is particularly useful for ensuring that the model continues to model development (consistent with planning policy) beyond the end of the LDF plan period. **Data requirements:** additional data on local planning policy.
Modelling of Land as additional to floorspace	This enhancement relates to the development model. It would permit quantities of land to be input, within the planning inputs and for the model to determine the appropriate use and density of development. This would overcome the problem currently identified that many employment allocations are described in terms of hectares of land rather than floorspace of office, warehouse or industrial land (or specific use class designations). The model would select a preferred land-use based upon demand, and constrained to planning policy on what would be permitted on a site. It would also select a density of development based upon demand.
Location Modelling: distance deterrence	Currently the residential location model applies a distance deterrence function to ensure households may move cross DELTA area boundary. This enhancement would introduce a similar functionality for employment related land-uses. This would ensure that the model does not underestimate some short distance moves, for example, from Leicester to some of the adjacent Areas, when new employment floorspace is provided close to the Leicester Area but within the neighbouring DELTA areas
Disaggregation of generalised costs	A straightforward implementation that would split the Generalised Cost file into several files. Currently the file is of a size that is too large to open in many text editors. A series of smaller files would allow easier interrogation of the generalised costs and identification of problems as required.
Freight Modelling- what could be done with existing LLITM	DSC's PN8 set out a proposal for Freight modelling. This would base the flows of Freight upon LLLUM employment forecasts. Implementation of this would largely be within the transport model
Freight Modelling – what could be done with enhanced version	A more sophisticated modelling could be scoped. This might include: a) Application of elements of DSC's Regional Economic Model within LLLUM. This might include the modelling of goods and the basing of freight flows on goods rather than employment b) Better modelling of some of the large Freight generators (for example, the Distribution Centres) where activity may be driven by demand outside of the LLUM Modelled Area (i.e. movement of goods from Felixstowe to East Midlands, then transhipment to HGVs for movement elsewhere).
Model Outputs	A review of the model applications over the past three years has identified a number of model outputs that are frequently requested by clients. We would look to either standardise the outputs or refine EASE in order to provide this information.

10.6 Calibration and Model Review

10.6.1 The development of a new database will require a recalibration of the model. Previously the recalibration has been based upon a number of different sources. These include:

- published research where it is specific to the processes modelled within DELTA;
- the constraining of the model to generate outputs that are consistent with published research;
- local surveys; and
- professional judgement.

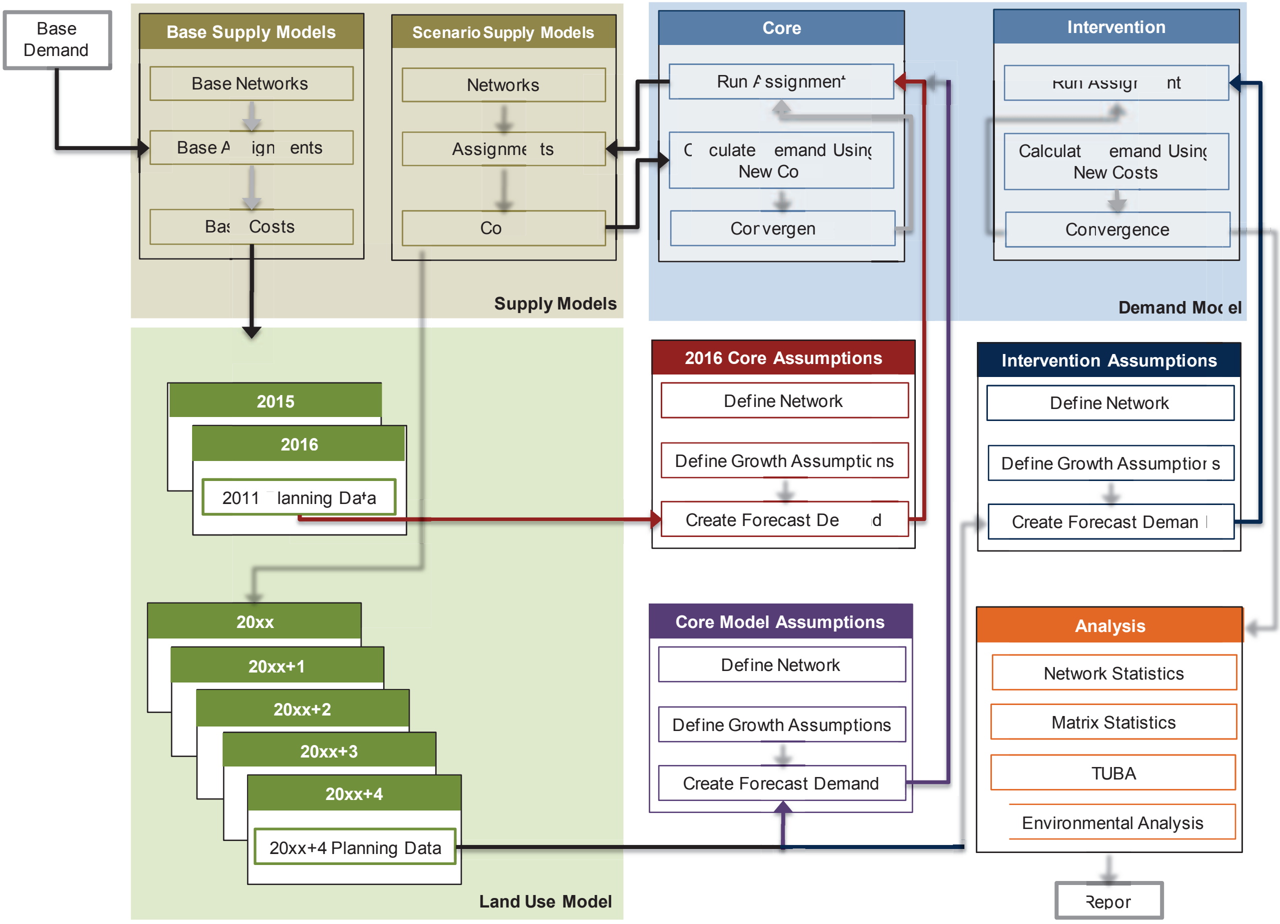
10.6.2 The interface between the land-use model and the transport model will require review following the change to the zone system.

Section 11 – Forecasting, Analysis and Handover

11.1 Forecasting Process

11.1.1 The operation of the LLITM 2014 Base suite for a forecast scenario is illustrated graphically below. The land-use-transport interaction will be modelled on a “time-delay” basis.

Figure 11.1: LLITM Forecasting Process



11.1.2 The base year 2014 transport model will be run to generate “base costs”. These will be supplied to the land-use model which will then run for 2015 and 2016, forecasting land-use planning data, which will be supplied to the 2016 transport model to estimate demand. The 2016 transport model will then be run, supplying generalised costs back to the land-use model to run land-use forecasts for 2017, 2018, 2019, 2020 and 2021, and the process repeated from 2021 to 2026, and in five year blocks thereafter to 2051.

11.1.3 In this way a transport model is run for every five years, while the land-use model is run between these transport model runs for every year. The five-yearly interaction represents the inevitable delay in response of population and employment locations in reacting to transport infrastructure changes.

11.1.4 Within the transport model, the trip-end model will be used to create forecast reference demand, the assignments will be run in the highway and public transport models, these will create costs which will be supplied to the demand model to calculate new demand and the demand supply loop will be iterated to convergence.

11.2 Demonstration Testing

11.2.1 As part of the model development, AECOM and DSC will carry out a set of tests to demonstrate that the model operates appropriately and forecasts plausible and realistic results. This will include the preparation of a series of future year core model runs, containing a “most likely” future scenario.

11.2.2 AECOM and LCC will agree a list of “schemes” to be included in the core model runs. These will include highway, public transport, residential, employment, active mode, “Smarter Choices” and parking interventions, and will include both new infrastructure and developments and removal of the same (for example, the cancelling of a bus service or closure of a parking site). This scheme list will then form a useful starting point for modelling work in LLITM 2014 Base, although it is expected that most model applications will require minor changes to scheme lists.

11.2.3 Public transport and highway networks, parking and active-mode inputs, and planning data will be prepared for each model year, including the appropriate schemes by year. The core models will be run through to the year 2051, the last model year that LLITM 2014 Base will forecast. This will involve eight transport model years.

11.2.4 The process will include an allowance for the calibration of “Smarter Choices” schemes; following WebTAG guidance these require iterative model runs to ensure the modelled response is appropriate.

11.3 Model Documentation

11.3.1 The following final project reports will be prepared, as follows:

- a Data Collection Report, outlining the data collected for the LLITM 2014 Base model development and the checks made to verify the data;
- a Highway Local Model Validation Report (LMVR), outlining the construction of the highway model and the validation and calibration performance;
- a Public Transport Local Model Validation Report (LMVR), outlining the construction of the public transport model and the validation and calibration performance;
- a Demand Model Report, outlining the construction of the demand and trip-end models and the realism testing and calibration performance;
- a Forecasting Report, detailing forecasting assumptions, core scheme list and summarising the core model forecasts;
- a Land-use Model Development Report;
- a Land-use Model Demonstration Report;
- a Land-use Model Forecasting Report;
- a Land-use Model Enhancements Demonstration Report;
- a LLITM 2014 Base User Guide, explaining the operation of the LLITM 2014 Base suite in practice; and
- a DELTA User Guide.

11.3.2 In addition to these reports, technical notes, including coding manuals for the highway and public transport models, will be produced starting early in the project programme to specify tasks in detail, as discussed in Section 2.2.

11.4 Environmental Analysis Suite (EASE)

11.4.1 The LLITM model included a tool designed to calculate environmental statistics, including carbon emissions, air quality emissions, road accidents, and noise, and to display these, along with results from the assignment and land-use models, in GIS software.

11.4.2 This EASE suite or a similar tool will be retained for LLITM 2014 Base. This will use the Emissions Factor Toolkit (EFT), published by Defra, to calculate carbon air quality emissions, and will estimate link-based noise and accidents following WebTAG and CoBA accident tables. The most recent available version of the EFT will be used. These and other useful link-based quantities, such as traffic flows, will be converted to GIS format to facilitate analysis.

11.4.3 The DfT now has an Excel (VBA)-based tool to assess accident savings, called CoBALT, which supersedes CoBA for this purpose. EASE in the existing LLITM contains an accident analysis module; we will replace this with CoBALT, seeking to integrate CoBALT within EASE.

11.5 Handover

11.5.1 The entire LLITM 2014 Base suite, including all data and processes, will be handed over to LCC, along with the core networks and inputs prepared for the demonstration testing. A user guide will be provided to inform users how to use the suite. AECOM will provide a day's handover session with suitable LCC staff, explaining the operation of the tool and its functionality.

A Forecasting Report has been produced based on the 'Core Scenario' assumptions regarding land-

Section 12 – Refinements Adopted for the PRTM

12.1 PRTM Refinements

12.1.1 As discussed in Section 1.1, the PRTM is an extension of the LLITM model, providing additional detail in the highway assignment model; all other model components are identical to LLITM.

12.1.2 The following outlines the key differences between PRTM and LLITM 2014 Base in terms of the highway assignment model:

- additional zone detail is represented outside Leicestershire;
- additional buffer network is represented outside Leicestershire, including the use of speed-flow curves on buffer network links in the enhancement area; and
- additional observed link flow and journey time data from Highways England's Midlands Regional Transport Model (MRTM).

12.1.3 The underlying demand data used within the highway model, developed primarily from mobile phone data, remains unchanged from LLITM 2014, with the highway demand disaggregated where additional zone detail is represented within PRTM. The observed traffic flow and journey time data used within Leicester and Leicestershire as part the highway model calibration and validation process is also unchanged, with additional data sourced from the MRTM used outside the county.

12.1.4 The additional zone and network detail has only been adopted in the highway assignment model, and therefore the public transport assignment model and demand model within PRTM operate using the LLITM 2014 zone system.

12.1.5 Figure 12.1 provides a comparison of the LLITM 2014 and PRTM zone systems as used within their respective highway assignment models. Where the red PRTM zone boundaries can be seen, these are areas where the PRTM zone system contains additional zone detail to that included within LLITM 2014. All the additional zone detail is outside Leicestershire, extending to around Bristol in the south-west and Hull in the north-east.

12.1.6 Figure 12.2 shows the highway network structure of the PRTM base year model. The simulation network, where individual junctions are modelled, is shown in red and this is unchanged from LLITM 2014. The buffer network, where junctions are not modelled, in LLITM 2014 is coded with fixed speeds, which vary between time periods and over time. Within PRTM additional network detail has been added into the buffer network where model zones have been disaggregated, and a subset of buffer links surrounding Leicestershire have been coded with speed-flow curves. These are shown in blue within Figure 12.2.

12.1.7 The application of speed-flow relationships to these buffer links allows the modelled speed on these links to respond to changes in modelled traffic levels on these routes, whereas in LLITM 2014 the modelled speed is independent of the modelled flow.

12.1.8 This additional zone and network detail within PRTM allows the model to better forecast the routeing of trips entering, leaving or passing through Leicestershire, and how these routes change over time as traffic volumes are forecast to change.

Figure 12.1: Overview of PRTM and LLITM 2014 Zoning

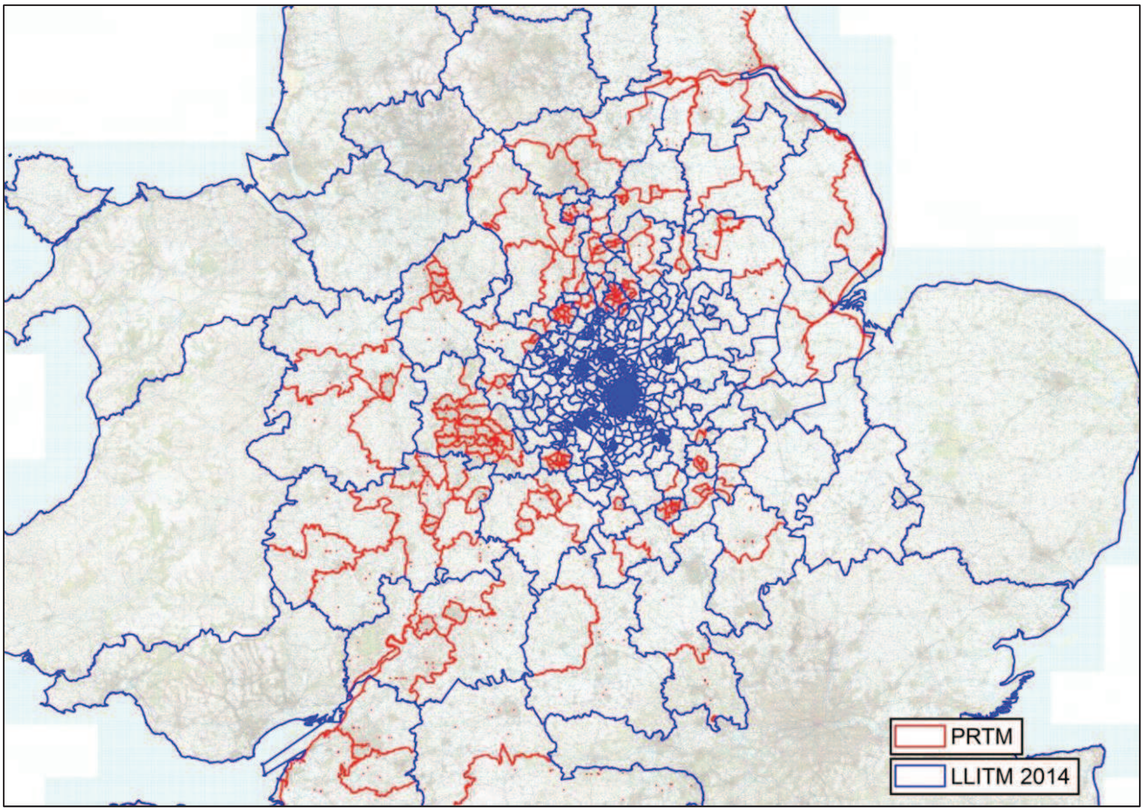
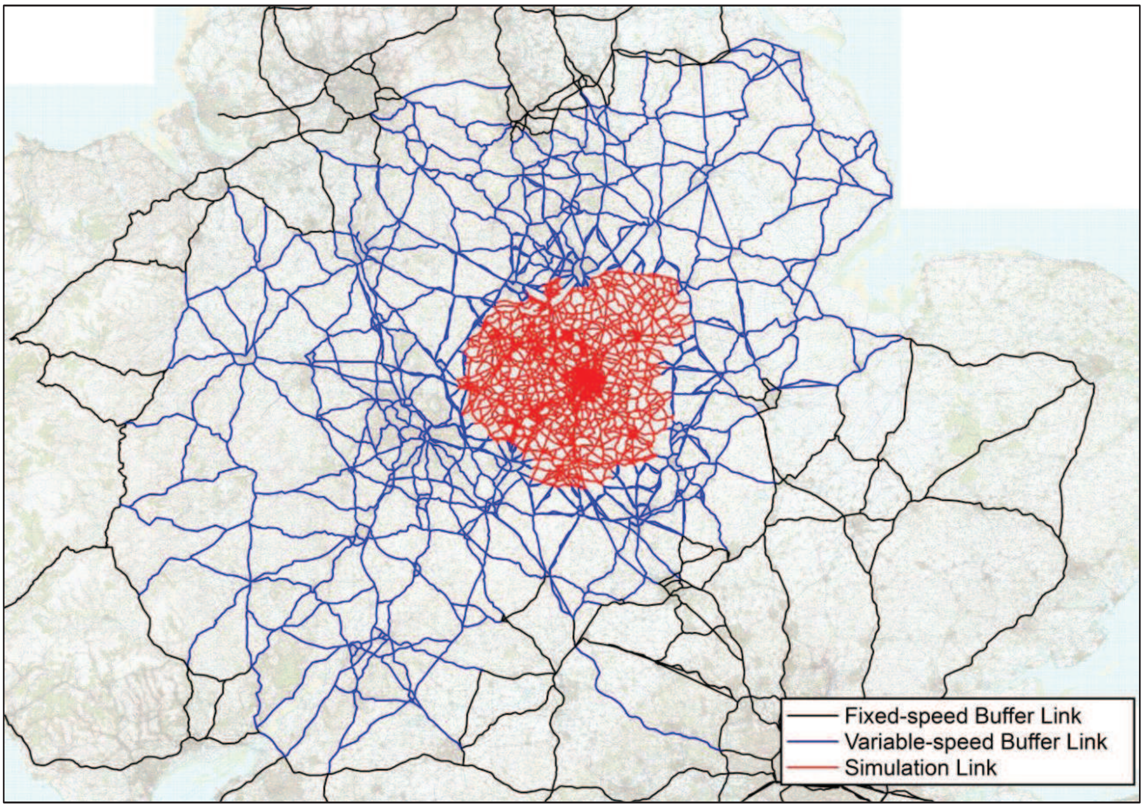


Figure 12.2: Overview of the PRTM Highway Network Structure



Section 13 – Application of the Model

13.1 Application of the PRTM for the A511 Growth Corridor OBC

13.1.1 LLITM 2014 Base (and hence PRTM) has been specified to be able to represent a number of different interventions (land-use and infrastructure), and assess the forecast impact of these interventions across Leicestershire. This includes responses within the land-use model (if used) to changes in travel costs, relocating residential and employment development, and responses within the demand model to changes in travel costs which influence mode choice, time of day choice and trip distribution.

13.1.2 The model has been specified with significant detail, both in terms of zoning and network detail, within urban areas, and market towns inside Leicestershire and also covers, albeit in a lower level of detail, areas in the immediate vicinity of Leicestershire.

13.1.3 Based on previous assessments of the proposed scheme, it is expected that the specified model contains the required level of detail and model responses to represent the expected impacts of the proposed A511 Growth Corridor scheme interventions.

13.1.4 This is subject to the results of the issues identified in the base year model review being resolved before any OBC submission. The existing PRTM model is deems suitable for use in the SOBC submission, noting its strengths and weaknesses in the A511 corridor; this is documented in "*PRTM - A511 - Base Year Model Review v1.2*".

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Appendix D

DMRB A511 RISK REGISTER REV D

MRN A511 Growth Corridor
Project Risk Register (Design)

Client - Leicestershire County Council
Design - Engineering Design
EECI Contractor - Morgan Sindall
REVISION B (DRAFT FOR REVIEW)

Leicestershire County Council

CELLS COLOURED IN THIS WAY CALCULATE BY FORMULA

Key to Risk Ratings				
Ranking	Likelihood		Impact	
Likelihood x Impact = Ranking	%age	Rating	value	Rating
Ranking < 5 = L	0% to 5%	1	£0 to £9,999	1
Ranking 6 to 12 = M	6% to 15%	2	£10,000 to £29,999	2
Ranking >12 = H	16% to 30%	3	£29,999 to £84,999	3
	31% to 50%	4	£84,999 to £199,999	4
	51% to 100%	5	£199,999 +	5

ID	Risk	Risk Rating *NB - These cells populate automatically*			Cost of Risk	% Likelihood	Cost Impact	Risk Owner (best placed to mitigate)	Risk Mitigation	
		Likelihood	Impact	Ranking					What	Status
1	**Resources**									
1.1	Key individuals leave employment and this affects progress.	4	3	17	£500,000	68%	£340,000	AMP	Allow sufficient lead in time to mobilise the works. Succesion planning. Collate calendars to assess leave issues.	Open
1.2	Staff sickness affects progress of works.	4	3	17	£50,000	68%	£34,000	AMP	Prepare delegation/succesion plan and identify potential to share some responsibilities.	Open
1.3	Uncertainty over Brexit leads to increase in materials and HR	2	4	16	£500,000	32%	£160,000	AMP	Monitor price fluctuations and adjust scope of project if necessary .	Open
1.4	Revisions to NWL conribution strategy not agreed leading to a reduction in S106 money	2	5	19	£500,000	38%	£190,000	AMP	Liaise with NWL at the earliest opportunity and emphasis the local contribution elelment requirement	Open
1.4	Poor project estimates lead to need to descope scheme	2	5	19	£500,000	38%	£190,000	EDS	Ensure estimates are as robust as possible and include for identified items.	Open
2	**Programme**									
2.1	Project milestones not met leading to delay to the project	3	4	18	£1,000,000	54%	£540,000	SRO	To be kept under constant review by project board. SRO to take appropriate action.	Open
2.2	Inforseen legal delays which affect project delivery	3	3	15	£1,000,000	45%	£450,000	SRO	To be kept under constant review by project board. SRO to take appropriate action.	Open
2.3	Layby café may refuse to leave site, leading to delays in the programme	3	3	15	£1,000,000	45%	£450,000	SRO	Negotiation with café owner to commence as soon as funding is in place.	Open
2.4	Highways England are not supportive of the scheme	2	5	19	£500,000	38%	£190,000	EDS	Liaise with HE at the earliest opportunity and ensure that they are aware of how the scheme will affect them and what mitigation we will be applying	Open
3	**Highways**									
3.1	Dualling of Stephensons Way may required more land than intially thought and would require some redesign	3	4	18	£500,000	54%	£270,000	EDS	Scheme progressing on assumption that road will ot be realigned.	Open
3.2	Design of punch-through could change due to the uncertainty of developer requirements.	3	5	21	£200,000	63%	£126,000	EDS	Continue to develop proposals in collaboration with developers to reach suitable agreement.	Open
3.3	Hermitage Leisure Centre development access will adversely affect the operation of the dual carriageway.	4	5	23	£200,000	92%	£184,000	EDS	Continue to develop proposals in collaboration with developers to reach suitable agreement.	Open
3.4	HS2 realignment of A512 could accelrated and impact on A511 programme	4	5	23	£200,000	92%	£184,000	EDS	Continue to develop proposals in collaboration with developers to reach suitable agreement.	Open
4	**Structures**									
4.1	Potential for Network Rail to require additional design work.	4	5	23	£2,000,000	92%	£1,840,000	EDS	Work with NE to confirm structure sizes.	Open
4.2	Structural survey required for Agricultural bridge . Assessment may indicate more work required than previously considered	4	5	23	£200,000	92%	£184,000	EDS	Discuss alternatives with canal support group. Original canal route already has significant blockers along its route.	Open
4.3	Deviation from NR standards required which delay technical approval	2	5	19	£200,000	38%	£76,000	EDS	Ensure liaison with NR at the earliest opportunity and maintain good relations	Open
5	**Drainage**									
5.1	Delays to drainage design resulting from late receipt of pollution control / attenuation requirements information from EA.	2	3	13	£40,000	26%	£10,400	EDS	Hold regular meetings with EA. Progress prelim design on basis of conservative pollution control / attenuation assumptions.	Open

MRN A511 Growth Corridor
Project Risk Register (Design)

Client - Leicestershire County Council
Design - Engineering Design
EECI Contractor - Morgan Sindall
REVISION B (DRAFT FOR REVIEW)

Leicestershire County Council

CELLS COLOURED IN THIS WAY CALCULATE BY FORMULA

Key to Risk Ratings				
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Likelihood x Impact = Ranking	%age	Rating	value	Rating
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Ranking 6 to 12 = M	6% to 15%	2	£10,000 to £29,999	2
Ranking >12 = H	16% to 30%	3	£29,999 to £84,999	3
	31% to 50%	4	£84,999 to £199,999	4
	51% to 100%	5	£199,999 +	5

ID	Risk	Risk Rating *NB - These cells populate automatically*			Cost of Risk	% Likelihood	Cost Impact	Risk Owner (best placed to mitigate)	Risk Mitigation	
		Likelihood	Impact	Ranking					What	Status
5.2	Proposed drainage outfall locations not feasible due to lack of discharge consent or unworkable levels. Delay to programme as highway alignment redesign required to facilitate required drainage changes.	2	4	16	£85,000	32%	£27,200	EDS	Early consultation with EA and checks on required outfall levels in relation to proposed vertical alignment to establish viability of outfall points.	Open
6	**Geotechnics**									
6.1	Little ground Investigation information for punch-through currently available.	3	5	21	£250,000	84%	£210,000	EDS	Early analysis of GI data to identify suitability of material.	Open
6.2	Little ground Investigation information currently available. Potential to encounter contaminated material.	2	3	13	£50,000	52%	£26,000	EDS	Confirm nature of material during GI.	Open
7	**Environmental**									
7.1	Results of environmental survey work and assessments require potential route realignment.	2	3	13	£50,000	26%	£13,000	EDS	Early analysis of environmental survey information to identify potential issues.	Open
7.2	Land where any new road alignment is identified could require archaeological assessment. The outcomes could lead to a potential conflict of approved scheme layout.	2	3	13	£50,000	26%	£13,000	EDS	Monitor the archaeological investigation work. Prioritisation of likely hotspots locations.	Open
7.3	Availability of suitable hydraulic models from the EA. Could impact programme by delaying confirmation of the proposed design of new structures, earthworks and highway alignment.	3	4	18	£90,000	54%	£48,600	EDS	Early consultation with EA to establish what hydraulic models they have and what changes are required in order to make them fit for purpose.	Open
7.4	Environment Agency flood models may require new baseline modelling is required to inform structure and highways designs, and to assess flood and environmental impact and mitigation.	3	4	18	£100,000	54%	£54,000	EDS	Modelling is progressing as a priority activity. Further topo is being specified , although model results won't be available to inform Preliminary Design. Agreed with LCC that modelling won't be undertaken at this stage.	Open
8	**Procurement / Approval**									
8.1	Delay in approvals leads to not spending funding within a specific timescale	2	5	19	£1,000,000	38%	£380,000	AMP	Ensure programme is realistic and achievable. Keep close control of those items outside of our control (e.g. power line diversion) and ensure float built into programme.	Open
8.2	Lack of Political support for the scheme which delays scheme approvals	2	5	19	£1,000,000	38%	£380,000	AMP	SRO to work closely with Members. Engagement strategy being developed to cover all stakeholders	Open
8.3	Turning movements required to make Flying Horse viable are not approved	2	3	13	£1,000,000	26%	£260,000	AMP	PM to work closely with Members. Engagement strategy being developed to cover all stakeholders	Open
8.4	Failure to secure a risk sharing agreement with NWLDC	3	4	18	£100,000	54%	£54,000	AMP	Enter discussions with MWLDC as soon as SOBC approved.	Open
9	**Operations**									
9.1	Increase in carrriageway construction due to low CBR values could cause increase service diversions / protection measures.	3	4	18	£100,000	54%	£54,000	AMP	GI data and pavement investigation will inform pavement design and expected CBR values. Complete CBR tests and provide alternative detail of construction in relation to CBR values.	Open
9.2	Poor existing carriageway construction leading to more extensive reconstruction.	4	4	20	£100,000	80%	£80,000	AMP	Investigation to confirm condition at tie-ins with existing construction.	Open
9.3	Traffic impact of incident on M1/A42. Levels of congestion in Coalville are particularly bad during incidents on the M1. Could also cause disruption to deliveries and access issues to site.	2	5	19	£10,000	38%	£3,800	AMP	Prepare emergency traffic management plan in discussion with MMBC/ECI. Include discussions with HE regarding A1 incidents.	Open
9.4	Timely approval of traffic management layouts for construction of junction improvements.	2	5	19	£15,000	38%	£5,700	AMP	Details to be agreed in ECI process to ensure traffic orders can be placed in advance to avoid delays to works.	Open
9.5	Acceleration of HS2 programme leads to condenced programme	1	5	17	£500,000	17%	£85,000	AMP	Liaise with HS2 team to ensure that any accelration has early warning	Open

MRN A511 Growth Corridor
Project Risk Register (Design)

Client - Leicestershire County Council
Design - Engineering Design
EECI Contractor - Morgan Sindall
REVISION B (DRAFT FOR REVIEW)

Leicestershire County Council

CELLS COLOURED IN THIS WAY CALCULATE BY FORMULA

Key to Risk Ratings				
Ranking	Likelihood		Impact	
Likelihood x Impact = Ranking	%age	Rating	value	Rating
Ranking < 5 = L	0% to 5%	1	£0 to £9,999	1
Ranking 6 to 12 = M	6% to 15%	2	£10,000 to £29,999	2
Ranking >12 = H	16% to 30%	3	£29,999 to £84,999	3
	31% to 50%	4	£84,999 to £199,999	4
	51% to 100%	5	£199,999 +	5

ID	Risk	Risk Rating (NB - These cells populate automatically) Likelihood	Impact	Ranking	Cost of Risk	% Likelihood	Cost Impact	Risk Owner (best placed to mitigate)	Risk Mitigation: What	Status
10	**Statutory Undertakers**									
10.1	Unknown services located which require diversion or protection.	2	4	16	£150,000	32%	£48,000	AMP	Service plans already provided. Complete GPRS to confirm locations.	Open
10.2	Services found to be in location different to that expected requiring diversion / protection.	3	4	18	£150,000	54%	£81,000	AMP	Complete GPRS / trial holes to confirm locations prior to construction.	Open
10.3	Utility diversion works not carried out in accordance with agreed programme .	3	5	21	£200,000	63%	£126,000	AMP	Set up meetings with ECI and Utility to confirm programme. Consider GPRS / trial holes / protection measures / advanced works.	Open
10.4	Services required for the adjacent development areas impact programme.	3	4	18	£120,000	54%	£64,800	AMP	Liaison with developers to ascertian their requirements.	Open
11	**Planning**									
11.1	CPO rejected/delayed.	1	4	14	£50,000	14%	£7,000	AMP	Consider nature of delays/ rejection and agree actions.	Open
11.2	Legal process delays. Potential for Public Inquiry.	5	3	19	£50,000	95%	£47,500	AMP	Ensure contingency plans prepared to programme in public enquiry	Open
11.3	Lack of clarity between developer and LCC/NWLDC over alignment ofpuch-through.	3	4	18	£85,000	54%	£45,900	AMP	Continue collaboration with developers throughout design process to confirm satisfactory proposals.	Open
11.4	Network Rail's property team may impose a charge for changes to agricultural bridge. This is considered case-by-case, taking account of the purpose of the crossing. It can be a significant sum. Significant additional project cost.	2	5	19	£200,000	38%	£76,000	EDS	Negotiate with NR to minimize any charge, stressing the benefits to the public of improvements to the A511 (as opposed to commercial benefits).	Open
11.5	Risk of proposed developments adjacent to the route with unknown requirements impacting on junction capacity/ design / safety for the A511.	3	4	18	£100,000	54%	£54,000	AMP	LCC to ensure that all relevant information regarding existing / proposed planning applications and developments is made available to aid understanding of the potential impact on the design. This should include regular updates from the NWLDC/LCC Planning Departments. Possibility of allowing additional left in/ left out junctions.	Open
12	**Statutory Undertakers**									
12.1	Unknown services located which require diversion or protection.	2	4	16	£150,000	32%	£48,000	AMP	Service plans already provided. Complete GPRS to confirm locations.	Open
12.2	Services found to be in location different to that expected requiring diversion / protection.	3	4	18	£150,000	54%	£81,000	AMP	Complete GPRS / trial holes to confirm locations prior to construction.	Open
	Total value of Risk Register					**Total Cost Impact**	**£7,662,900.00**			

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