Central Lancashire Highways & Traffic Model

Local Model Validation Report

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1 Introduction

1.1 City Deal Vision

Lancashire will become one of the fastest growing and commercially dynamic locations in the UK over the next decade – thanks to the Preston and Lancashire City Deal. The City Deal is a once-in-a-lifetime opportunity to transform the area by creating thousands of new jobs and homes.

Key to the City Deal is new transport infrastructure, which will radically improve access by road to Preston and South Ribble from other parts of Lancashire and the UK.

By 2026, Central Lancashire is expected to have an additional 20,000 homes, a large office-based service sector employment, and 2,000 additional jobs in strategic employment sites. The newly established Enterprise Zone covering the BAE Systems sites at Samlesbury and Warton has the potential to create up to 6,000 jobs in advanced engineering and manufacturing.

Against this backdrop, and by 2026, Central Lancashire's transport network will no longer be able to cope with the additional demands placed on it as a result of population increase and economic growth, and the masterplan represents the county council's priorities for future investment in highways and transport across Central Lancashire.

This represents a delivery programme for the next 10 years which will see new road space built, public transport enhancements, and public realm improvements in city, town and local centres.

1.2 The Project Context

To support delivery of schemes within the City Deal programme and the Masterplan, a transport model for Central Lancashire was required.

In 2015 Jacobs developed a new Central Lancashire Highway and Traffic Model (CLTHM) that was used for the planning, optioneering and business cases for a set of core transport interventions required for the successful delivery of the Masterplan and City Deal Vision - and in particular the Preston Western Distributor (PWD) Scheme planning application and Outline Business Case (OBC).

Following the approval of the PWD Outline Business Case in January 2018, Jacobs was commissioned to re-validate the model with the latest WebTAG guidance values which had changed since 2015 when the original model was built. In addition, the updated model would aim to strengthen model performance in certain areas based on the comments/conditions received from review of the OBC deliverables by the LEP Independent Assurer and DfT in 2017. The updated model will be used to support the economic assessment of the PWD as part of the Full Business Case (FBC) development; therefore, it will be referred to as the PWD FBC model.

It has been agreed with the DfT that no present year validation would be required to support the PWD FBC and therefore the model was calibrated and validated to the same 2013 traffic data, as was used in the original model.

This Local Model Validation Report (LMVR) details the data, processes, methodologies and results of the base year model development which are generally consistent between the original model and the PWD FBC model unless specified otherwise in the subsequent sections of the report ; with additional supporting information also found in the Traffic Forecasting Report.

1.3 Report Structure

The remainder of this report is set out as per WebTAG Unit M-3 on assignment modelling, and as follows:

Chapter 2 - *Details the uses of the model and key design considerations*

Chapter 3 - *Identifies the standards to which the model was built*

Chapter 4 - *Describes the key features of the model*

Chapter 5 - *Details the data used for model calibration and validation*

Chapter 6 - *Describes the processes used in developing the modelled network*

Chapter 7 - *Describes the processes used in developing the modelled demand (i.e. trip matrices)*

Chapter 8 – *Details prior matrices calibration and validation*

Chapter 9 - *Details the network calibration and validation*

Chapter 10 - *Describes the route choice calibration and validation*

Chapter 11 - *Provides information on the calibration and validation of the trip matrices*

Chapter 12 - *Details the calibration and validation of the assignment*

Chapter 13 - *Details the development and validation of Variable Demand Model*

Chapter 14 - *Provides a summary of the model and its development*

2 Proposed Uses of the Model and Key Model Design Considerations

2.1 Transport Model Requirements

Key documentation with respect to Highway Assignment modelling is held in TAG Unit M-3, and in line with TAG guidance and the requirements related to the PWD FBC outlined above, the local context has been considered in the design of the CLHTM.

The Central Lancashire Transport Masterplan details the various options for the area, but in light of high levels of existing delay, limited alternative route options, and forecast background growth in traffic levels due to both local and national trends, the Masterplan, accepts that there is limited choice but to create new highway capacity to support new development and allow us to solve specific problems, prior to seeking to enhance public transport and public realm environments.

The development of the transport model is necessarily informed by this Strategy, and its ability to support and enhance the deliverability of each of the component schemes.

New highway capacity would be created by:

- *The Preston Western Distributor, a new road linking the M55 near Bartle with the A583/A584 at Clifton, providing access to the North Preston housing sites via a new link between the M55 and the A583*
- *The East-West Link Road, that links to the Preston Western Distributor as a key access/egress route for the unlocked housing*
- *The upgrading of the A582 South Ribble Western Distributor to improve capacity on the existing A582 between Cuerden and Penwortham Triangle, supporting delivery of the south of Penwortham/North of Farington strategic housing location; and,*
- *The completion of Penwortham bypass between the Broad Oak roundabout and Howick Cross.*

Each of these schemes has been used to inform the area of influence and requirements for fully observed data within the core model area, and requirements for proportionate levels of detail regarding the network build and validation requirements of the new model, as discussed in subsequent chapters.

New capacity would also impact on a number of key arterial and radial corridors in Preston and include:

- *Warton EZ ~ Freckleton ~ Riversway ~ Preston city centre*
- *New Hall Lane ~ Samlesbury EZ*
- *North West Preston/Cottam ~ Ingol ~ Preston city centre*
- *Broughton ~ Fulwood ~ Preston city centre*
- *Longridge ~ Grimsargh ~ Ribbleton ~ Preston city centre*
- *Samlesbury EZ ~ New Hall Lane ~ Preston city centre*

- *Moss Side ~ Leyland ~ Cuerden ~ Lostock Hall ~ Lower Penwortham ~Preston city centre*
- *Chorley ~ Cuerden ~ Bamber Bridge ~ Preston city centre*
- *Hutton ~ Higher Penwortham ~ Preston city centre*

These have been again taken into account in relation to the base year model development, especially with respect to screenline development, and the journey time validation routes selected, to ensure the model is suitable for informing inputs to large scheme development, such as the Preston Western Distributor, to more localised corridor usage.

However, there are also a number of other potential uses of the new model that have been sought to be inbuilt as part of the methodology, as far as practicable. These include the potential for the model to inform potential highway model/demand inputs towards:

- *A new 'Parkway' rail station in Cottam to serve the North West Preston strategic housing location; and*
- *Associated Urban Realm improvements, in areas such as Seven Stars, Hough Lane, Tardy Gate, Bamber Bridge, Penwortham, Lane Ends, Broughton, Ribbleton Lane and New Hall Lane.*

These are shown in Figure 2-A.

Longer term aspirations for Guild Bridge, to connect South and North Preston avoiding the City Centre and Managed Motorways around Preston, may also be future uses of the model and for comparative business case and traffic assessments.

As a result, specific and particular attention has also been paid to the performance of the Strategic Road Network within the model; both within and separate from, other calibration and validation statistics in conjunction with Highways England.

2.2 Growth Context

Associated with this are a number of significant development areas, which also need to be covered suitably by the model. These are shown in Figure 2-B.

The most significant of the strategic development sites around Central Lancashire are:

- *Housing developments in North West Preston that would otherwise see new residents in over 5,000 homes using narrow country lanes or busy urban roads on a daily basis.*
- *1,200 new homes at Pickerings Farm in the Penwortham/Lostock Hall/ Farington area which will connect to the road network via the A583, a single carriageway road already having significant congestion.*
- *The Cuerden Green Strategic employment site, which is well located for motorway access but has connections to the west via the A582.*

These developments, and their respective levels of certainty, have informed the key development of an uncertainty log as part of the forecasting procedures associated with the development of the CLHTM model.

This is reported in further detail in the Traffic Forecasting Report but has also informed base year network considerations around key growth locations; to ensure that all roads around these areas are fully modelled.

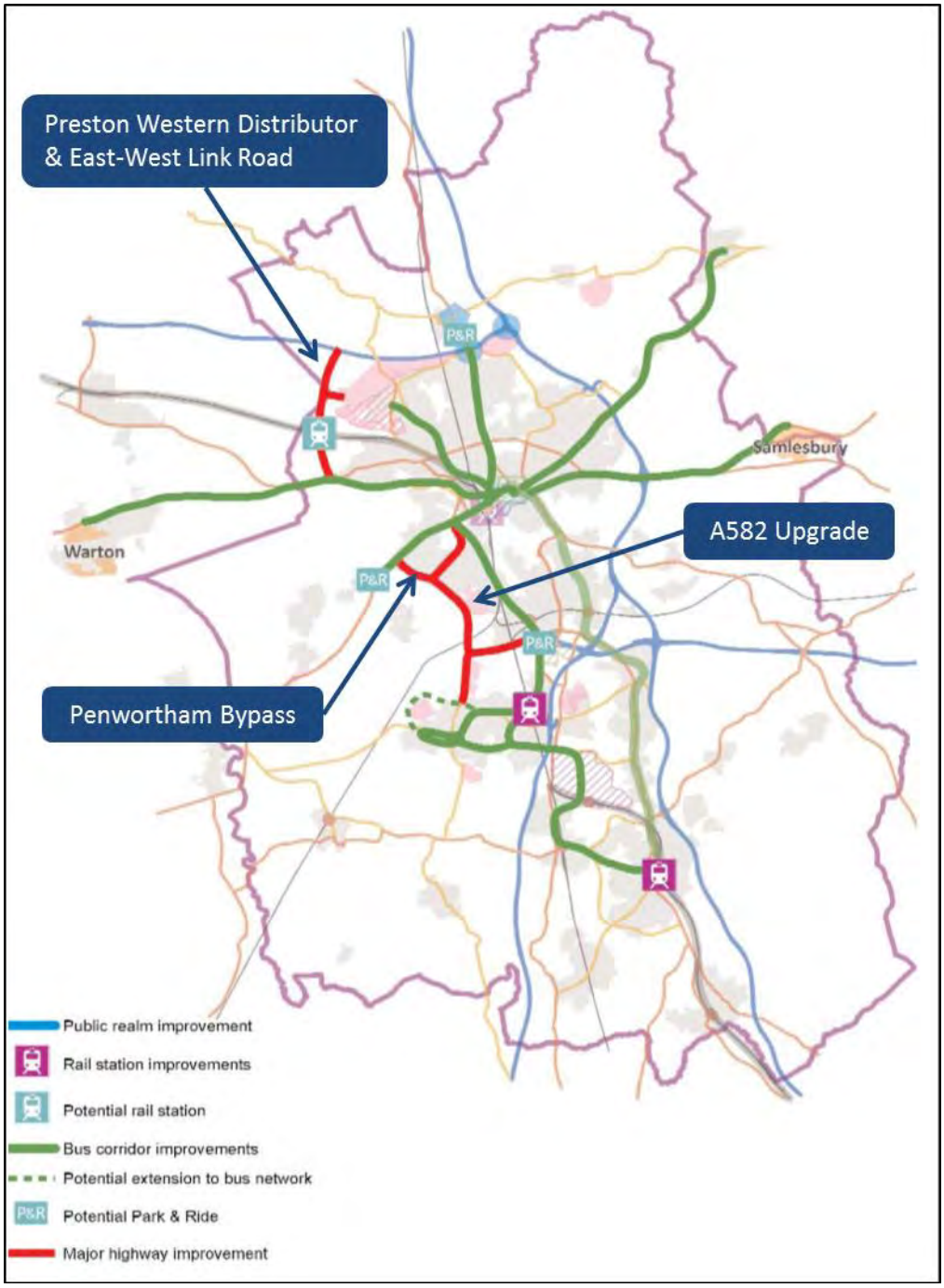

Figure 2-A - Key Transport Masterplan Schemes

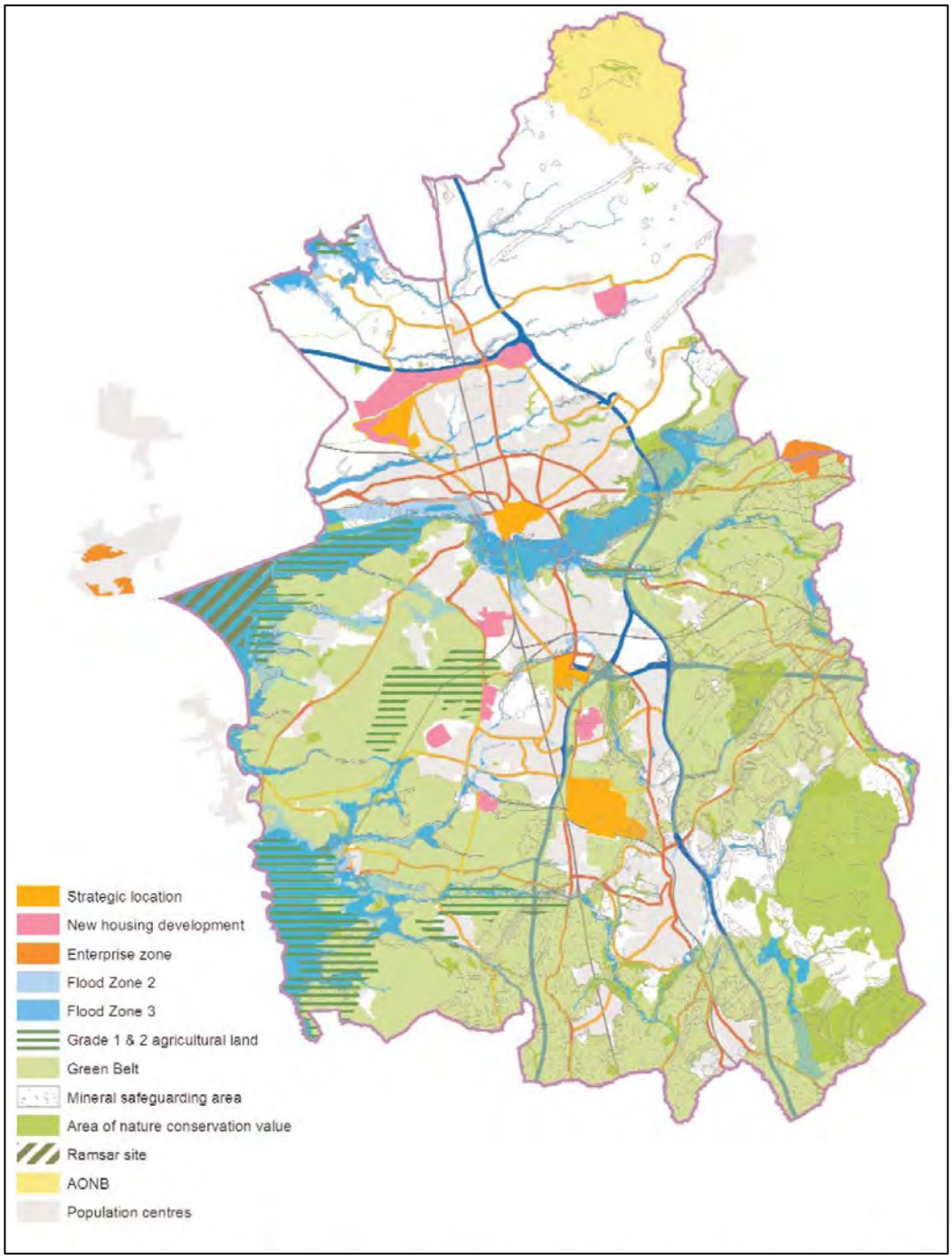

Figure 2-B - Key Development Locations

2.3 Key Considerations & Features

The updated model will be used to inform an economic assessment as part of the Full Business Case for the Preston Western Distributor Scheme; as well as supporting planning for other CLTM masterplan schemes, including the A582 Dualling scheme.

To reflect the impact that the schemes will have during the busiest parts of the day, a morning peak and evening peak model was developed.

The scheme is considered likely to also have an impact during less busy times of the day and therefore an average inter-peak hour is also required.

The key characteristics of the model are described in Table 2-1, with further details on each of these areas covered in Chapters 3 & 4.

Table 2-1 - Key model features

Characteristic	Model approach
Model form	Highway Assignment Model
Software package	SATURN V11.3.12W
Base year	2013 (standardised to October 2013)
Time periods	AM peak (0800-0900) Interpeak (average hour between 1000 and 1600) PM peak (1700-1800)
User classes	5 – Car Business, Car Commute, Car Other, LGV, HGV
Zone system	579 zones in model
Assignment methodology	SATURN assignment- Wardrop Equilibrium
Capacity restraint mechanism	Capacity Index functions on links. Defined Capacity at junctions Fixed Speed Buffer Networks
Relevant guidance	WebTAG Unit M3.1

3 Model Standards

3.1 Introduction

This chapter summarises the criteria used for calibration and validation of the model, and convergence standards used to check the stability and reliability of the assignment results.

These criteria and standards are based on the measures set out in TAG Unit M3.1, and are used consistently in terms of the performance of the CLHTM model in the LMVR.

3.2 Validation Criteria and Acceptability Guidelines

The validation of the highway assignment has been quantified using the following measures taken from WebTAG unit M3.1 paragraph 3.2.3:

- *Assigned flows and counts totalled for each screenline or cordon, as a check on the quality of the trip matrices;*
- *Assigned flows and counts on individual links as a check on the quality of the assignment; and*
- *Modelled and observed journey times along routes, as a check on the quality of the network and the assignment.*

3.2.1 Screenlines

Base matrix validation is defined as the differences between modelled and observed flows along screenlines within the model, the criteria to meet is set out in Table 3-1.

Table 3-1 - Screenline Flow Validation Criterion

Criterion	Acceptability Guideline
Differences between modelled flows and counts should be less than 5% of the counts	All or nearly all screenlines

WebTAG specifies the following, within unit M3.1 paragraph 3.2.6:

- *Screenlines should normally consist of five or more links;*
- *The comparison of modelled and observed flows for screenlines containing high flow routes (such as motorways) should be presented both with and without such routes;*
- *The comparison should be presented separately for:*
  - *roadside interview screenlines;*
  - *other screenlines used as constraints in matrix estimation; and*
  - *screenlines used as independent validation.*
- *The comparison should be presented by vehicle type.*

It should be noted here that, as explained in chapter 12, given the relatively small study area in certain sections of the model, and the limited number of traffic counts, it was not always possible to draw up screenlines consisting of more than five links.

This is also in part due to the rural nature of a number of areas outside of Preston and limited route choice, whilst also making best use of the data that are available.

The GEH value (see definition below) has also been used to assess screenline performance. This is deemed prudent where percentage differences on short or low flow screenlines, particularly for LGV and HGV, is above 5%.

3.2.2 Link based calibration and validation

In addition to validation of total screenline flows, WebTAG Unit M3.1 also contains guidelines on the validation criteria for individual links or turning movements.

These criteria are detailed in Table 3-2 presented below and include reference to the GEH statistic measuring the difference between modelled and observed flows. The GEH statistic is of the form:

$$GEH = \sqrt{\frac{(M-C)^2}{(M+C)/2}}$$

where M is the modelled flow and C is the observed count.

Table 3-2 - Link Flow and Turning Movement Validation Criteria

Criteria	Description of Criteria	Acceptability Guideline
1	Individual flows within 100 veh/hr of counts for flows less than 700 veh/hr	> 85% of cases
	Individual flows within 15% of counts for flows from 700 veh/hr to 2,700 veh/hr	> 85% of cases
	Individual flows within 400 veh/hr of counts for flows more than 2,700 veh/hr	> 85% of cases
2	GEH < 5 for individual flows	> 85% of cases

WebTAG guidance unit M3.1 paragraph 3.2.9 states that the above comparison of modelled and observed flows should be presented for total vehicle flows and for car flows, but not for LGV and HGV flows due to there being insufficient accuracy in the individual link counts for these vehicle types. In addition, the above information should be presented by time period and applied to link flows.

Data collection sites used in the validation of the base year, as well as those sites used in the development of the base year model are presented within Chapters 5 and 11 respectively.

3.2.3 Journey Times

WebTAG also contains acceptability guidelines for the validation of journey times. The acceptability criterion for journey time validation is given in Table 3-3.

Table 3-3 - Journey Time Validation Criterion

Criterion	Acceptability Guideline
Modelled times along routes should be within 15% of surveyed times, or 1 minute if higher	> 85% of routes

3.2.4 Impact of Matrix Estimation

Independent validation as specified above quantifies the ability of the model to replicate base year travel conditions within the model area. To ensure these conditions have a sound basis WebTAG provides guidance as to the acceptable changes to the highway 'prior' matrices that should result from the application of matrix estimation. These have been reproduced in Table 3-4.

Table 3-4 - Significance of Matrix Estimation Changes

Measure	Significance Criteria
Matrix zonal cell values	Slope within 0.98 and 1.02 Intercept near zero R^2 in excess of 0.95
Matrix zone trip ends	Slope within 0.99 and 1.01 Intercept near zero R^2 in excess of 0.98
Trip length distributions	Means within 5% Standard deviations within 5%
Sector to sector level matrices	Differences within 5%

WebTAG Unit M3.1 paragraph 8.3.15 states that all exceedances of the above should be noted and assessed as to their importance to assess the scheme.

3.3 Convergence Criteria and Standards

In order for the outcomes of the modelling to be reliable, the stability of the modelled flows needed to be confirmed. This ensures that when modelling the scheme, any flow changes which occur do so directly as a result of the scheme, rather than as a result random flow changes due to poor convergence. In addition, the model should converge to a point in which routes obey Wardrop's First Principle of Traffic Equilibrium which unit M3.1 paragraph 2.7.3 defines as:

"Traffic arranges itself on networks such that the cost of travel on all routes used between each OD pair is equal to the minimum cost of travel and all unused routes have equal or greater cost."

This relates to how close the model is to a particular converged solution, which varies depending on the preferences of the user or software package being used. In SATURN this equates to how close the model is to Wardrop's Principle of Equilibrium and is measured using the Gap function.

The gap value therefore represents the excess cost incurred by failing to travel on the route with the lowest generalised cost and is expressed relative to that minimum route cost. The excess cost is summed over each route between each O/D pair and multiplied by the number of trips between each O/D pair. This is divided by the minimum cost summed over each route between each O/D pair, also multiplied by the number of trips between each O/D pair.

For the model to be considered sufficiently well converged, the gap value must be less than 0.1%.

WebTAG describes other measures for assessing the model convergence, as detailed in Table 3-5; in terms of both stability and proximity measures.

Table 3-5 - WebTAG Convergence Measures

Measure of Convergence	Base Model Acceptable Values
Delta and %Gap	Less than 0.1% or at least with convergence fully documented and all other criteria met
Percentage of links with flow change < 1%	Four consecutive iterations greater than 98%
Percentage of links with cost change < 1%	Four consecutive iterations greater than 98%
Percentage change in total user costs	Four consecutive iterations less than 0.1%

The convergence statistics provided in the LPN output file enable the ability to both check and ensure the model converges within the WebTAG guidance provided above, for base and future years (in the traffic forecasting report).

4 Model Development - Key Features of the Model

4.1 Fully Modelled Area and External Area

As outlined in Chapter 2, the primary use of the CLHTM Model will be the planning, assessment and appraisal of the PWD scheme in Central Lancashire, along with planning and supporting assessment of future transport schemes in and around Preston.

Therefore, the geographical scope of the model network, in particular the detailed/simulation area, should cover an area around the key schemes to ensure an accurate reflection of the current trip movements within this area.

In line with latest WebTAG Unit M3.1 guidance, the modelled area makes use of a three stage structure with levels of detail of network coding reducing away from the centre of the study area.

The breakdown of the modelled area is outlined below:

- *Fully modelled area:*
  - *Area of detailed modelling (Detailed); and*
  - *Rest of fully modelled area (ROFMA).*
- *External Area.*

The area of detailed modelling is characterised by where the level of impact from the schemes is likely to be significant and, as such, the detail within the network and demand matrices is at its greatest.

The rest of the fully modelled area is where the level of detail is not as great but capacity restraint is still modelled. Speed flow curves have been defined for the area of detailed modelling and the rest of fully modelled area.

The external area is where the level of detail is at its lowest- and covering the rest of the UK. In the CLHTM model, and to represent best practice, the external links have been coded with observed fixed times (which are time period specific) rather than speed flow curves. The fixed times have been derived from Google journey planner travel times.

The detailed and rest of fully modelled area tier structure is shown in Figure 4-A.

Figure 4-A - Two tier model structure

Note that in addition to the two tier coloured area shown above, the model was also extended to include all of the rest of Great Britain; this is classed as the 'external' area.

4.2 Zoning system

The model zone system was constructed using Census Output Areas (COAs) as building blocks. These COAs are used to report data from the national Census (conducted every ten years in the UK) and are the finest level of spatial detail at which such data is reported. Each output area typically comprises around 100-200 households and is designed to be as socially homogenous as possible. The COA boundaries fit within (and do not straddle) local authority boundaries. Since the demand matrix building relies on good land use data, it was convenient to use COAs in this fashion to make maximum use of data from the 2011 Census.

Within the detailed model study area (illustrated in Figure 4-A) the zones were comprised of COAs or aggregations thereof. In some instances, zones were based on a disaggregation of COAs in order to isolate individual pockets of land (for example, to separate large industrial land uses from residential uses). The area approximately covered by the Preston City Council boundary was zoned in this way.

Areas further away from the study area, where less spatial detail was required were based on National Trip End Model (NTEM) zone boundaries. These are usually identical to local authority districts. In the area immediately surrounding the study area (the rest of the fully modelled area, in Figure 4-A) these were mostly comprised of single NTEM zones, with some zones based on a disaggregation of NTEM. Beyond that point, in the

external area of the model, several NTEM zones were aggregated to comprise the modelled zone.

Initial results from the Roadside Interview surveys indicated a small number of zones in the vicinity from which a very large number of trips originated or destinated.

In line with WebTAG best practice, these zones were further disaggregated to ensure greater homogeneity of trip ends. This ensured as much as possible that the internal zones trip ends were no greater than 300, in line with WebTAG Unit M-3 recommendations on zone size.

When comparing this SATURN network with the previous Central Lancashire CUBE model developed in 2009, it is worth noting the increase in the number of zones from 273 to 579. As a result, this further increases the accuracy in observed traffic movements, providing a more accurate traffic flow model, with particular attention paid to zoning in and around key schemes and future developments.

The zone system covering the extents of the model is shown in Appendix A. The zoning system within Preston is shown in detail in Figure 4-B.

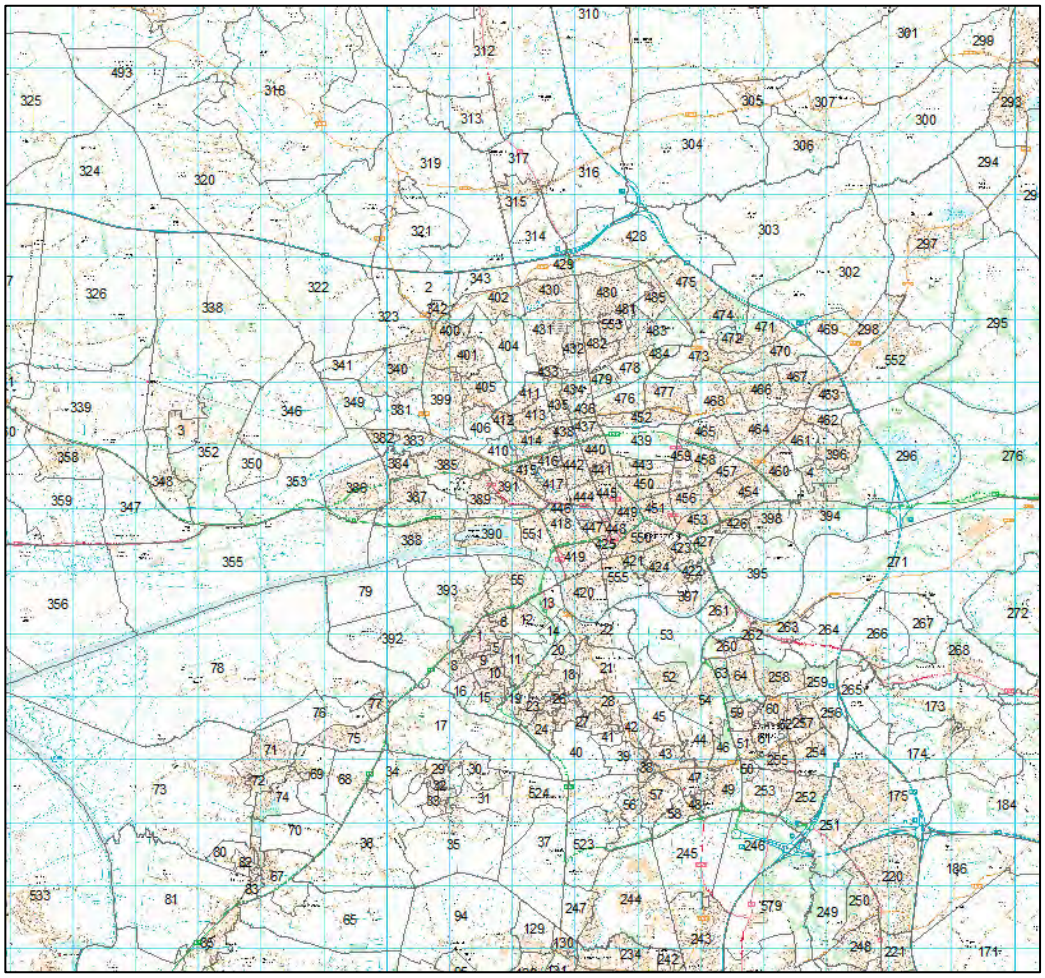

Figure 4-B - Zone System surrounding Preston

4.2.1 Zone sectoring

For ease of reporting and analysis, the zones in the model were aggregated into 'sectors'. The 20 sectors were originally developed with LCC and Highways England input and collaboration, and further disaggregated into 33 sectors as part of the FBC model updates for better disaggregation of the area with respect to screenlines. Colour coded sectors around Preston are shown in Figure 4-C

Figure 4-C - 33x33 Sector System Preston

There are 33 sectors in total, as listed in Table 4-1 below.

Table 4-1 - List of the Model Sectors

Number	Sector
1	Preston City Centre
2	Inner North Preston - North East
3	Inner South Preston - South
4	North Preston
5	South East Preston
6	South Preston
7	Leyland
8	South Outer Screenline
9	Chorley
10	West Outer Screenline
11	Blackpool
12	Fleetwood / Garstang
13	North East of Model 1- Grimsargh etc
14	Manchester
15	South
16	Scotland
17	North
18	Midlands
19	Wales
20	East of Model - Blackburn etc
21	South West of Model - Southport
22	South of Model - Skelmersdale etc
23	South East of Model - Wigan
24	East Preston
25	North of Model - Lancaster etc
26	North East of Model 2- Clitheroe etc
27	North East Outer Screenline
28	Inner South Preston - South West
29	Inner South Preston - South East
30	North Outer Screenline
31	Inner North Preston - North West
32	Inner North Preston - North
33	Hutton

These sectors are to be used in subsequent reporting of the model.

4.3 Network Structure

LCC and Highways England were also consulted to agree the extent of the highway network.

This was informed by evidence led testing of the PWD scheme in the previous version of the CLTM CUBE model, with a further enhanced simulation network beyond the area of 5% flow change from this model, such that a sufficiently wide area of simulation