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Warrington Multi-Modal Transport Model
Local Model Validation Report (LMVR)
Final

Warrington Borough Council & Partners

April 2010

QM

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Model QM

Version		VISUM Version 10.03.20
Filename and Date	Demand Model Tier 1	Demand Model_v3_Final_C3.ver – 29/03/10 Demand Model AM Assignment.ver – 19/03/10 Demand Model IP Assignment.ver – 19/03/10 Demand Model PM Assignment.ver – 19/03/10
	Demand Model Tier 2	T2 Demand Model_v2.ver – 14/04/10 AM BY v37 T2_demand Model_AM Assignment_2.ver– 24/03/10 IP BY v37 T2_demand Model_IP Assignment_2.ver– 24/03/10 PM BY v37 T2_demand Model_PM Assignment_2.ver-24/03/10
	AM Observed Model	AM BY v48_Val_Block Final.ver – 10/12/09
	IP Observed Model	IP BY v48_v5_Val_Block Final.ver – 10/12/09
	PM Observed Model	PM BY v48_v5_Val_Block Final_2010_v11.ver– 12/01/10
Assignment		Equilibrium Lohse, Node Impedance & Blocking Back During Assignment
Number of Nodes, Zones and Link		2,058, 378, 5,378
Transport Modes		Car and LGV, HGV , Rail, Bus, Slow (walk and cycle)

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BACKGROUND

In September 2008 WSP were appointed by Warrington Borough Council (WBC) along with their partners, (Highways Agency (HA), Homes and Communities Agency (HCA) the North West Development Agency (NWDA) and Peel Holdings), to develop the Warrington Multi Modal Transport Model (WMMTM) in a manner that enables the testing of future transport proposals and developments on the transport network in an efficient, consistent and evidentially based manner.

Warrington is extremely well located on both the national road and rail networks, allowing good connections with both the North West region and the rest of the country. This has led to substantial development in the past 30 years, and the designation of Warrington as a New Town has contributed to a large population increase in the same time frame. Housing has grown alongside employment areas such as Birchwood, Centre Park, Woolston Grange and Gemini.

In September 2008 this population and employment expansion was forecast to continue with a number of housing approvals running ahead of forecasts, and new employment sites such as Omega given the go-ahead for development. This expansion is expected to bring with it a substantial increase in traffic movements within Warrington that may cause significant congestion within the town. Warrington Borough Council and partners have recognised that, with a sound transport strategy and appropriate investment in infrastructure, there is the potential to reduce the transportation impacts of this development and ensure the continued prosperity and status of the town.

The Brief

This extract taken from The Brief for the study summarises the practical uses that the model could be adopted for.

> To be able to determine the wider effects of our current transportation proposals as well as the consequential effects of development, the Borough Council has determined the need for a multi modal transportation model of the Warrington Borough area. The main deliverable will be a multi modal transport model of the Borough. It is particularly important that the model is multi modal and is capable of accurately representing existing modal shares and generalised cost relationships but also of assessing the impact of transportation proposals on future modal split.
>
> The uses of the model will be wide ranging. For example, The Council require that the model will be able to assess its existing transport strategy, which is set out in full in the Council's second Local Transport Plan and the delivery framework, which is set out in the recently developed Transportation Framework. As well as this, in the future, the MMTM once developed needs to be used to assess the following:
>
> - Assessing the effect of current and future LTP programmes
> - Assessing future transport policies and proposals for the Borough, including future major schemes which may incorporate innovative solutions
> - Assisting in the development and appraisal of the next and subsequent LTPs
> - Assess the impact of parking interventions (price or supply) on town centre traffic

- Examining the effects of introducing new policy measures such as road user or workplace charging schemes
- Examining the impact of Park and Ride sites located at or near motorway junctions on modal share and on traffic levels
- Examining the impact of bus priority measures or quality bus corridors on modal share and on traffic levels
- Development of traffic management schemes
- Assessment of the ability of the transport infrastructure of the Borough (both the local and national transport networks) to accommodate planned future development, including the identification of specific transport schemes and measures required to accommodate planned developments. To this end a significant use of the MMTM will be to assess such requirements to inform the development of the Borough's Local Development Framework (LDF) which will replace the Borough's current Unitary Development Plan (UDP)
- Assessment of major planning applications

The model must be sufficiently robust and documented to satisfy Department for Transport WebTAG standards.

Building on this some of the potential transport improvement schemes and measures that the model will need to assess the impact of could also include:

- The potential for a 'Northern Orbital' bus corridor connecting Omega with Birchwood, utilising the alignment previously proposed for the Northern Expressway
- The possible construction of a 'Parkway' type railway station at Chapelford
- Potential transport and access schemes identified for 'Major areas of change' such as Arpley, Bridgefoot and Warrington Waterfront areas
- Potential adjustments to levels of parking supply and charges
- A high level crossing of the Manchester Ship Canal
- It is also intended to use the model to assess future private developer funded planning applications for major developments in the Borough.

The model has therefore been developed in accordance with the Design Manual for Roads & Bridges Volume 12 (DMRB) guidance. A Technical Working Group (TWG) comprising members of WBC, the Steering Group's consultant advisors, AECOM and the HA, was set up to monitor the model development and to provide workshop style input to the more difficult aspects of the model. The TWG was also charged with making pragmatic decisions on methodologies and model functionality to ensure the final delivered model is fit for purpose. To this end, the TWG are ***aux fais*** with the model build and are in a position to advise the Steering Group of the model's robustness and readiness for actual use in preparing and assessing future scenarios.

The brief contains additional technical details relating to the model requirements and specific functionality and should be read in conjunction with this report.

MODEL PLATFORM

A number of former models using STRATEGEM, SATURN and TRIPS software covering the area were made available to WSP by the Council. However, a lack of validation and severe discontinuity between models led to WSP putting forward the use of VISUM as the best available software in which to build a model meeting the Council's criteria.

The VISUM model platform proposed in the brief has been agreed upon for a number of reasons:

- Connectivity between the highway and public transport models, where both are assigned together within one software
- GIS based environment allowing for easy representations of the model for the client and other interested parties
- Detailed junction modelling to represent real delays experienced at signals, priorities and roundabouts

INCEPTION REPORT

An Inception Report was prepared and issued for client comment that captured the expected model functionality, the model build process, the programme, the core deliverables from the study and anticipated future model uses. This document has evolved over the course of the first six months of the study so that it incorporated the fresh ideas and methodologies that were actually adopted in the study. The primary deliverable is the Warrington MMTM itself and this Local Model Validation Report which details the development process and overall quality of the WMMTM.

MODEL OVERVIEW

The model has been developed using the PTV Vision VISUM software (VISUM version 10.03). The highway and public transport components and the demand model stages are all reported and housed within the software making it a holistic model. The operation of the demand model is driven by a series of bespoke Visual Basic script files developed by WSP for studies of this nature to ensure the model follows the WebTAG four stage modelling principles.

The WMMTM is designed to enable future land use planning and transport policy initiatives to be assessed in an integrated fashion. This integration aims to take account of:

- The impacts of economic and demographic trends and of land use change on the spatial and modal pattern of the demand for passenger transport.
- The impacts of changes in transport costs on the spatial patterns of the location of employment and households.

The WMMTM is an integrated holistic tool operating and reporting entirely within the VISUM software. The model reflects the changing impacts related to land use, policy and infrastructure on car, bus, rail and slow modes. Being WebTAG compliant it can be used to support the Local Development Framework (LDF) core strategy development, the Local Transport Plan, development control and major scheme business cases. It incorporates a methodology for modelling the three swing bridges over the Manchester Ship Canal, although the main model assumes conditions where these are open to traffic. The model also has the functionality to model car park policies including fiscal measures and car parking supply. These features are reported separately in the Swing Bridge and Car Park Modelling Reports.

The model represents 2008 conditions in the AM peak (0800 – 0900), average inter peak hour (1100 – 1400) and the PM peak (1700 – 1800).

SURVEYS

A survey scope was prepared including Roadside Interviews (RSI), Automatic Traffic Counts (ATC), manual junction turning traffic counts (MCC), journey times, automatic number plate recognition (ANPR) surveys on the motorway network to capture strategic routings and bus and rail origin & destination and patronage surveys. All of this data was collected in the autumn of 2008. These were supplemented by highway and Public Transport (PT) data provided by WBC and motorway flow data extracted from the HA's TRADS website. This data ranges in age but has been factored to reflect 2008 levels where appropriate. The data collection/collation exercise is presented in the Survey Report.

NETWORK EXTENT

The model highway network covers Warrington in its entirety including all the residential and commercial areas which fall under the Borough Council's remit. The motorway box which surrounds Warrington has also been included for the purpose of strategic trip making within the model. All roads and junctions within this area have been coded in detail to ensure junction delays are accurately reflected. A skeletal trunk road network covering has also been included for the rest of England and Wales.

The surveyed bus network for Warrington has been coded into the model to include bus stops, routes and service frequencies within the local area and those services serving the nearby towns and villages. Long distance services were not included as they are unlikely to be subject to modal shift as influenced by any WBC initiatives.

The strategic rail network and services covering the entirety of England and Wales including major rail stations were coded in the model to take account of long distance rail trips. All the stations and services within Warrington and along the lines between Liverpool and Manchester were also incorporated into the model.

HIGHWAY MATRIX DEVELOPMENT

The observed matrices were developed from a total of 22 Roadside Interviews collected from four studies in and around Warrington including 6 commissioned for this study. All of the matrices were rebuilt to the Warrington zone system and to represent 2008 traffic flow conditions. The data collected was thoroughly processed to ensure that only logical origin-destination data was included within the matrices.

Separate RSI directional matrices were produced for five different journey purposes covering the AM, inter and PM peak hours. Non RSI direction matrices were developed by essentially transposing the RSI matrices. The matrices were expanded to match ATCs ensuring the expansion factors were within DMRB limits.

Some trips may have been observed at more than one RSI site and therefore theoretically included in the matrix building process more than once, i.e. double counted (or triple counted in some cases). An indicator method was used to identify double/triple counted OD pairs. Trips created in these pairs were then factored down accordingly to cancel out any double/triple counting. The summation of the RSI matrices produced the 'partially observed' matrix (for each time period).

The Prior Observed matrix was created by taking an infill (OD movements not covered by the RSI matrices) from the first demand model matrices produced and incorporating it into the partially observed matrix. The infill typically included strategic motorway through trips and trips internal to Warrington itself. The filtering of demand infill trips was undertaken to ensure the infill OD pairs did not double count the RSI OD pairs. The infilling became an iterative process where the travel costs taken from the assigned prior matrix were used to produce a more accurate demand matrix which was then fed back into the observed model for a new assignment until the changes in the demand model were so small they are said to be converged. WebTAG guidance on the demand / supply convergence was adopted to demonstrate the state of convergence.

The end result of this exercise was the best Prior Matrix and this was assigned and the network improved to a point where no further improvement in calibration and validation was possible. At this stage, determined by a close match between assigned and observed traffic flows at the RSI sites, matrix estimation was used to improve the overall validation/calibration. Approximately 80% of the available traffic count data was used in this calibration process. The RSI Interview Direction component of the prior matrix was frozen so as to preserve the integrity of this 'observed' part of the matrix. A maximum of two matrix estimations loops were undertaken so as to contain the changes made to the prior matrix.

PUBLIC TRANSPORT MATRIX DEVELOPMENT

Bus matrices were built from observed origin-destination surveys taken on board the 24 bus routes surveyed within Warrington. These matrices were factored up to represent the observed number of passengers who boarded the bus along each route and then validated against boarding and alighting surveys at the Warrington bus station.

Rail matrices were built from observed origin-destination surveys taken at the five stations within Warrington. These were factored up to represent the observed number of passengers boarding at each station. These matrices were then transposed to give the alighters at each station to complete the matrices. The rail matrices were built by the access mode to each station, i.e. car, bus or walk up.

No matrix estimation was required in the PT matrix development process.

HIGHWAY OBSERVED MODEL CALIBRATION & VALIDATION

The observed models all meet DMRB criteria for model convergence which demonstrates a stable model under assignment.

The observed model was calibrated against traffic count data (80% of available sites) used in the matrix development and validated against journey times and traffic count data independent to the matrix development process (20% of available sites). The validation / calibration highlights are presented below.

Observed Model Summary - Meeting DMRB Standards

	Criteria	No of Counts / Routes	AM (%)	IP (%)	PM (%)
Validation	**GEH and Flow**	58	76	76	81
Calibration		226	83	88	84
Val/Cal		284	81	86	83
Validation	**GEH or Flow**	58	86	88	84
Calibration		226	88	94	88
Val/Cal		284	88	93	88
	Journey Times	34	79	79	85

DMRB guidance suggests flow volumes should meet the criteria for 85% of the sample compared. All time period models meet the criteria required with 88%, 93% and 88% when GEH or flow is considered. Overall, the observed model is demonstrating correct levels of traffic, where compared, across the modelled area including key links in and around Warrington and on the motorway box.

DMRB guidance states that 85% of the journey times must also meet the DMRB criteria and in this case, as the table above shows, only the PM model has met DMRB criteria, but both AM and IP models are demonstrating reliable travel times through the network with the correct levels of delay being reflected in and around Warrington. Closer inspection of the journey time routes falling outside of the criteria indicate that the modelled times are within the maximum and minimum journey times observed, if falling outside of 15% limit stated by DMRB. As with the flows, the model will not be materially improved by further intensive work.

A final check of the observed model measures the trip total differences between the matrix prior to and post matrix estimation. The DMRB criteria is met in the AM peak but falls just short in the inter and PM peak models.

The Final matrices were compared against the matrices prior to matrix estimation to check on the magnitude of the changes. This has shown that the differences at a sector to sector level are minimal and that this process has not overly changed the observed matrix.

PUBLIC TRANSPORT OBSERVED MODEL CALIBRATION & VALIDATION

Observed Model

Bus matrices were built from the number of boarders along the route. The public transport network and assignment was validated in accordance to WebTag criteria. Firstly network and service validation was completed which included network sanity checks and validation of PSV counts against bus services. Assignment validation was then conducted using bus screenline data and boarding and alighting data for bus and rail. This showed the modelled publis transport volumes met WebTAG criteria where comparison data was available.

DEMAND MODEL DEVELOPMENT

The demand model development followed the WebTAG approved four-stage model sequence of trip generation, mode choice, trip distribution and assignment. In theory this means individuals select their mode of travel before they choose their destination. This sequence, whilst not intuitive or likely to be the order in which individuals base their travel choices upon in reality is predicated upon order of least sensitivity to change. In principle and in the long term, as individuals we are more likely to change our destination than to change mode.

The ***Trip Generation*** stage calculates the total number of all mode (Car, PT and slow) person trips that will occur in a 24 hour period. Population data taken from the 2001 census was adjusted to account for known changes in population levels between 2001 and 2008. The 2008 population data was broken down into 125 distinct population segments categorised by age/employment status, household/car availability types and journey purposes. Each population segment was factored by a trip rate taken from the National Travel Surveys (NTS) to produce the number of person trips by population segment. Once created the 125 segments were aggregated into 15 segments categorised by household/car availability and Home Based journey purposes. These segments were taken forward to the mode choice stage.

The ***Mode Choice*** stage calculates the probability of choosing one mode over another based upon the relative costs of travel by all modes which creates the mode share proportions. The proportions were applied to the number of trips produced in stage 1 to create trips by mode (car, PT and slow). The PT element went through a second mode choice calculation to create Bus and Rail trips.

The ***Trip Distribution*** stage calculates the probability of trips travelling to any destination based upon the relative attractiveness of that destination compared to all other possible destinations. Checks were made to ensure the total sum of trips to the workplace and education destinations were of the correct order. This produces the demand model synthetic trip matrices. An infill taken from the synthetic matrices was combined with the observed model RSI matrix prior to assignment.

The fourth stage, ***Assignment***, simply assigns the distributed matrices. The assignment stage is therefore reflected in the Observed model rather than the demand model.

For reference, the Forecast Demand Model will predict the ***'change'*** in demand relative to the Base Year Demand Model and this change will be passed onto the Observed model to create the forecasts for assignment.

DEMAND MODEL HIGHWAY CALIBRATION & VALIDATION

Highway Model

WebTAG does not provide any clear guidance on the levels to which a demand model should be validated. Therefore several validation benchmarks have been drawn from existing datasets at each stage of the process to ensure that accurate results are being produced.

Trip generation is compared against Travel to Work census data and is shown to produce similar trip numbers at a zonal level.

Mode choice is compared against National Travel Survey and Travel to Work census data and is shown to be in line with these figures for the Warrington area for all modes.

Trip distribution is compared to Travel to Work census data at a sector to sector level and has been shown to validate against this data for trips within, to and from the study area. For the strategic motorway trips through the model, Automatic Number Plate Recognition surveys have been used to validate the motorway box turning proportions. Trip lengths are compared against National Travel Survey, Census and RSI data which shows that the model is producing the correct trip lengths by journey purpose.

Public Transport Model

The public transport demand model went through the same process as the highway model with regard to mode choice, trip distribution and validation. The bus and rail demand was measured against census and observed data, as used to develop the observed matrices, to demonstrate that the PT demand model reflects reality across the Warrington area.

DEMAND MODEL REALISM TESTS

WebTAG suggests that demand model should undergo realism tests to measure the level of elasticity under changing characteristics relating to increased fuel prices, highway journey times and public transport costs. Each time period has to be within a predefined elasticity range for each test with certain journey purposes showing different degrees of elasticity relative to each other. In September 2009 the Department for Transport (DfT) issued a revision of this guidance for consultation. It is highly likely that the revised guidance will be adopted sometime in 2010, so with this in mind, the demand model elasticity has been measured against the consultation guidance.

The realism test for journey times and increased fuel costs gave results that met the WebTAG criteria. However, the Public Transport fare increase test suggests the model is not as elastic as the WebTAG criteria advises. The reasons are linked to very low PT fares in Warrington due to the high proportion of concessions meaning that a 10% increase in PT fares is a marginal increase in the generalised cost.

SUMMARY

WSP has developed a multi-modal transport demand model covering the Warrington area in detail using the VISUM software. It reports car, bus, rail and slow modes and has the functionality to report new modes such as park & ride in the future. The model has been developed in accordance with and the spirit of the latest DMRB and WebTAG guidance. This was facilitated by a series of Technical Working Groups comprising WSP and members of the Steering Group.

The model’s wider functionality is now ready to be utilised for a number of studies and initiatives including supporting the LDF and LTP processes, development control exercises and can be used to support major scheme business cases. In this respect the base year Warrington Multi-Modal; Demand Model is deemed by WSP to be ‘fit for purpose’.

GLOSSARY OF TERMS

RSI MATRIX (Observed Model)

The OD trip matrix built from Roadside Interview origin and destination surveys.

SYNTHETIC DEMAND MODEL MATRIX (Demand Model)

The OD synthetic trip matrix produced by the Demand model.

INFILL MATRIX (Demand Model)

An extract from the OD synthetic demand model matrix that covers the OD patterns not observed or included in the RSI matrix.

PRIOR MATRIX (Observed Model)

The RSI matrix and the Infill matrix combined together.

FINAL MATRIX (Observed Model)

This matrix is produced after the prior matrix has undergone matrix estimation in the Observed Model.

1 Introduction

1.1 BACKGROUND

1.1.1 Warrington is extremely well located on both the national road and rail networks, allowing good connections with both the North West region and the rest of the country. This has led to substantial development in the past 30 years, and the designation of Warrington as a New Town has contributed to a large population increase in the same time frame. Housing has grown alongside employment areas such as Birchwood, Centre Park, Woolston Grange and Gemini.

1.1.2 In September 2008, this population and employment expansion was forecast to continue with a number of housing approvals running ahead of forecasts, and new employment sites given the go-ahead for development. This expansion is expected to bring with it a substantial increase in traffic movements within Warrington that may cause significant congestion within the town. Warrington Borough Council and partners have recognised that, with a sound transport strategy and appropriate investment in infrastructure, Warrington has the potential to reduce the transportation impacts of this development and ensure the continued prosperity and status of the town.

1.1.3 In order to provide technical evidence for such strategies, WSP was commissioned by Warrington Borough Council (WBC) and their partners, (Highways Agency (HA), Peel Holdings (PH), Homes and Communities Agency (HCA) (previously English Partnerships) and the North West Development Agency (NWDA)), to undertake a transportation study to support, in the first instance, the Local Development Framework (LDF) process. The strategic model developed by WSP offers an integrated system for a range of transport modes, representing private and public transport as well as modal interchange behaviour such as walking. The model will have the ability to quantify the benefits of a policy change or new transport infrastructure in Warrington, enabling the testing of future transport proposals and developments (including developer led) in an efficient, consistent and evidentially based manner.

1.1.4 The model is able to assess the Council's existing transport strategy set out in the second Local Transport Plan and the delivery framework, developed in the Transportation Framework. Evidence gained from the model may be used in furthering submissions made to the North West Regional Funding Allocation (RFA) and therefore must be sufficiently robust and documented to satisfy Department for Transport WebTAG standards.

1.1.5 The model specification was developed in accordance with current Department for Transport guidelines detailed in WebTAG, which is aimed at ensuring a consistent and reputable basis for forecasting. The highway model was developed in line with Design Manual for Roads and Bridges (DMRB) guidance.

1.2 MODEL REQUIREMENTS

1.2.1 The Multi Modal Transport Model is required for wider strategic testing, localised testing, plan policy evaluation and scheme appraisal within Warrington. This must be done in a fair and transparent manner to ensure that the impacts of all proposals can be compared honestly. Impacts to the transport network from individual developments must also be equally assessed in order to fairly calculate contributions required from developers. For this reason it was necessary to obtain a particularly well validated model of Warrington and the surrounding area.

1.2.2 A Technical Working Group (TWG) comprising technically able members from WSP, WBC, AECOM (as advisors to the Steering Group) and the HA, was set up to agree modelling principles, methodologies, assumptions and scope. This provided a high degree of control and minimised grounds for disagreement at a later stage in the study process.

1.3 REPORT PURPOSE

1.3.1 Ultimately, the purpose of this Local Model Validation Report (LMVR) is to present the development of the Warrington Multi-Modal Transport Model (WMMTM) and demonstrate that it was developed in a robust manner, meets the DMRB criteria and is fit for purpose.

2 Model Overview

2.1 INTRODUCTION

2.1.1 The purpose of this study is to inform the development of a transport and accessibility strategy, and to establish a sound basis for consultation on the LDF and proposed development areas. With this in mind, the WMMTM has been constructed in two stages, firstly as a strategic model of the wider area to establish major routes into and out of Warrington, secondly as a more detailed multi modal transport model capable of assessing the impacts of future changes in journey patterns within Warrington.

2.1.2 This section describes the model approach, the software applied and the data collated for use in developing the WMMTM.

2.2 MODELLING APPROACH

2.2.1 The WMMTM is designed to enable future land use planning and transport policy initiatives to be assessed in an integrated fashion. This integration aims to take account of:

- The impacts of economic and demographic trends and of land use change on the spatial and modal pattern of the demand for passenger transport
- The impacts of changes in transport costs and characteristics on the costs and spatial patterns of location of employment and households.

2.2.2 The modelling specified is wide ranging, in that it includes all modes of travel and has the ability to assess a wider set of short term and longer term behavioural responses to policy initiatives than is normal in more traditional models.

2.2.3 This model represents, at the strategic levels, the main long-distance transport routes in the entire study area. There is a detailed representation of traffic and public transport service levels within the WMMTM area. As a result the key abilities of the model are:

- Assessing the transport impacts of significant developments
- Reviewing the impact of development plans to the transport network
- Forecasting changes in demand as a result of changes in the socio-economic characteristics
- Allowing forecasting of demand by all modes for a period in line with current Local Development Framework timescales
- Identification of schemes and measures for LTP3 and considering the impact of improvements on the strategic network
- Identifying current and future congestion hotspots and assist in the modelling of the network management scenarios assisting the local transport authority to fulfil its requirements as required by the Traffic Management Act 2004.

2.2.4 The model has been developed with due cognisance of WebTAG on model form and development to accommodate major public transport improvements and the sensitivity analysis required to achieve central government funding.

2.2.5 The WMMTM is built on a behavioural basis that determines the travel demand from the underlying characteristics of the transport supply and characteristics of the travellers in the area. Key features of the model are:

- The input of detailed planning / land use assumptions
- The generation of trips by all modes of travel for the different segments of the population
- The choice of mode of travel
- The distribution of the different trip types to the various destinations available
- The choice of routes of travel
- An accurate representation of the observed base year travel patterns
- Realistic representation of the observed base year, congestion and queuing in peak periods

2.2.6 This list of requirements is a mixture of the features typically found in strategic transport models, focusing primarily on travel demand choices, and the features of a local highway model, representing the local road network in detail incorporating junction delays and queuing.

2.2.7 Local highway models typically use highway demand matrices derived from survey data which can be calibrated to accurately match traffic counts in the base year. However, the lack of any behavioural basis in the derivation of these matrices means that a relatively crude approach is required to modify these matrices through time in order to produce future year matrices. This approach cannot take into account any fundamental changes in trip patterns arising through changing population and attraction opportunities.

2.2.8 Strategic travel demand models derive synthetic trip matrices through a series of behaviourally-based relationships using population, employment and trip rate information. Unless these synthetic matrices are subsequently manipulated to match some observed targets, it is unlikely that a validation of resulting traffic flows would be as accurate in the base year as those obtained in a local model using matrices built from survey data.

2.2.9 To produce a satisfactory model for this study it is important to bring the best aspects of the two types of model together into a single modelling framework; synthetic travel demand matrices are developed based on the choices facing travellers and observed matrices calibrated with observed origin and destination information from survey data. By making the two sets of matrices (synthetic and observed) comparable, the synthetic model is able to forecast changes in model matrices which can be applied to the observed highway matrices.

2.3 MODEL FORM AND STRUCTURE

2.3.1 The WMMTM model structure is shown in Figure 2.1 and Figure 2.2, the model consists of two main models:

- Synthetic or **Demand** model, incorporating the traditional four stages of trip generation, mode choice, trip distribution and assignment
- **Observed** assignment model which uses the synthetic model outputs

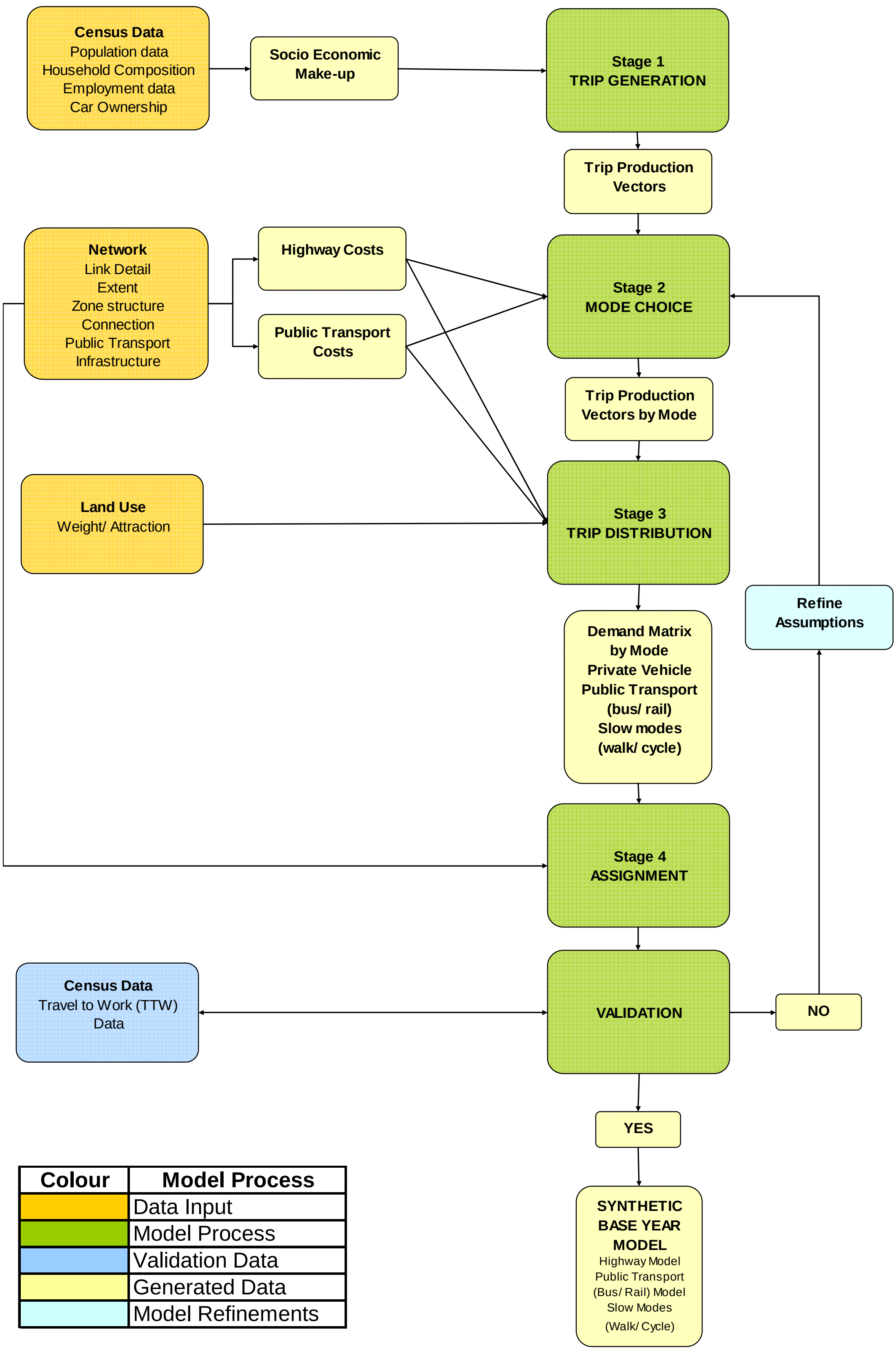
2.3.2 The base year synthetic model is validated to the known observed travel choices and is used to produce future forecasts. The changes, which take into account changes in generalised cost and zone attractiveness, between the base year and the future forecast in the synthetic model are then inputted into the base observed model to measure the actual change between the base year and the future forecast.

CHOICE OF SOFTWARE

2.3.3 WSP identified VISUM, developed by PTV, as the most appropriate strategic multi-modal modelling package for the development of the WMMTM. VISUM is a comprehensive and flexible software system which operates in a Windows and GIS environment making it a very user friendly tool for assessing transport schemes. It is designed for multi-modal analysis and can integrate all relevant modes including car, goods vehicle, bus, tram/guided bus, park & ride and rail into a holistic network model. This removes the need for cumbersome interfaces between highway and public transport models that more conventional methods employ (such as SATURN – EMME/2 models). VISUM is also capable of exporting whole models or parts thereof directly into VISSIM, a micro-simulation modelling tool also developed by PTV.

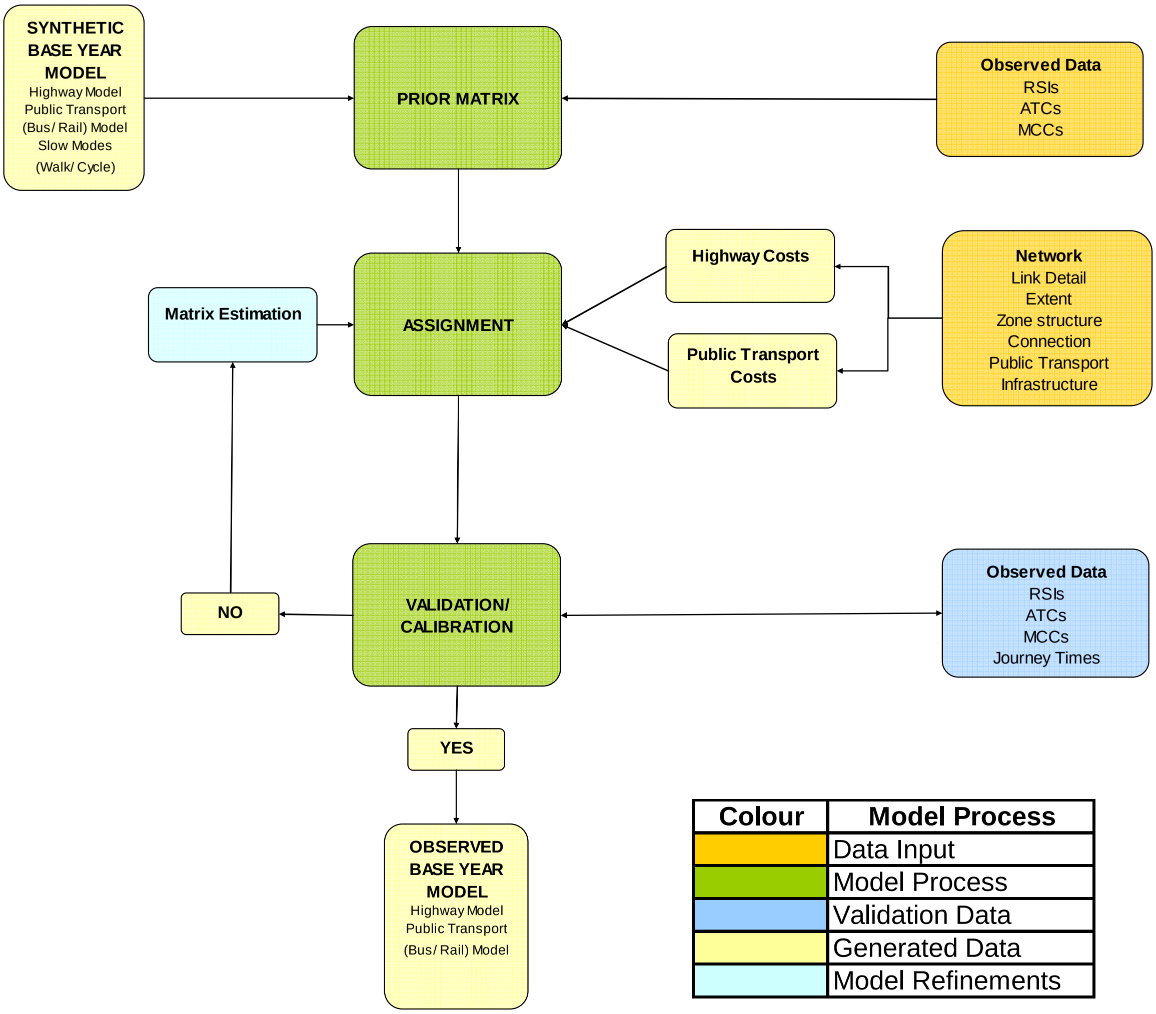
2.3.4 Figure 2.3 shows the interaction between the VISUM software and the specially developed Visual Basic Scripts that allow the four stage process to occur in the WebTAG required order.

Figure 2.1 – Warrington Demand Model Structure



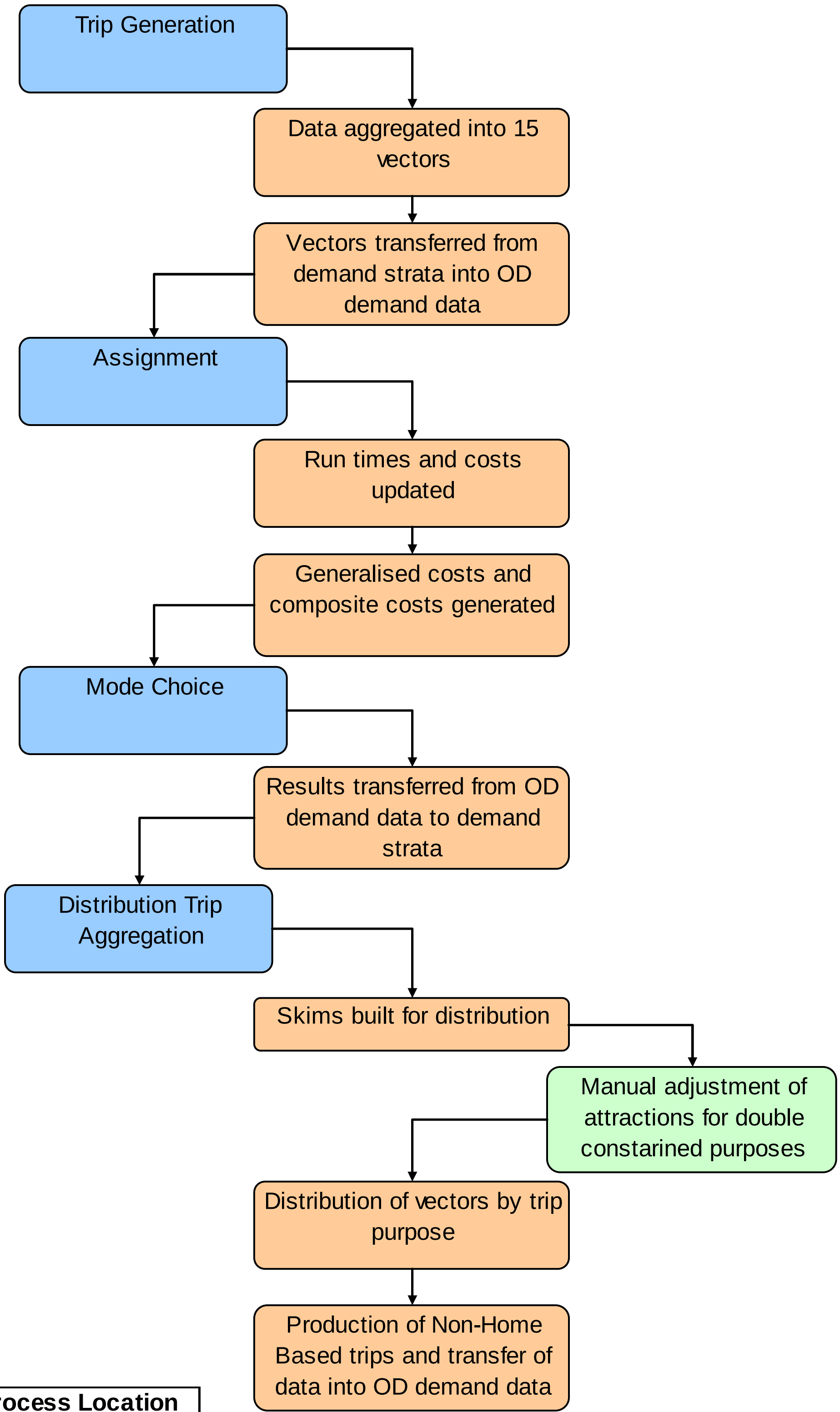
Colour	Model Process
	Data Input
	Model Process
	Validation Data
	Generated Data
	Model Refinements

Figure 2.2 – Warrington Observed Model Structure



Colour	Model Process
(orange-yellow)	Data Input
(green)	Model Process
(light blue)	Validation Data
(pale yellow)	Generated Data
(pale cyan)	Model Refinements

Figure 2.3 – VBA/ VISUM Interaction



Colour	Process Location
(blue)	VISUM
(orange)	VBA Script
(green)	Manual Adjustment

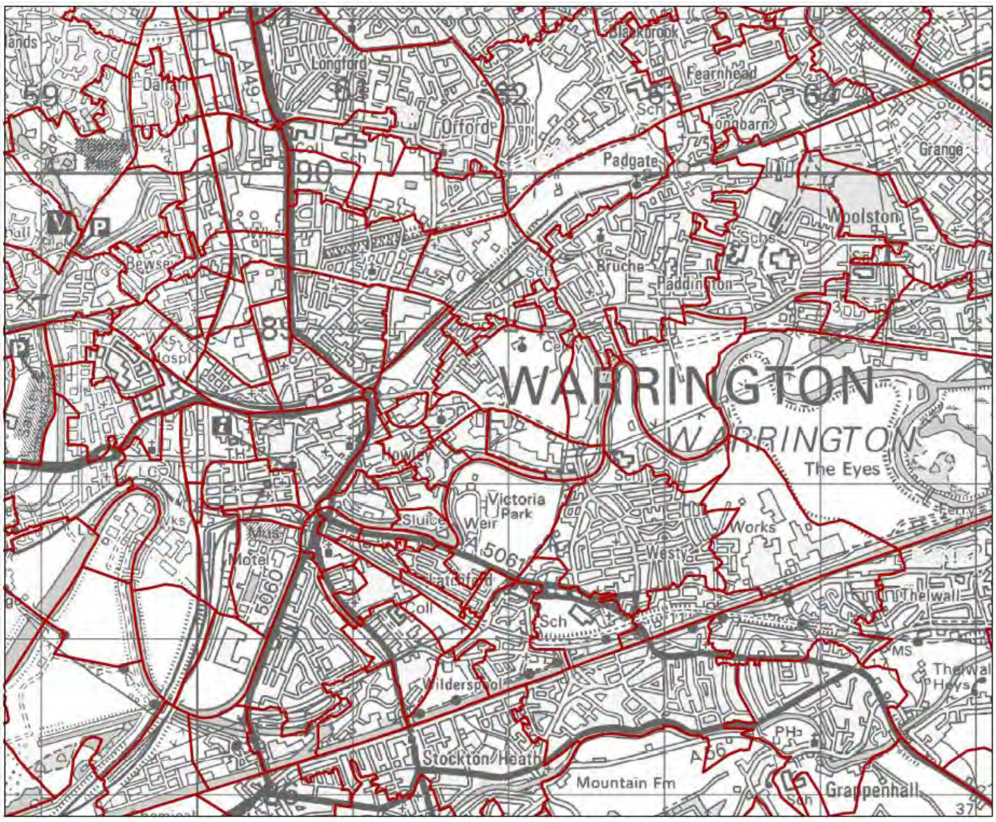
2.4 OBSERVED ASSIGNMENT MODEL

2.4.1 An existing earlier VISUM model that covered a large part of the Warrington area was used to provide the basis of the strategic network. NAVTEQ™, a GIS based tool which can generate exact link structure and attributes in VISUM from its mapping knowledge was used to complete a spatially accurate strategic road network.

2.4.2 Detailed **Base Year (2008)** multi-modal networks were constructed for roads and buses and rail in one connected environment. These were based on the initial strategic model refined to the study area, using available data including signal plans, site inventory data and scheduled public transport services.

2.4.3 Since VISUM operates on a GIS platform, it can therefore link with other GIS datasets such as the 2001 Census data. The model zone system therefore is based upon the 2001 Census Output Areas (COAs); aggregated beyond Warrington and disaggregated or refined in detail within central Warrington. This is shown graphically in Figure 2.4, as an output from VISUM. A larger version of the zonal plan can be found in Appendix A.

Figure 2.4 – Zone System based upon 2001 COAs



2.4.4 AM peak (0800-0900), Inter Peak (IP) (12:00-13:00) and PM peak (17:00-18:00) observed assignment models were developed for the base year. The observed base year matrices were developed for each existing mode type (i.e. bus, rail, and vehicles including private vehicle and goods vehicle). These matrices were partially developed from observed trip behaviour determined through a combination of Roadside Interviews (RSIs), Automatic Traffic Counts (ATC), Manual Classified Counts (MCC), Bus and Rail surveys. The unobserved trips were created using census data within the four-stage demand model. All peak models have been calibrated and validated to the current acceptability criteria as detailed in DMRB volume 12.

2.4.5 Figure 2.5 and Figure 2.6 present the observed base year highway and public transport model development processes in the form of a flow chart. The model development is described in detail in the following sections.

Figure 2.5 – Observed Base Year Highway Model Development Flow Chart

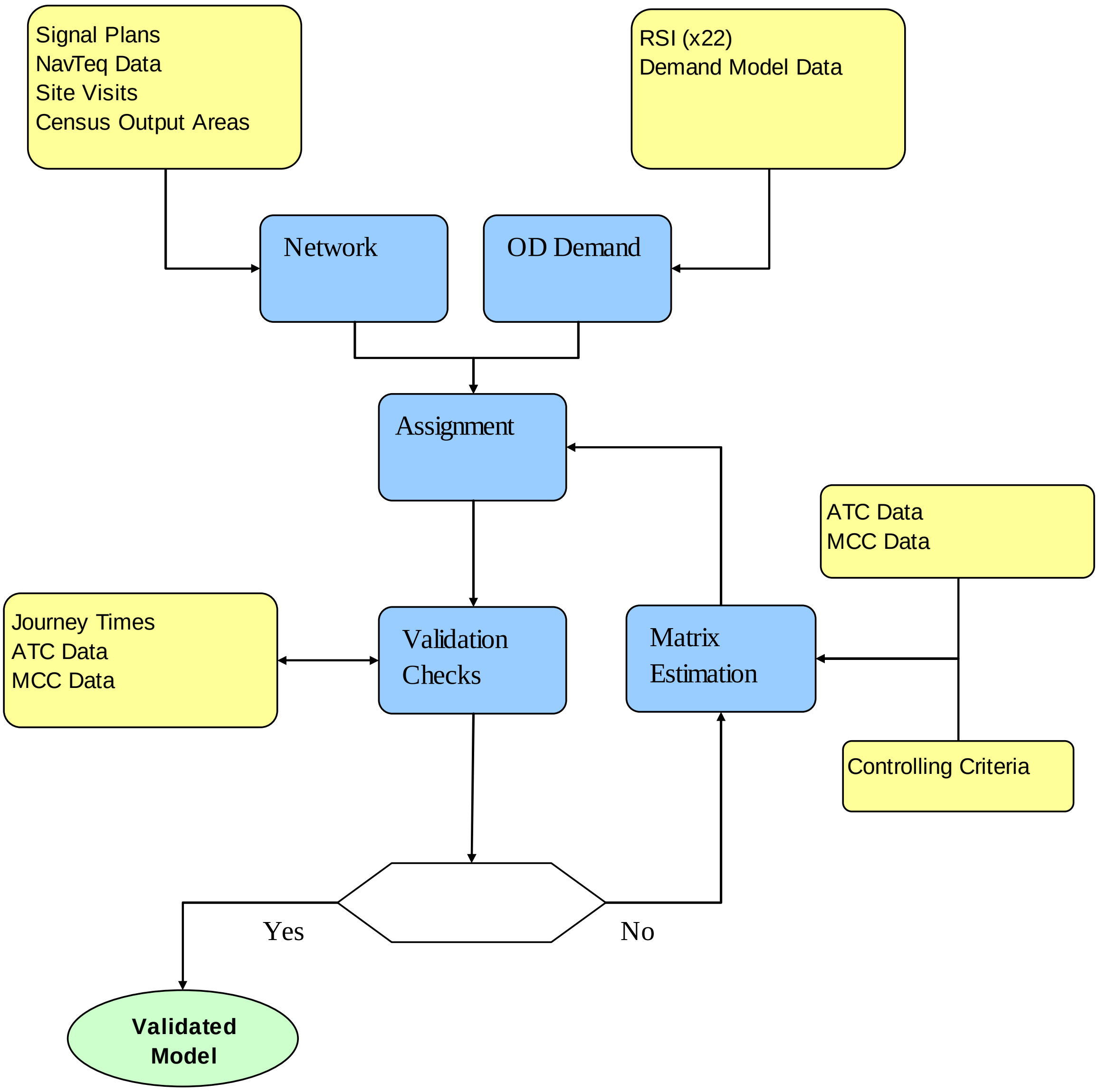
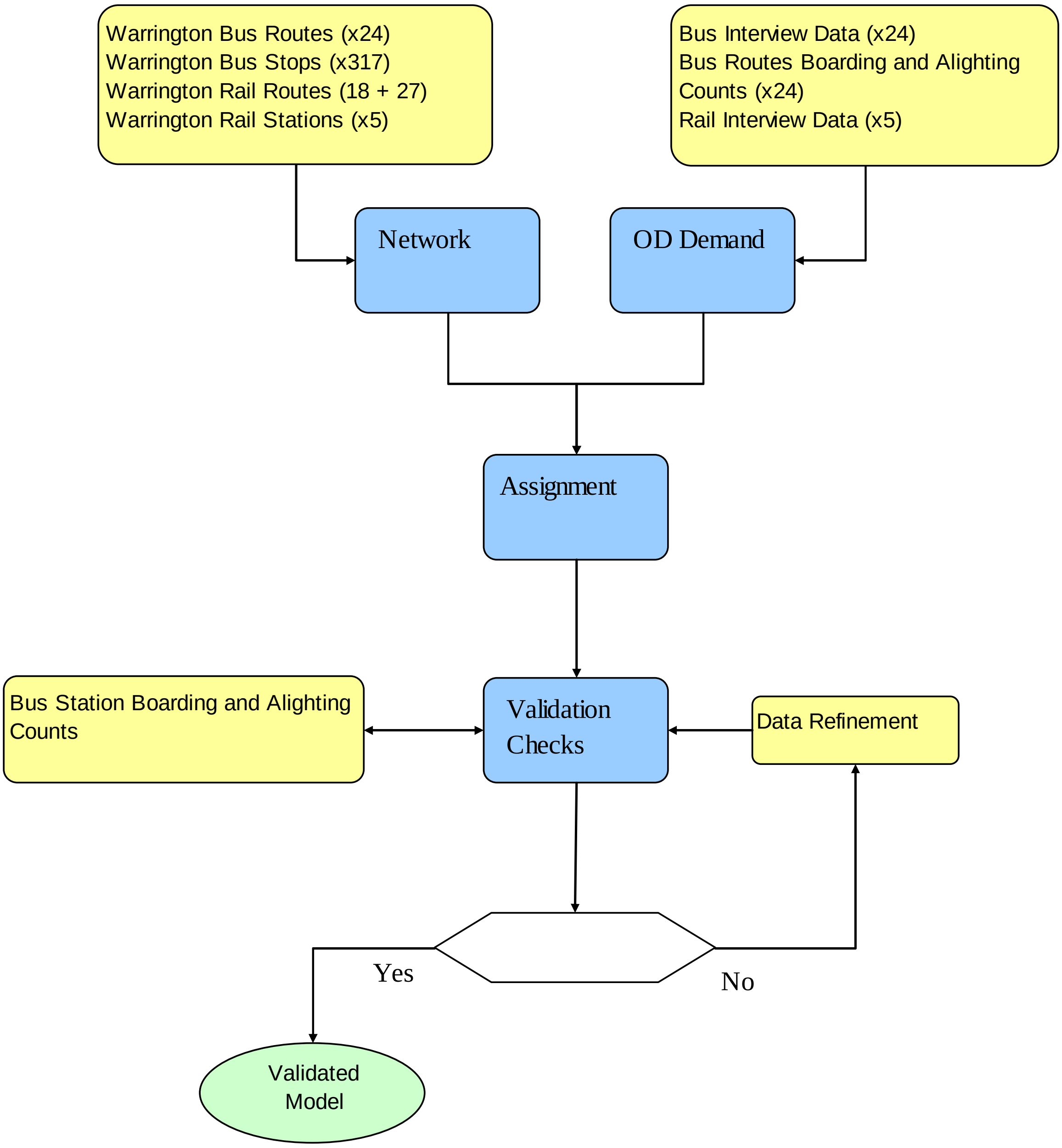


Figure 2.6 – Observed Base Year Public Transport Model Development Flow Chart



OBSERVED MODEL DATA COLLECTION

2.4.6 Warrington Borough Council (WBC) provided WSP with a large quantity of existing data that included existing RSI data, manual traffic counts, automatic traffic counts, journey time surveys, bus passenger data, rail passenger data and car parking data. The existing data received by WSP included previously built models:

- 2005 SATURN Highway Model data (Warrington Borough Council)
- Mersey Gateway Model data (Halton Borough Council)

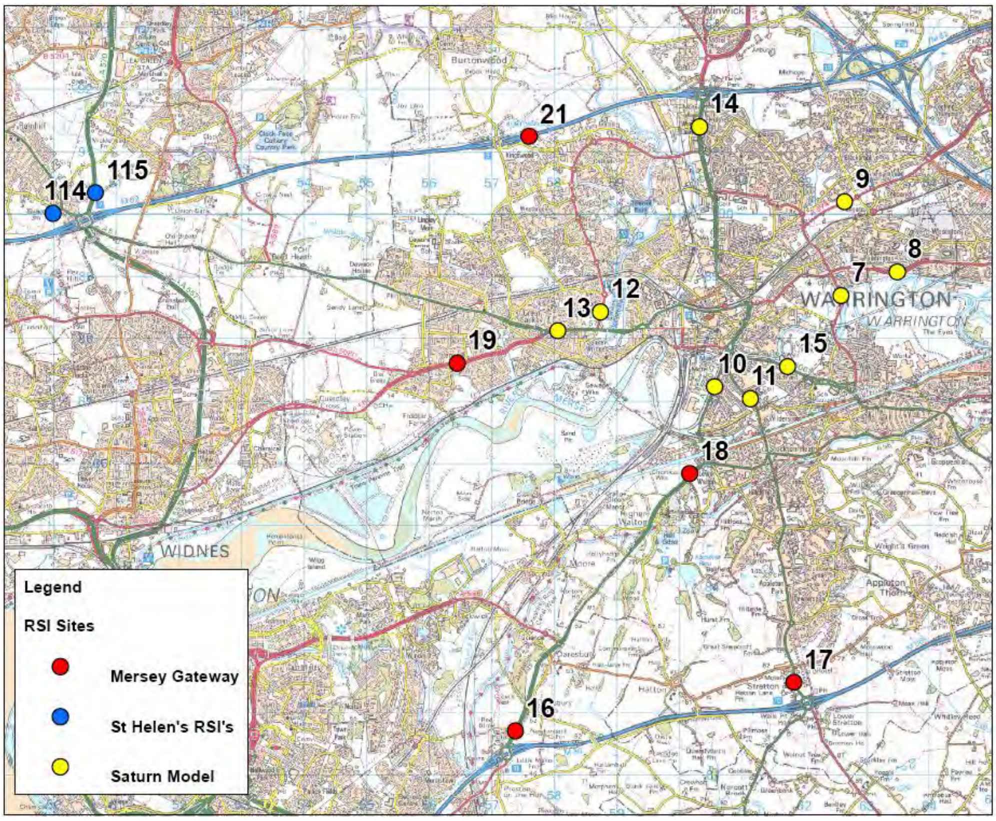
- Liverpool City Region Transport Model (St Helen's Study) (Merseytravel for City Region)
- Paramics Model Siemens (Warrington Borough Council)

And additional sources of data:

- Birchwood Travel Survey (Highways Agency)
- Citizens Panel Survey Report (Warrington Borough Council)
- Chapelford Survey Rail data including surveys at Sankey and Warrington Central (Warrington Borough Council)
- Ship canal bridge swing times data (Peel Ports)
- Automatic Traffic Count data (Warrington Borough Council)
- Journey Time data (Warrington Borough Council)
- Travel Survey data (Warrington Borough Council)
- Bus Patronage Count data (Warrington Borough Council)
- TRADS ATC data (Highways Agency)

2.4.7 The locations of the 2005 SATURN sites, along with the Mersey Gateway and St Helens' RSI sites, used in the model development are shown in Figure 2.7.

Figure 2.7 - Location of Mersey Gateway, Saturn and St Helens' RSI sites



2.4.8 Following a review of the quality of the available data (age, time periods covered, location, etc.), WSP commissioned the collection of additional data in and around Warrington to compliment the existing data and provide a more comprehensive understanding of travel patterns. The following data was collected for use in developing the WMMTM:

Roadside Interview surveys (survey locations are illustrated on Figure 2.8)

- 6 RSI surveys (one direction, 12 hours)
- 6 ATC counts at RSI survey locations (for 2 weeks)
- 6 Manual Classified Counts on day of RSI surveys at RSI locations

Junction Turning Counts (survey locations are illustrated on Figure 2.9)

- 20 Junction Turning Counts for three time periods (AM, IP and PM) (3/4 arm junctions)

Link Counts (survey locations are illustrated on Figure 2.9)

- 4 ATC link counts for two weeks

Figure 2.8 - Location of 2008 RSI Surveyed Sites

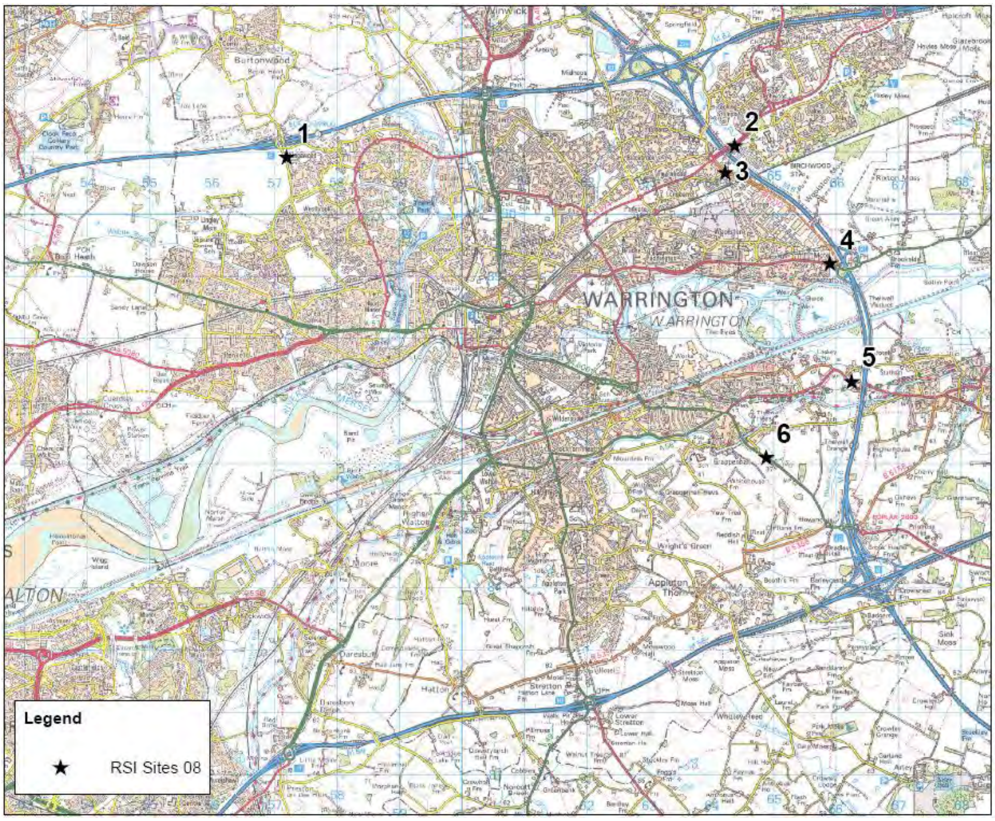


Figure 2.9 – Link and Turning Count Locations in Warrington

Journey Times

- 4 journey time routes run 6 times for three periods (AM, IP and PM)

Railway

- Passenger Counts and Origin/Destination (OD) interviews of passengers boarding and alighting at two railway stations, Bank Quay station (0600-2000) and Padgate station (0700-1900)

Bus

- Boarding and alighting counts and on board passenger interview surveys for one 12 hour day on 25 bus services
- Passenger Counts and interviews of passengers boarding and alighting at THE central bus station (from 0600-2000)

Car Park Inventory

- Access and egress counts taken at 14 car parks over a 12 hour period
- Interviews undertaken at 5 car parks
- Length of stay surveys undertaken at 5 car parks

Automatic Number Plate Recognition (ANPR) Surveys

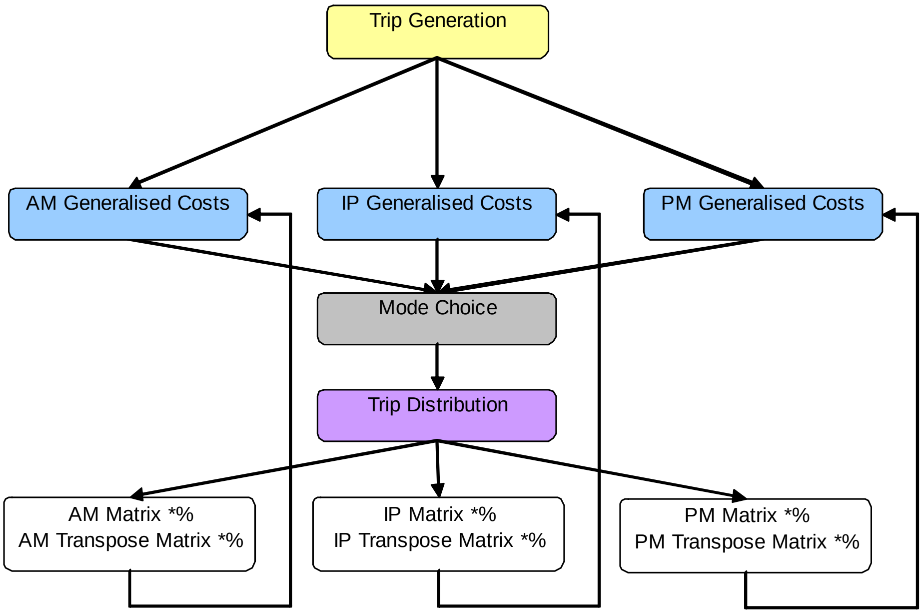
- 52 cameras covering all lanes of 12 separate two way sites around the M62-M6-M56 motorway box covering three time periods

2.4.9 Full detail of the data collection process can be found in the Warrington MMTM Survey Report (March 2009).

2.5 SYNTHETIC DEMAND MODEL

2.5.1 A 24-hour synthetic demand model has been developed using generalised costs from the peak hour assignments, as shown in Figure 2.10. The generalised cost for HBW is an average cost between the AM and PM peak generalised costs and the HBEb, HBO, HBEd and HBSh take the generalised costs from the Inter peak.

Figure 2.10 – Demand Model Structure



2.5.2 The demand model has been validated against observations to ensure that robust estimates of future trip numbers are being generated. The synthetic demand model uses the same network and zoning system as the observed model.

2.5.3 The guidance available from WebTAG contains advice on the most appropriate choice hierarchies to adopt for the mode and distribution stages within travel demand models. This guidance has been given significant weight in the design of this model. The WebTAG guidance states that the hierarchy of choice components, ranging from the choices at the top that are least sensitive to supply characteristics in the order of increasing sensitivity to the bottom, is as follows:

- Trip frequency (or generation) which may be represented as inelastic if all modes of transport (i.e. walk and cycle) are included
- Main mode choice (i.e. between car, public transport and walk/cycle) is as insensitive as macro time of day choice (i.e. peak-peak period, rather than micro Time of Day (TOD) choice, i.e. minor peak spreading variations within a period)
- Destination Choice (or trip distribution) is a sensitive choice component as it is based upon the relative attractiveness and the travel cost to a destination zones

- Route assignment is at the bottom of the choice hierarchy, being the most sensitive of all of the choices, to the measured cost and time characteristics of the route options available

2.5.4 Trip frequency and mode choice are significantly less sensitive than destination choice. The WMMTM follows the hierarchy stated above for all trip purposes and is compliant with current guidance and advice.

2.6 GENERALISED COST PARAMETERS IN ASSIGNMENT

2.6.1 All assignments have been undertaken for cars and HGVs based on time only. Extensive research was undertaken into using a combination of both time and distance to calculate route search in assignment as advised in WebTAG Unit 3.5.6. Ordinarily an element of distance would be a factor in determining route choices between OD pairs. However, because of the motorway box around Warrington and the limited number of River Mersey and Shipping Canal crossings this produced unexpected routings including HGVs diverting through Warrington instead of using the motorway network. Therefore it was decided that time only assignment was most suitable and also brought about the best calibration/validation results.

2.7 BLOCKING BACK

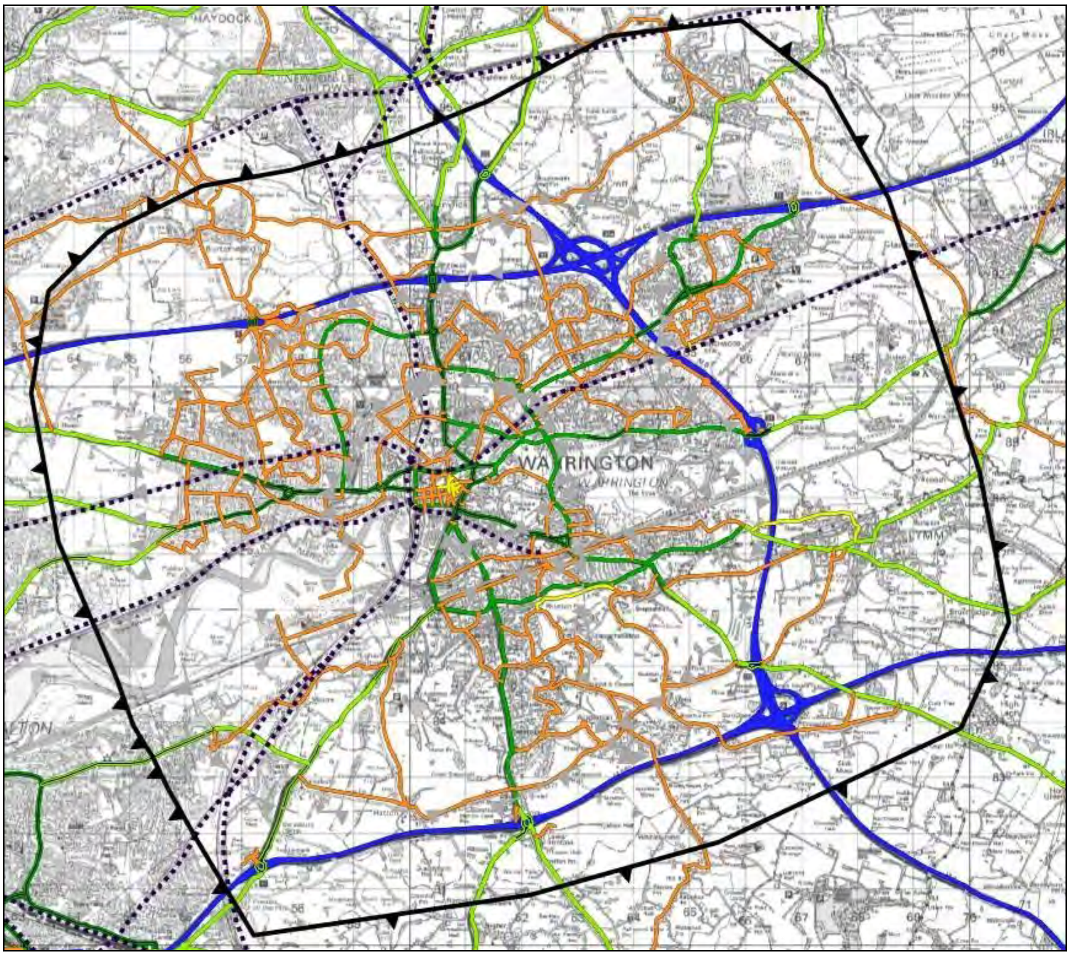
2.7.1 VISUM has a 'Blocking Back' feature that ensures demand does not exceed link capacity during assignment. In the event that demand is greater than the link capacity queues will form and block back the upstream link(s). This will increase delays and affect route choice. Blocking Back is calculated during assignment between assignment iterations thereby allowing the model to convergence its assignments. Whilst this is not a particularly important issue in the base year without Blocking Back the future year forecasts could underplay the level of congestion and delay.

3 Model Extent and Network

3.1 MODEL EXTENT

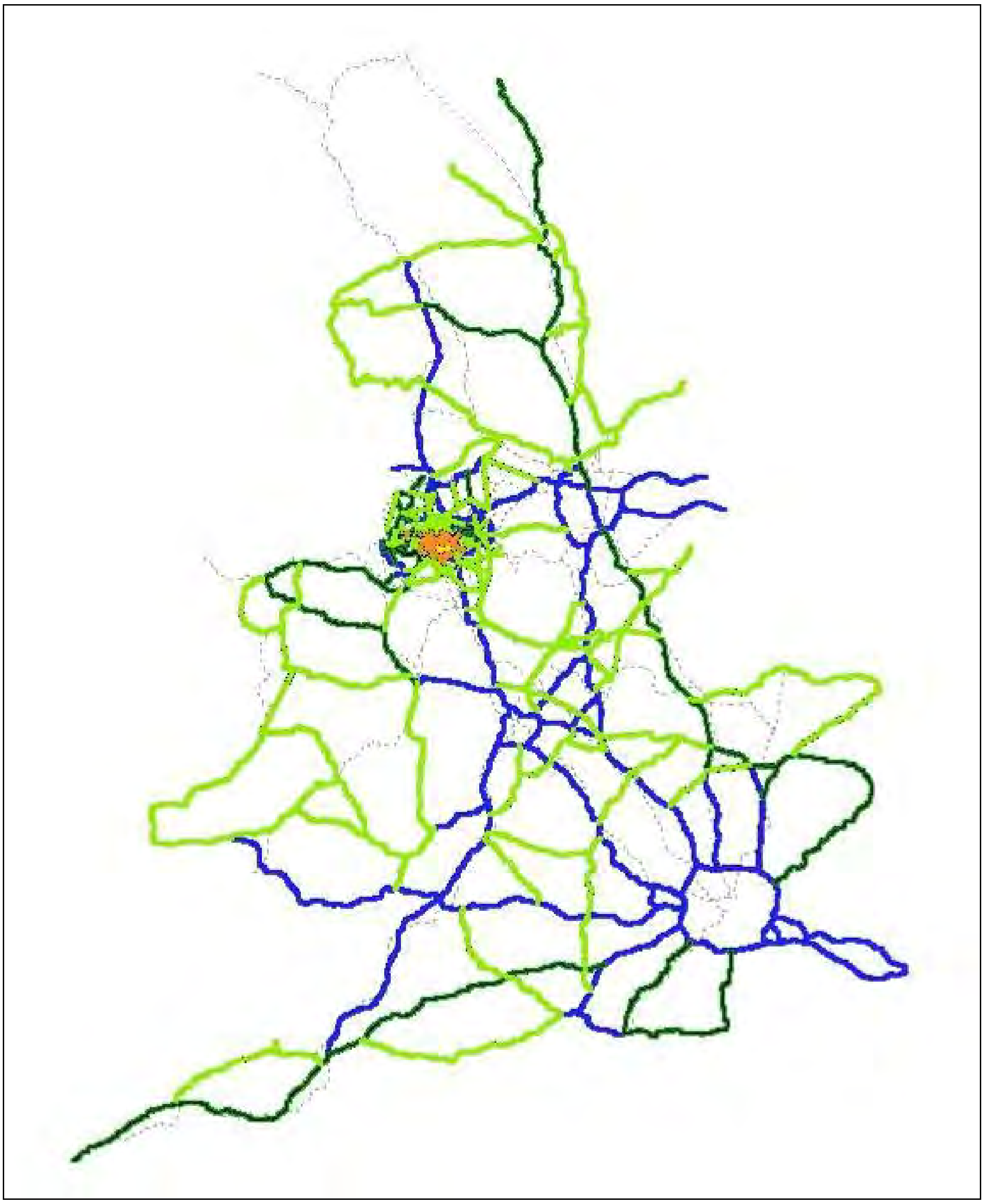
3.1.1 The extent of the detailed highway network is shown in Figure 3.1. This area was chosen to cover the residential and commercial areas that fall under Warrington Borough Council's remit and include all those areas likely to be proposed as development sites in the Core Strategy of the LDF and the associated strategic re-routing of trips or potential modal transfer to public transport. In addition to the detailed Warrington highway network, a skeletal strategic network was included for the whole of England and Wales. This enabled accurate routing of long distance trips into Warrington and can be seen in Figure 3.2.

Figure 3.1 – Warrington VISUM Detailed Network Coverage



Colour	Road Type
(blue)	Motorway
(dark green)	Urban A Road
(light green)	Rural A Road
(orange)	B Road
(yellow)	Minor Road
(black line with triangles)	Area of Simulation

Figure 3.2 – VISUM strategic network



Colour	Road Type
(blue)	Motorway
(dark green)	Urban A Road
(light green)	Rural A Road
(orange)	B Road
(yellow)	Minor Road

3.2 HIGHWAY NETWORK

3.2.1 A base highway network was available from a previous study in the area. The old highway network was developed further into the new highway and rail network using a GIS environment from NAVTEQ™ and OS Meridian data, which included geographically correct lengths, road classification and number of lanes. Following the development of the full network, an on-site inventory was carried out to check and clarify the number of lanes, link type, capacity and speed limit. The road network includes all A and B roads and other strategic local roads. Other unclassified local roads were also included to a high level of detail.

3.2.2 The classification of link types used within the model is detailed below in Table 3.1.

Table 3.1 – Link Type Classification used in the Warrington Multi-Modal Model

Link Type		Number of lanes	Capacity / lane (pcu)	Free Flow Velocity (kph)
1	Motorway D4	4	2520	116
2	Motorway D3	3	2520	116
3	Motorway D2	2	2430	112
4	Motorway Slips 2	2	1500	65
10	Primary A Road D2 Rural	2	2260	108
11	Primary A Road D2 Sub-Urban	2	1860	91
12	Primary A Road D2 Urban	2	1720	78
20	A Road D2 Rural	2	2180	105
22	A Road S2 Urban	1	1500	58
23	A Road S2 Rural	1	1860	91
31	B Road S2 Rural	1	1380	78
32	B Road S2 Sub-Urban (Good B-40mph)	1	1285	61
33	B Road S2 Sub-Urban (Avg B-30mph)	1	1030	58
40	Minor Road Suburban 2-lane	1	1500	58
42	Minor Road Urban (Typical Dev, 2-lane)	1	780	48
43	Minor Road Urban (Low Dev)	1	980	54
45	Minor Road Rural Village (40mph low development)	1	1300	66
46	Minor Road Rural Village (30mph)	1	880	47
48	Pedestrianised	1	99999	4
50	Unclassified (residential)	1	500	20
80	Rail	1	99999	100

3.2.3 Speed flow curves or volume-delay relationships (as referred to in VISUM) are applied to all links outside of the main study area, where junctions are not modelled in detail. Within the study area, volume-delay relationships are applied to the strategic and local highway network around Warrington. This is due to link capacities not being constrained by the capacities at the junctions. The volume-delay function used is as follows:

$$t_{new} = t_0 \cdot (1 + a \cdot sat^b)$$

where

$$sat = \frac{q}{q_{\max} \cdot c}$$

t_{new} = the volume dependent time;

t_0 = the free flow time;

q = the vehicle flow;

$q_{\max}$ = the link capacity; and

a, b and c are user defined parameters.

3.2.4 The parameters a, b and c have been selected to best replicate the COBA speed-flow relationships described in DMRB Volume 12.

3.2.5 For the wider network where junctions are not modelled in detail, speed flow curves based on COBA are used to model the relationship between traffic volumes and vehicle travel times.

Table 3.2 – Speed Flow Curves for VISUM Model

Link Type	Parameters		
	a	b	c
Motorway D4 and D3	0.8	3.5	1
Motorway D2	0.8	3	1
Primary and A Road D2 Rural	0.5	3	0.9
A Road D2 Sub-Urban (Avg A-40mph)	1	3	1
A Road Single	1	3	1
B Road S2 Sub-Urban (Good B-40mph)	0.5	4	1
Minor Urban Road	2	3	1.5
B Road Rural	1.7	2.5	1.7
Minor Road Rural Village	0.2	4	1

3.2.6 The network was developed to facilitate the export to the VISSIM micro-simulation package.

3.3 JUNCTIONS

3.3.1 All of the junctions within the Warrington area illustrated in Figure 3.1 were modelled in detail. The junction coding for the network included junction type (priority, roundabout or signalised), the number of approach lanes and whether there were any approach lane pockets (flares), saturation flows, and signal configurations where relevant. Detailed junction information including signal layouts and timings where appropriate was obtained from WBC for the key junctions listed in Appendix B, whilst all other junctions in the network were coded using standard junction templates. This allowed those junctions likely to suffer the greatest impact from the development of Warrington to be modelled in sufficient detail to enable the robust assessment of the highway network and development of any mitigation measures. The locations of all signalised junctions are shown in red in Figure 3.3.

Figure 3.3 – Location of Signalised Junctions in Warrington

3.4 BUS NETWORK

3.4.1 The main local bus services in Warrington were included in the WMMTM and are listed in Table 3.3. The location of the bus stops was taken from WBC data, and the bus routes and service frequencies were gathered from published timetables and site visits. Long distance bus routes were not included in the model as they are unlikely to be subject to modal shift.

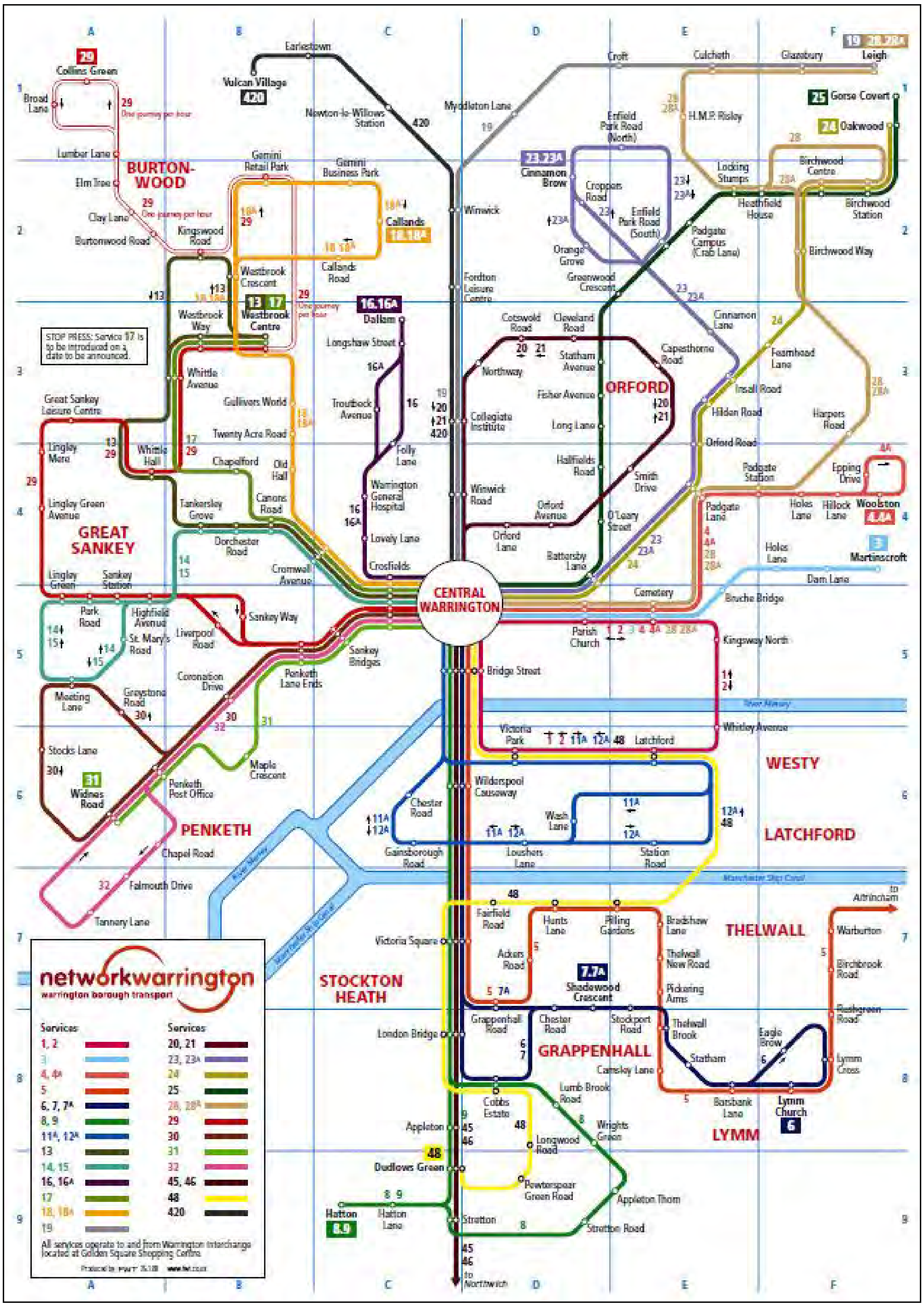
3.4.2 All bus routes surveyed in the data collection process were included in the models. Those not surveyed were not included as this would affect the public transport calibration.

Table 3.3 – Bus Services Included in the WMMTM

Route Number	Route	No of Services		
		AM 08:00-09:00	PM 17:00-18:00	IP 11:00-14:00
1	Warrington - Westy (circular - anti-clockwise)	4	4	4
2	Warrington - Westy (circular - clockwise)	4	4	4
3	Warrington - Martinscroft	5	4	4
3		6	4	4
4	Warrington - Woolston	4	4	4
4		4	4	4
5	Warrington - Altrincham	2	2	2
5		2	2	2
6	Warrington - Liverpool	2	2	2
6		2	2	2
11	Warrington - Loushers Lane (circular - clockwise)	0	1	1
12	Warrington - Loushers Lane (circular - anti-clockwise)	2	1	1
13	Warrington - Westbrook	2	2	2
13		2	2	2
14	Warrington - Sankey (circular - anti-clockwise)	2	2	2
15	Warrington - Sankey (circular - clockwise)	2	2	2
16	Warrington - Dallam	5	8	5
16		5	8	5
17	Warrington - Westbrook	2	2	2
17		2	2	2
18	Warrington - Callands	6	6	6
18		6	6	6
20	Warrington - Orford (circular - clockwise)	5	5	5
21	Warrington - Orford (circular - anti-clockwise)	5	5	5
23	Warrington - Cinnamon Brow	4	4	4
23		4	4	4
24	Warrington - Gorse Covert	2	2	2
24		2	2	2
29	Warrington - Lingley Green/ Westbrook	4	4	4
29		4	4	4
30	Warrington - Penketh	2	2	2
30		2	2	2
31	Warrington - Penketh	2	2	2
31		2	2	2
32	Warrington - Penketh	2	2	2
32		2	2	2
48	Warrington - Dudlows Green	2	2	1
48		2	2	1
360	Warrington - Wigan	2	2	2
360		2	2	2

3.4.3 The bus routes, displayed in Figure 3.4, were coded into VISUM by first inputting the bus stops of the chosen routes, which were then linked together by the relevant bus routes. Attached to the bus network was a data table containing the service information; the bus stops served, the dwell time at each stop, and the headway (bus frequency) for each route. The bus service headways inputted into the model are also presented in Table 3.3.

Figure 3.4 – Warrington Bus Routes



3.5 RAIL NETWORK

3.5.1 The main rail services through Warrington were included in the WMMTM and are listed in Table 3.4. The location of the stops within Warrington was taken from WBC data and the frequencies were gathered from published timetables.

Table 3.4 – Rail Services Included within the WMMTM

Provider	Route
Northern Rail	Manchester - Liverpool
	Liverpool - Manchester
Trans-Penine Express	Liverpool - York
	York - Liverpool
Virgin	London - Edinburgh
	Edinburgh - London
Arriva Wales	Llandudno - Manchester Piccadilly
	Manchester Piccadilly - Llandudno

3.5.2 In addition to the rail services that travelled directly through one of the Warrington stations, a dummy strategic rail network of 27 lines was coded into the wider network of the model connecting the majority of the zones in the model to the rail network. This ensures that travelling by rail is an option for people making strategic trips in the model.

3.5.3 The rail routes were coded into VISUM by first inputting the rail stations of the chosen routes, which were then linked together by the relevant route. Attached to the rail network was a data table containing the service information; the stations served, the dwell time at each stop, the timetable for each route through Warrington and the headway for each dummy strategic route.

3.6 ZONING SYSTEM

3.6.1 The zone system was based on 2001 Census Output Areas (COAs) and wards ensuring compatibility with Census household data. The COAs were aggregated or disaggregated into different land uses within Warrington where deemed appropriate.

3.6.2 Zones were created with the LDF in mind, to accommodate future development.

3.6.3 In total there are 378 zones within the WMMTM, of which 188 were allocated to Warrington. The zones are categorised into twelve regional sectors. The level of zoning detail is centred on Warrington with the zones increasing in size with distance away from Warrington. Zone and sector plans of the Warrington area and of the entire model are presented in Figure 3.5 to Figure 3.7. A larger version of Figure 3.5 to Figure 3.7 can be found in Appendix A.

Figure 3.5 – Zone and Sector Plan UK

Figure 3.6 – Zone and Sector Plan North West Region

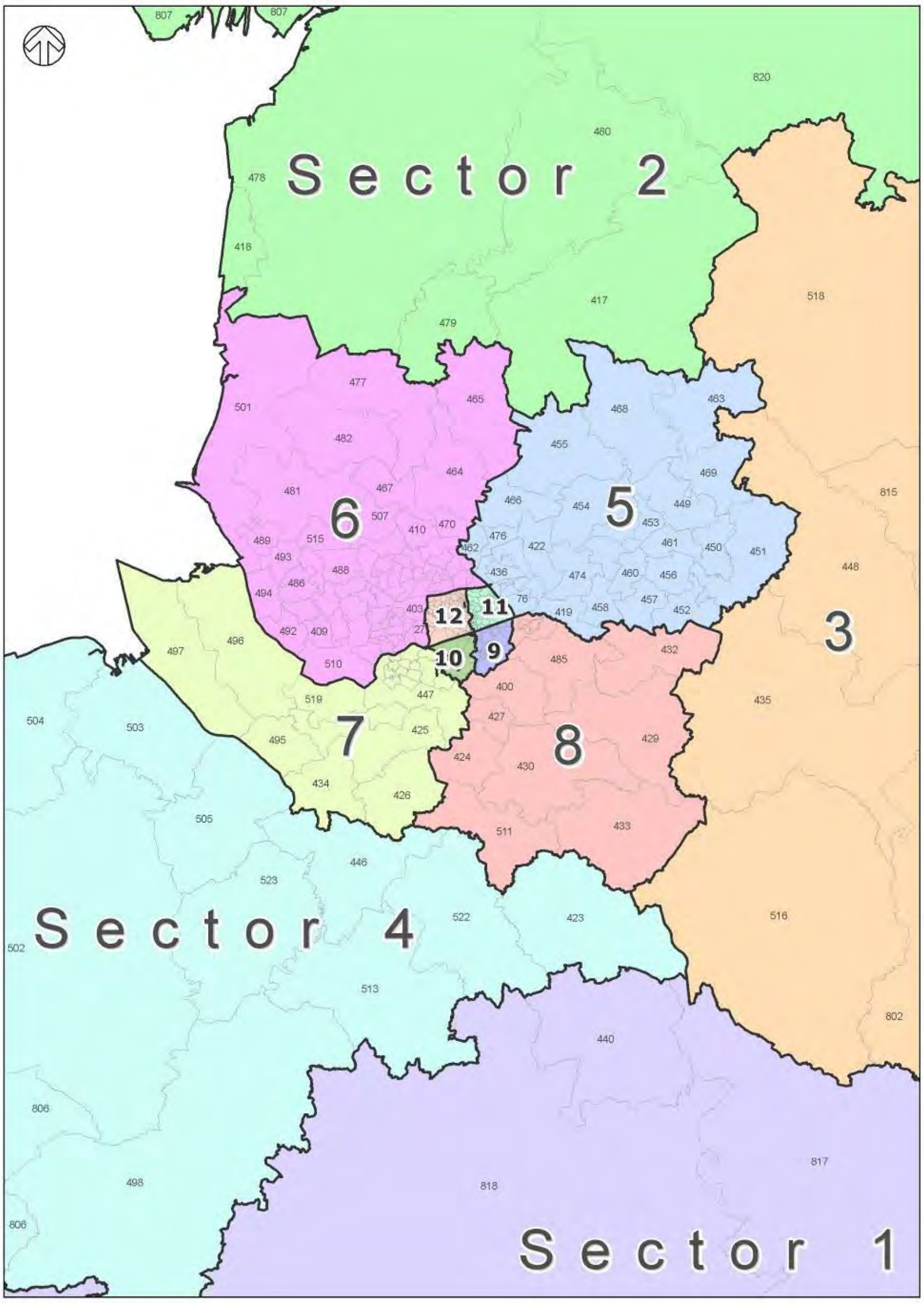


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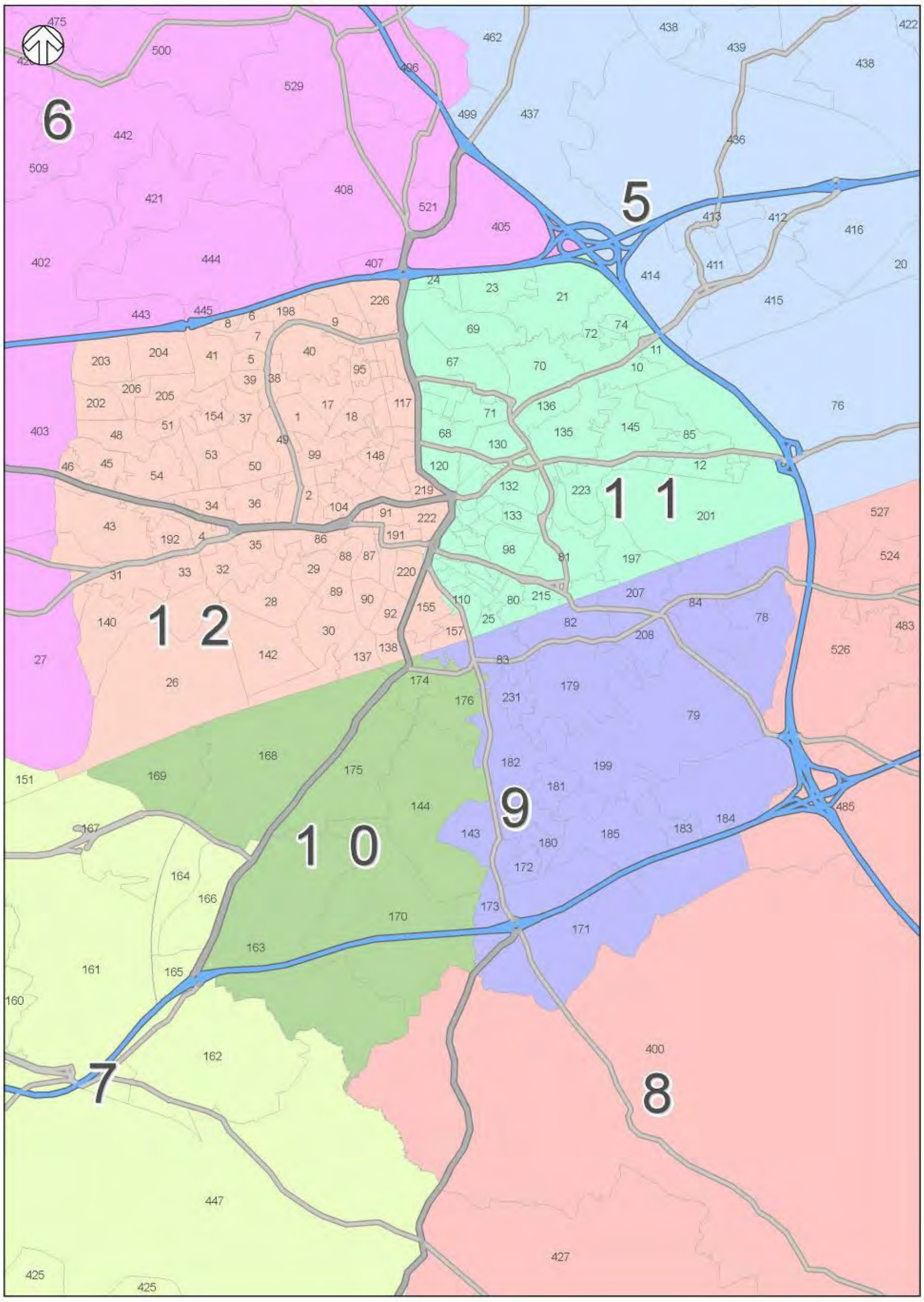
Figure 3.7 – Zone and Sector Plan Warrington



4 Observed Highway Matrix Development

4.1 INTRODUCTION

4.1.1 The Prior matrices were developed using data from 23 Roadside Interview (RSI) sites, plus trips taken from the synthetic base year demand model. The RSI data was used to create an initial matrix based fully on observed data; this is known as the RSI matrix. Synthetic demand model data was used to infill trip patterns missed by the RSI surveys known as the Infill matrix. The combined RSI and Infill matrix is known as the Prior matrix.

4.1.2 Highway matrices for Car/LGV and HGV vehicle classifications were developed separately. All Car/LGV and HGV volumes presented in this report are in Passenger Car Units (PCUs) rather than vehicles.

4.2 HIGHWAY SURVEY DATA

4.2.1 Five sources of OD data were available for the development of the highway matrices as follows:

- Six commissioned Roadside Interviews in and around Warrington
- Nine existing Roadside Interviews from the 2005 SATURN model
- Six existing Roadside Interviews from the Mersey Gateway Model
- Two existing Roadside Interview s from the St Helen's Study
- Synthetic Base Year Demand Model Trips

4.3 MODEL ZONES

4.3.1 Each highway interview record was assigned an origin and destination model zone number based upon the Ordnance Survey Grid Reference associated with the postcode details collected.

4.4 DATA CLEANING

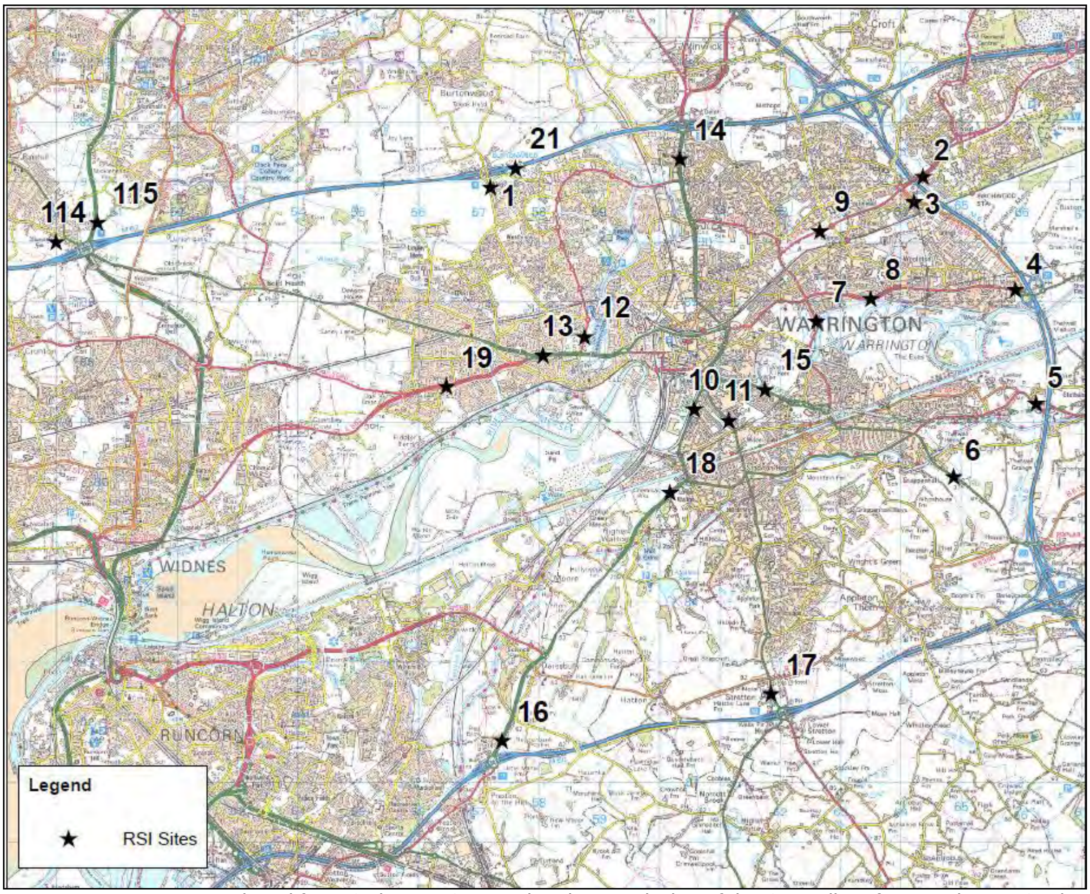
4.4.1 Using a set of logical rules developed for each individual site, the interview data was cleaned of trips that were deemed to be illogical in terms of sector to sector movements, to produce sets of clean data covering the three hour AM, Inter and PM peak periods.

4.4.2 Table 4.1 shows the extent of data cleaning and Figure 4.2 shows the location of the RSI sites.

Table 4.1 – Data Cleaning

Site Number	Site	Location	Interview Direction	OD Pair Total Surveyed	OD Pair Illogical	OD Pair Logical
1	Traffic Senses RSI 1	Burtonwood Road	Southbound	1127	91	1036
2	Traffic Senses RSI 2	A574 Birchwood Way	Westbound	1211	229	982
3	Traffic Senses RSI 3	Woolston Grange Avenue	Northbound	1239	255	984
4	Traffic Senses RSI 4	A57 Manchester Road	Westbound	1017	274	743
5	Traffic Senses RSI 5	A56 Stockport Road	Westbound	910	242	668
6	Traffic Senses RSI 6	A50 Knutsford Road	Northbound	877	263	614
7	2005 SATURN model RSI 1	A50 Kingsway	Northbound	1011	119	892
8	2005 SATURN model RSI 2	A57 Manchester Road	Eastbound	1164	242	922
9	2005 SATURN model RSI 3	A574 Birchwood Way	Westbound	1250	273	977
10	2005 SATURN model RSI 4	A5060 Chester Road	Northbound	996	129	867
11	2005 SATURN model RSI 5	A49 Wilderspool Causeway	Northbound	1212	206	1006
12	2005 SATURN model RSI 6	A574 Cromwell Avenue	Southbound	997	95	902
13	2005 SATURN model RSI 7	A57 Sankey Way	Eastbound	1752	143	1609
14	2005 SATURN model RSI 8	A49 Winwick Road	Southbound	1060	204	856
15	2005 SATURN model RSI 9	A5061 Knutsford Road	Westbound	1076	219	857
16	Mersey Gateway RSI 6	Chester Road - A56 Daresbury	Northbound	1115	375	740
17	Mersey Gateway RSI 7	A49 London Road	Northbound	931	144	787
18	Mersey Gateway RSI 8	A56 Chester Road	Northbound	1054	129	925
19	Mersey Gateway RSI 10	Widnes Road/ Warrington Road	Eastbound	1323	556	767
21	Mersey Gateway RSI 9	Gemini Retail Park	Eastbound	758	141	617
114	St Helen RSI 114	A57 Warrington Road	Northbound	1096	181	915
115	St Helen RSI 115	A570 St Helen's Linkway	Northbound	1463	265	1198

Figure 4.1 – Location of RSI Sites



4.4.3 The illogical totals include questionnaire responses that were incomplete (i.e. no OD pair could be established). They have been included to demonstrate the total number of surveys undertaken. The number of logical surveys at each site is within the required DMRB sample rate.

4.5 RSI MATRIX

ROADSIDE INTERVIEW DATA

4.5.1 The RSI data was used to construct the RSI Matrix based completely upon observed data. The surveyed movements represented the interview direction (ID), whereas the non-interview direction (NID) trips were derived from the transpose of the opposite time period; the origins and destinations of the AM peak ID records were reversed to represent the PM NID trips and vice versa. The process described below was applied on a site by site basis to the AM, Inter and PM peak periods in the interview and non-interview directions.

INTERVIEW EXPANSION FACTORS

4.5.2 The 10 journey purposes (JPs) collected for the RSIs were aggregated into a total of five JPs as follows:

- Home-Based Work (HBW)
- Home-Based Other (HBO)
- Employers Business (Emp Bus)
- Home-Based Education (HB Ed)
- Non Home-Based (NHB)

4.5.3 The number of interviews obtained at an RSI can typically represent between 10-20% of the total flow. Therefore, to develop a matrix that is equal in size to the observed traffic flow the RSI samples have to be factored up to match the Automatic Traffic Count (ATC) values. The key to developing a well distributed matrix is to derive as small as possible expansion factors. Small expansion factors can be derived by using RSI survey data from the three hour peak period to produce a single peak hour distribution pattern.

4.5.4 The peak hour MCC totals observed at each site were factored by the peak hour JP proportions obtained from the peak hour records. This generated MCC based counts for the peak hours by JP. The peak period records were then expanded to the appropriate peak hour total for each JP. This method increased the sample size by using interviews from the three hour peak periods instead of those only from the peak hour, thus maintaining the journey purpose distribution pattern of the peak hours. The peak hour ATC flows and sample sizes are shown in Table 4.2 to Table 4.4, for the AM, Inter and PM peak periods respectively.

Table 4.2 - AM Peak Hour Factored ATC and Peak Period Sample Size

Data Source	Location	Interview Direction	Peak Hour		Sample Size		Sample Proportion	
			Car /LGV	HGV	Car /LGV	HGV	Car /LGV	HGV
2008 Traffic Sense RSIs	1	ID	542	58	307	20	56.64%	34.48%
		NID	732	60	248	20	33.88%	33.33%
2008 Traffic Sense RSIs	2	ID	884	79	218	33	24.66%	41.77%
		NID	1801	105	264	33	14.66%	31.43%
2008 Traffic Sense RSIs	3	ID	1194	74	283	10	23.70%	13.51%
		NID	946	64	202	8	21.35%	12.50%
2008 Traffic Sense RSIs	4	ID	545	81	179	44	32.84%	54.32%
		NID	753	113	184	44	24.44%	38.94%
2008 Traffic Sense RSIs	5	ID	279	43	181	7	64.87%	16.28%
		NID	464	47	93	7	20.04%	14.89%
2008 Traffic Sense RSIs	6	ID	498	49	147	3	29.52%	6.12%
		NID	702	58	167	3	23.79%	5.17%
2005 SATURN Model RSIs	7	ID	949	71	314	12	33.09%	16.90%
		NID	903	124	179	12	19.82%	9.68%
2005 SATURN Model RSIs	8	ID	563	122	233	38	41.39%	31.15%
		NID	679	125	210	38	30.93%	30.40%
2005 SATURN Model RSIs	9	ID	507	18	314	5	61.93%	27.78%
		NID	685	27	234	7	34.16%	25.93%
2005 SATURN Model RSIs	10	ID	790	85	324	18	41.01%	21.18%
		NID	647	88	167	18	25.81%	20.45%
2005 SATURN Model RSIs	11	ID	892	63	284	34	31.84%	53.97%
		NID	588	116	247	34	42.01%	29.31%
2005 SATURN Model RSIs	12	ID	980	68	191	20	19.49%	29.41%
		NID	625	51	208	20	33.28%	39.22%
2005 SATURN Model RSIs	13	ID	1482	88	466	30	31.44%	34.09%
		NID	875	102	443	30	50.63%	29.41%
2005 SATURN Model RSIs	14	ID	1605	192	206	14	12.83%	7.29%
		NID	1195	358	143	14	11.97%	3.91%
2005 SATURN Model RSIs	15	ID	824	108	260	25	31.55%	23.15%
		NID	584	78	163	25	27.91%	32.05%
2006 Mersey Gateway RSIs	16	ID	1158	181	183	100	15.80%	55.25%
		NID	1008	241	166	100	16.47%	41.49%
2006 Mersey Gateway RSIs	17	ID	658	58	184	14	27.96%	24.14%
		NID	732	43	190	9	25.96%	20.93%
2006 Mersey Gateway RSIs	18	ID	1011	112	226	26	22.35%	23.21%
		NID	1013	98	233	12	23.00%	12.24%
2006 Mersey Gateway RSIs	19	ID	576	53	222	50	38.54%	94.34%
		NID	883	102	150	50	16.99%	49.02%
2006 Mersey Gateway RSIs	21	ID	742	47	198	22	26.68%	46.81%
		NID	223	25	132	22	59.19%	88.00%
2008 St. Helen's RSIs	22	ID	351	20	199	35	56.70%	175.00%
		NID	519	24	251	13	48.36%	54.17%
2008 St. Helen's RSIs	23	ID	774	172	252	121	32.56%	70.35%
		NID	1027	135	240	41	23.37%	30.37%

Table 4.3 – Inter Peak Factored ATC and Peak Period Sample Size

Data Source	Location	Interview Direction	Peak Hour		Sample Size		Sample	
			Car /LGV	HGV	Car /LGV	HGV	Car /LGV	HGV
2008 Traffic Sense RSIs	1	ID	327	40	199	20	60.86%	50.00%
		NID	324	59	197	20	60.80%	33.90%
2008 Traffic Sense RSIs	2	ID	770	51	292	33	37.92%	64.71%
		NID	740	42	295	33	39.86%	78.57%
2008 Traffic Sense RSIs	3	ID	441	38	263	10	59.64%	26.32%
		NID	401	29	263	10	65.59%	34.48%
2008 Traffic Sense RSIs	4	ID	445	66	171	44	38.43%	66.67%
		NID	499	79	184	44	36.87%	55.70%
2008 Traffic Sense RSIs	5	ID	233	20	168	7	72.10%	35.00%
		NID	247	17	92	7	37.25%	41.18%
2008 Traffic Sense RSIs	6	ID	319	44	146	3	45.77%	6.82%
		NID	327	45	167	3	51.07%	6.67%
2005 SATURN Model RSIs	7	ID	676	125	204	12	30.18%	9.60%
		NID	660	72	204	12	30.91%	16.67%
2005 SATURN Model RSIs	8	ID	462	92	205	38	44.37%	41.30%
		NID	488	92	223	38	45.70%	41.30%
2005 SATURN Model RSIs	9	ID	412	26	209	5	50.73%	19.23%
		NID	445	22	209	5	46.97%	22.73%
2005 SATURN Model RSIs	10	ID	470	99	201	18	42.77%	18.18%
		NID	660	119	201	18	30.45%	15.13%
2005 SATURN Model RSIs	11	ID	551	89	208	34	37.75%	38.20%
		NID	578	88	208	34	35.99%	38.64%
2005 SATURN Model RSIs	12	ID	604	78	241	20	39.90%	25.64%
		NID	604	71	241	20	39.90%	28.17%
2005 SATURN Model RSIs	13	ID	835	106	397	30	47.54%	28.30%
		NID	807	97	392	30	48.57%	30.93%
2005 SATURN Model RSIs	14	ID	1030	279	267	14	25.92%	5.02%
		NID	1036	269	267	14	25.77%	5.20%
2005 SATURN Model RSIs	15	ID	548	95	216	25	39.42%	26.32%
		NID	584	78	163	25	27.91%	32.05%
2006 Mersey Gateway RSIs	16	ID	447	161	141	100	31.54%	62.11%
		NID	493	166	146	100	29.61%	60.24%
2006 Mersey Gateway RSIs	17	ID	375	43	189	12	50.40%	27.91%
		NID	345	66	189	12	54.78%	18.18%
2006 Mersey Gateway RSIs	18	ID	485	99	178	23	36.70%	23.23%
		NID	518	80	178	23	34.36%	28.75%
2006 Mersey Gateway RSIs	19	ID	462	69	166	50	35.93%	72.46%
		NID	499	110	176	50	35.27%	45.45%
2006 Mersey Gateway RSIs	21	ID	547	32	120	22	21.94%	68.75%
		NID	384	33	132	22	34.38%	66.67%
2008 St. Helen's RSIs	22	ID	338	40	158	33	46.75%	82.50%
		NID	372	39	158	33	42.47%	84.62%
2008 St. Helen's RSIs	23	ID	523	183	138	100	26.39%	54.64%
		NID	573	263	138	100	24.08%	38.02%

Table 4.4 - PM Peak Hour Factored ATC and Peak Period Sample Size

Data Source	Location	Interview Direction	Peak Hour		Sample Size		Sample Proportion	
			Car /LGV	HGV	Car /LGV	HGV	Car /LGV	HGV
2008 Traffic Sense RSIs	1	ID	836	39	248	20	29.67%	51.28%
		NID	604	27	307	20	50.83%	74.07%
2008 Traffic Sense RSIs	2	ID	1410	37	264	33	18.72%	89.19%
		NID	1089	41	218	33	20.02%	80.49%
2008 Traffic Sense RSIs	3	ID	1125	36	202	8	17.96%	22.22%
		NID	1231	18	283	10	22.99%	55.56%
2008 Traffic Sense RSIs	4	ID	947	25	184	44	19.43%	176.00%
		NID	593	57	179	44	30.19%	77.19%
2008 Traffic Sense RSIs	5	ID	357	13	93	7	26.05%	53.85%
		NID	433	15	181	7	41.80%	46.67%
2008 Traffic Sense RSIs	6	ID	758	33	167	3	22.03%	9.09%
		NID	553	27	147	3	26.58%	11.11%
2005 SATURN Model RSIs	7	ID	1014	37	179	12	17.65%	32.43%
		NID	1183	37	314	12	26.54%	32.43%
2005 SATURN Model RSIs	8	ID	972	81	210	38	21.60%	46.91%
		NID	679	35	233	38	34.32%	108.57%
2005 SATURN Model RSIs	9	ID	569	12	234	7	41.12%	58.33%
		NID	668	13	314	5	47.01%	38.46%
2005 SATURN Model RSIs	10	ID	591	80	167	18	28.26%	22.50%
		NID	1106	47	324	18	29.29%	38.30%
2005 SATURN Model RSIs	11	ID	451	31	247	34	54.77%	109.68%
		NID	775	37	284	34	36.65%	91.89%
2005 SATURN Model RSIs	12	ID	727	48	208	20	28.61%	41.67%
		NID	1201	47	191	20	15.90%	42.55%
2005 SATURN Model RSIs	13	ID	1024	39	443	30	43.26%	76.92%
		NID	1113	31	466	30	41.87%	96.77%
2005 SATURN Model RSIs	14	ID	1082	133	143	14	13.22%	10.53%
		NID	1463	145	206	14	14.08%	9.66%
2005 SATURN Model RSIs	15	ID	738	52	163	25	22.09%	48.08%
		NID	881	57	260	25	29.51%	43.86%
2006 Mersey Gateway RSIs	16	ID	893	95	166	100	18.59%	105.26%
		NID	1375	92	183	100	13.31%	108.70%
2006 Mersey Gateway RSIs	17	ID	681	30	190	9	27.90%	30.00%
		NID	684	31	184	14	26.90%	45.16%
2006 Mersey Gateway RSIs	18	ID	946	31	233	12	24.63%	38.71%
		NID	911	42	226	26	24.81%	61.90%
2006 Mersey Gateway RSIs	19	ID	774	34	150	50	19.38%	147.06%
		NID	877	30	222	50	25.31%	166.67%
2006 Mersey Gateway RSIs	21	ID	321	9	132	22	41.12%	244.44%
		NID	407	6	198	22	48.65%	366.67%
2008 St. Helen's RSIs	22	ID	569	10	251	13	44.11%	130.00%
		NID	405	6	199	35	49.14%	583.33%
2008 St. Helen's RSIs	23	ID	963	64	240	41	24.92%	64.06%
		NID	1016	66	252	121	24.80%	183.33%

4.5.5 Where an expansion factor derived from the three hour peak period interviews exceeded 10, either interview data from outside the peak periods was added to increase the sample size, or JPs were combined in order to lower the expansion factor where possible. Expansion factors for the AM, Inter and PM peak hours are displayed in Table 4.5 to Table 4.7 below.

Table 4.5 - AM Peak Hour Expansion Factors

Data Source	Location	Interview Direction	Expansion Factor					
			HBW	Emp Bus	HEd	HBO	NHB	HGV
2008 Traffic Sense RSIs	1	ID	1.86	1.97	0.00	0.64	0.00	2.89
		NID	3.24	3.06	3.22	1.71	4.02	3.02
2008 Traffic Sense RSIs	2	ID	4.79	2.77	6.39	3.00	1.78	2.39
		NID	7.56	9.40	9.30	3.15	7.23	3.17
2008 Traffic Sense RSIs	3	ID	4.47	2.90	8.61	2.69	2.69	7.45
		NID	4.40	6.05	7.01	3.94	6.31	7.98
2008 Traffic Sense RSIs	4	ID	3.36	3.70	4.49	0.70	4.49	1.84
		NID	4.76	4.39	3.59	2.15	2.09	2.56
2008 Traffic Sense RSIs	5	ID	1.86	1.34	2.28	0.83	1.79	6.09
		NID	6.35	3.36	3.36	4.54	8.06	6.71
2008 Traffic Sense RSIs	6	ID	4.10	2.66	0.00	1.33	4.15	16.31
		NID	4.36	4.37	2.40	3.92	3.21	19.21
2005 SATURN Model RSIs	7	ID	3.20	2.24	3.85	2.21	3.26	5.94
		NID	5.56	6.39	9.78	1.74	5.75	10.37
2005 SATURN Model RSIs	8	ID	2.52	3.06	3.67	1.36	6.12	3.22
		NID	5.41	3.69	9.49	0.77	1.48	3.30
2005 SATURN Model RSIs	9	ID	1.83	1.81	1.92	1.03	1.14	3.60
		NID	3.17	5.01	3.92	1.45	2.13	3.82
2005 SATURN Model RSIs	10	ID	2.67	2.72	2.96	0.98	2.24	4.71
		NID	7.76	2.81	6.34	0.80	2.94	4.88
2005 SATURN Model RSIs	11	ID	3.40	1.69	7.31	2.24	0.00	1.87
		NID	5.59	0.50	3.21	0.62	0.00	3.42
2005 SATURN Model RSIs	12	ID	5.94	5.03	6.85	1.32	5.63	3.40
		NID	5.50	8.93	6.31	0.28	1.75	2.55
2005 SATURN Model RSIs	13	ID	3.85	3.57	2.84	1.28	2.52	2.92
		NID	2.73	3.07	5.42	0.41	1.28	3.39
2005 SATURN Model RSIs	14	ID	7.79	7.79	7.79	7.79	7.79	13.73
		NID	8.91	8.11	18.38	7.97	5.66	25.58
2005 SATURN Model RSIs	15	ID	3.62	2.73	2.86	2.79	4.29	4.32
		NID	4.15	2.03	1.74	3.49	7.60	3.12
2006 Mersey Gateway RSIs	16	ID	6.46	5.55	7.93	5.67	0.00	1.81
		NID	7.99	3.33	9.20	2.30	0.00	2.41
2006 Mersey Gateway RSIs	17	ID	3.90	1.28	6.50	2.53	0.00	4.16
		NID	6.27	1.57	9.41	1.00	0.00	4.81
2006 Mersey Gateway RSIs	18	ID	4.22	3.82	8.02	6.21	0.00	4.30
		NID	5.24	5.23	6.03	2.68	0.00	8.20
2006 Mersey Gateway RSIs	19	ID	2.47	3.22	3.56	1.98	0.00	1.06
		NID	7.60	9.60	9.10	1.58	0.00	2.05
2006 Mersey Gateway RSIs	21	ID	4.24	3.86	0.00	2.48	1.12	2.16
		NID	3.26	1.31	0.00	0.64	0.22	1.13
2008 St. Helen's RSIs	22	ID	1.85	1.86	3.73	0.99	0.00	0.57
		NID	1.92	3.01	1.51	2.10	1.51	1.84
2008 St. Helen's RSIs	23	ID	3.32	2.48	5.63	1.28	0.00	1.42
		NID	4.73	3.79	0.00	3.50	3.11	3.30

Table 4.6 - Inter Peak Hour Expansion Factors

Data Source	Location	Interview Direction	Expansion Factor					
			HBW	Emp Bus	HEd	HBO	NHB	HGV
2008 Traffic Sense RSIs	1	ID	1.64	1.64	1.64	1.64	1.64	2.02
		NID	1.64	1.64	1.64	1.64	1.64	2.96
2008 Traffic Sense RSIs	2	ID	2.64	2.64	2.64	2.64	2.64	1.56
		NID	9.97	0.27	5.45	1.50	1.17	1.28
2008 Traffic Sense RSIs	3	ID	1.68	1.68	1.68	1.68	1.68	3.79
		NID	1.53	1.53	1.53	1.53	1.53	2.93
2008 Traffic Sense RSIs	4	ID	5.07	1.35	7.40	2.34	1.04	1.49
		NID	2.95	2.95	0.00	2.95	2.95	1.79
2008 Traffic Sense RSIs	5	ID	0.79	1.21	3.16	1.53	0.88	2.92
		NID	1.47	1.47	1.47	1.47	1.47	2.48
2008 Traffic Sense RSIs	6	ID	2.17	2.21	2.17	2.17	2.17	14.79
		NID	2.22	2.22	2.22	2.22	2.22	14.91
2005 SATURN Model RSIs	7	ID	3.31	3.31	3.31	3.31	3.31	10.42
		NID	3.23	3.23	3.23	3.23	3.23	5.99
2005 SATURN Model RSIs	8	ID	2.25	2.25	2.25	2.25	0.00	2.43
		NID	6.23	0.68	5.48	1.25	5.48	2.43
2005 SATURN Model RSIs	9	ID	1.97	1.97	1.97	1.97	1.97	5.29
		NID	2.13	2.13	2.13	2.12	2.13	4.41
2005 SATURN Model RSIs	10	ID	3.52	2.40	3.59	1.86	1.54	5.52
		NID	3.29	3.29	3.29	3.29	3.29	6.60
2005 SATURN Model RSIs	11	ID	4.51	1.68	2.47	2.17	2.40	2.61
		NID	4.59	1.32	1.72	2.43	4.91	2.60
2005 SATURN Model RSIs	12	ID	2.50	2.50	2.50	2.50	2.50	3.91
		NID	4.79	1.76	1.62	1.73	2.85	3.53
2005 SATURN Model RSIs	13	ID	2.10	2.10	2.10	2.10	2.10	3.55
		NID	6.86	0.68	2.78	1.28	0.80	3.23
2005 SATURN Model RSIs	14	ID	3.86	3.86	3.86	3.86	3.86	19.92
		NID	5.49	3.41	6.37	3.24	1.68	19.24
2005 SATURN Model RSIs	15	ID	2.54	2.54	2.54	2.54	2.54	3.79
		NID	1.69	2.44	6.71	2.64	2.01	3.38
2006 Mersey Gateway RSIs	16	ID	3.17	3.17	3.17	3.17	3.17	1.61
		NID	9.57	0.81	8.66	1.78	0.00	1.66
2006 Mersey Gateway RSIs	17	ID	1.98	1.98	0.00	1.98	1.98	3.60
		NID	1.83	1.83	0.00	1.83	1.83	5.50
2006 Mersey Gateway RSIs	18	ID	2.73	2.73	2.73	2.73	2.73	4.28
		NID	2.91	2.91	2.91	2.91	2.91	3.46
2006 Mersey Gateway RSIs	19	ID	2.74	2.98	2.64	2.67	2.90	1.38
		NID	2.84	2.84	2.84	2.84	2.84	2.20
2006 Mersey Gateway RSIs	21	ID	4.14	4.32	0.00	4.67	4.72	1.47
		NID	2.91	2.91	0.00	2.91	2.91	1.51
2008 St. Helen's RSIs	22	ID	2.14	2.14	2.14	2.14	2.14	1.22
		NID	2.35	2.35	2.35	2.35	2.35	1.17
2008 St. Helen's RSIs	23	ID	3.79	3.79	3.79	3.79	3.79	1.83
		NID	4.15	4.15	4.15	4.15	4.15	2.63

Table 4.7 - PM Peak Hour Expansion Factors

Data Source	Location	Interview Direction	Expansion Factor					
			HBW	Emp Bus	HEd	HBO	NHB	HGV
2008 Traffic Sense RSIs	1	ID	3.71	3.50	3.67	1.95	4.59	1.95
		NID	2.09	2.22	0.00	0.72	0.00	1.35
2008 Traffic Sense RSIs	2	ID	6.00	2.91	9.09	5.16	0.00	1.13
		NID	5.90	3.41	9.84	3.69	2.19	1.26
2008 Traffic Sense RSIs	3	ID	5.23	6.98	8.33	4.69	9.37	4.56
		NID	4.60	3.28	8.87	2.77	0.00	1.80
2008 Traffic Sense RSIs	4	ID	5.99	5.52	4.51	2.71	2.63	0.58
		NID	3.66	3.99	4.88	0.76	7.32	1.29
2008 Traffic Sense RSIs	5	ID	4.89	2.59	2.59	3.49	7.76	1.81
		NID	2.89	2.47	3.54	1.28	0.00	2.11
2008 Traffic Sense RSIs	6	ID	4.71	4.52	2.60	4.23	4.16	11.00
		NID	4.56	2.73	0.00	1.48	6.92	8.95
2005 SATURN Model RSIs	7	ID	6.72	5.52	8.52	3.44	4.97	3.09
		NID	3.99	2.99	4.80	2.75	3.78	3.10
2005 SATURN Model RSIs	8	ID	6.43	6.31	8.68	3.44	0.00	2.13
		NID	2.95	3.39	4.29	1.64	0.00	0.93
2005 SATURN Model RSIs	9	ID	3.28	2.05	2.41	1.23	1.99	1.68
		NID	0.00	3.88	4.54	2.45	2.98	2.62
2005 SATURN Model RSIs	10	ID	3.02	4.47	6.82	3.02	1.93	4.42
		NID	3.74	3.92	4.14	1.37	2.92	2.59
2005 SATURN Model RSIs	11	ID	2.07	1.67	1.79	1.62	2.44	0.91
		NID	2.96	1.47	6.36	1.95	0.00	1.09
2005 SATURN Model RSIs	12	ID	3.97	5.01	1.75	2.78	4.04	2.42
		NID	7.28	6.16	8.40	1.62	6.90	2.36
2005 SATURN Model RSIs	13	ID	3.21	1.47	2.67	1.77	1.36	1.29
		NID	2.91	2.72	2.14	0.93	1.95	1.03
2005 SATURN Model RSIs	14	ID	8.06	7.34	16.64	7.21	5.12	9.47
		NID	6.71	6.71	6.71	6.71	6.71	10.34
2005 SATURN Model RSIs	15	ID	3.91	5.86	4.40	4.75	5.13	2.10
		NID	3.87	3.44	3.06	2.98	3.44	2.30
2006 Mersey Gateway RSIs	16	ID	6.45	3.24	7.84	4.18	0.00	0.95
		NID	7.67	6.59	9.42	6.73	0.00	0.92
2006 Mersey Gateway RSIs	17	ID	3.77	3.51	0.00	3.84	5.01	3.33
		NID	4.05	1.33	6.77	2.63	0.00	2.19
2006 Mersey Gateway RSIs	18	ID	4.52	3.75	5.63	3.44	2.25	2.54
		NID	3.81	3.44	7.23	5.60	0.00	1.60
2006 Mersey Gateway RSIs	19	ID	5.85	3.82	8.19	4.89	7.17	0.67
		NID	3.65	4.64	5.43	3.01	0.00	0.60
2006 Mersey Gateway RSIs	21	ID	2.89	2.29	0.00	1.81	2.49	0.40
		NID	2.33	2.07	0.00	1.36	0.65	0.28
2008 St. Helen's RSIs	22	ID	2.11	3.13	1.65	2.30	1.65	0.79
		NID	2.13	2.15	4.30	1.14	0.00	0.16
2008 St. Helen's RSIs	23	ID	4.44	3.60	0.00	3.28	2.19	1.57
		NID	4.35	3.26	7.39	1.68	0.00	0.55

ATC FACTORS

4.5.6 ATC data was collected at the six RSI sites commissioned for this study over a two week period in September 2008 encompassing the week of the RSIs. ATCs are considered to provide a more reliable estimate of average flows compared to MCCs undertaken on the day of the RSI. The average ATC flow was taken from Tuesday to Thursday inclusive. The interviews were factored to match the average ATC flows. At the other 17 RSI sites ATCs taken at the site during the time of the RSIs were used or when this data was not available, up to date MCC data was used.

PCU FACTORS

4.5.7 The RSI surveys produced data in vehicle totals. Cars and LGVs were assumed to have a PCU factor of 1.0 and HGVs were taken to have a PCU factor ranging from 1.5 to 2.3 depending on the specific type of HGV. These factors were applied to data collected by the RSI surveys to convert the data from vehicles to PCUs. Factors derived from the MCC data were used to convert the average HGV totals obtained from the ATCs into PCUs, on a site by site basis.

DOUBLE COUNTING FACTORS

4.5.8 Through trips that pass through more than one RSI site are considered to be double counted. The indicator method was used to identify and deal with these trips.

4.5.9 The indicator method involves assigning a matrix to the model where every OD pair is given a value of 0.01. Flow bundles, also known as select link analysis, at each RSI site identify the OD pairs that pass through the site. These are converted into a series of matrices containing a record of all OD pairs passing through each site. The RSI flow bundle matrices are summed together and any OD pairs that then have 0.02 trips or more are deemed to be counted more than once.

4.5.10 A factor of 0.5 was applied to the OD pairs that were double counted and a factor of 0.33 for those that were triple counted.

RSI MATRIX

4.5.11 The individual matrices for each JP in the ID and NID at each site were combined to produce the RSI AM, Inter and PM peak interview matrices.

4.5.12 The RSI matrices were assigned to the network and subsequent sensitivity testing of traffic routings and comparisons between observed and modelled flows were undertaken. This ensured that the best possible RSI matrix, producing the optimum fit to the observed flows, was progressed to the Prior matrix development.

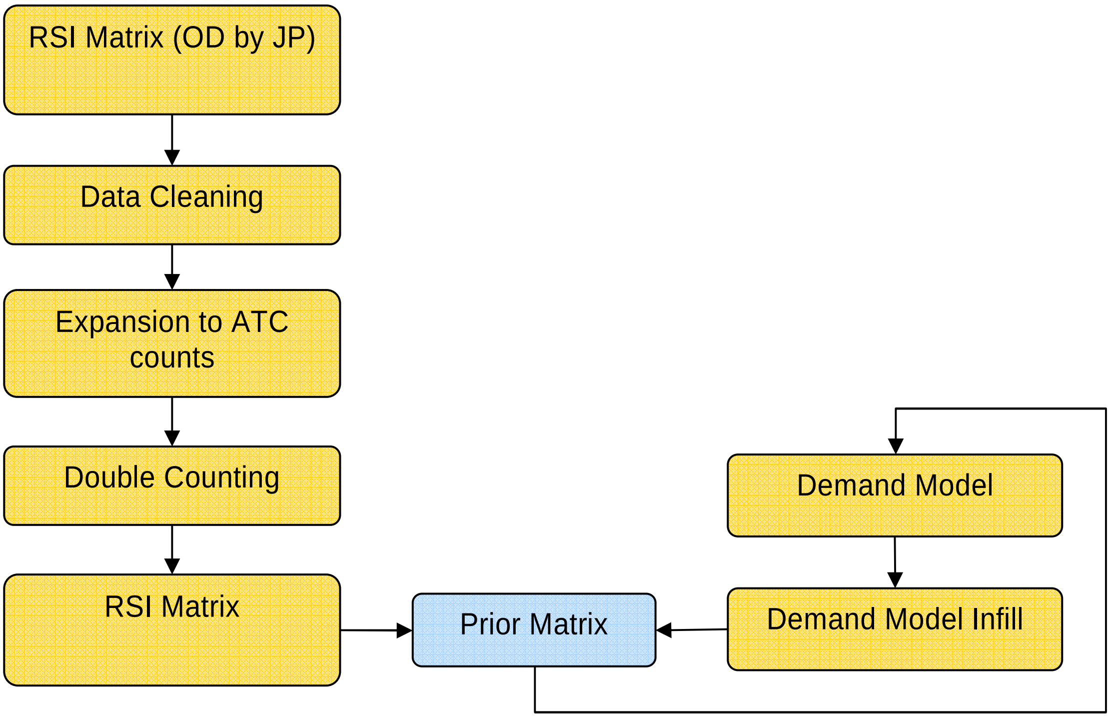
4.6 SYNTHETIC MATRIX

4.6.1 As only a portion of the study area traffic has been observed at the Roadside Interviews, the matrices are infilled with trips obtained from the Demand Model. The Demand Model is validated at different stages throughout its development to ensure that a realistic matrix is being produced.

4.6.2 Before the demand model Infill matrix is used to infill the Prior matrix any OD pairs that have trips already observed within the RSI matrix are taken out of the demand model. This reduces the risk of RSI trips being replicated by the demand model matrices. Trips produced within the demand model that have no bearing on the study area, for example trips between London and Cornwall are also taken out of the matrix.

4.6.3 The initial Infill matrix produced by the demand model uses the RSI matrix to generate costs within the model. As this matrix is missing a large portion of trips, a proxy demand of 0.01 is given to missing OD pairs to ensure a cost is derived for every OD pair within the model. The first Prior matrix, made up of the RSI matrix and the first demand model infill matrix, can then be fed back into the demand model to replace the proxy demand matrix used initially. This iterative process will generate more accurate costs between OD pairs and produce a more accurate second demand model infill matrix. This process can be seen below in Figure 4.2.

Figure 4.2 – Highway Observed Matrix Development



4.6.4 Further information on the development of the Demand Model can be found in Chapter 6 Demand Model Development.

5 Public Transport Matrix Development

5.1 INTRODUCTION

5.1.1 Public transport survey data collected on the main bus routes serving Warrington was used to construct bus demand matrices for the Warrington MMTM.

5.1.2 Public transport survey data collected at the five railway stations in Warrington were used to construct rail demand matrices for the WMMTM.

BUS OBSERVED MATRIX DEVELOPMENT

5.2 BUS SURVEY DATA

5.2.1 Twenty four main bus routes serving Warrington were surveyed in November 2008 over a fourteen hour period providing the following data:

- Boarders and alighters at all bus stops on surveyed routes
- OD data for a proportion of passengers surveyed on each route resulting in a sample rate of approximately 40% of all passengers travelling on the surveyed routes.
- Independent counts of boarders and alighters using the surveyed services at the town centre bus station.

5.3 MODEL ZONES

5.3.1 Each public transport survey record was assigned an origin and destination model zone number based upon the Ordnance Survey Grid Reference associated with the postcode details collected. Using a set of logical rules developed for each individual route, the survey data was cleaned of trip patterns deemed to be illogical.

5.4 BUS EXPANSION FACTORS

5.4.1 The number of interviews by journey purpose obtained on each bus was factored up to represent the observed number of passengers on that bus i.e. the number of boarders. These were in turn factored by the number of buses in the peak hour to represent total hourly patronage levels. OD survey data from the three hour peak period was used in creating the peak hour demand in order to increase the sample size and reduce the expansion factors.

5.4.2 Some peak hour services on a number of routes either started or finished outside of the peak hour. A view was taken on their inclusion in the analysis and manual adjustments were made to produce sensible matrices.

5.5 SURVEY RECORDS OUTSIDE THE PEAK PERIOD

5.5.1 OD survey data from the three hour peak period was initially used to derive the interview expansion factors. However, where the initial expansion factors were greater than ten, survey records from outside of the three hour peak period were added in order to increase the sample size and reduce the expansion factors.

5.6 ROUTE SECTIONS

5.6.1 The bus surveys were conducted along a moving route with passengers interviewed at some point during their journey. As such, there is no fixed point at which the interview data can be expanded to represent full passenger volumes at all points along the route. It was found that expanding all interviews collected to the total number of boarders for each route can create a bias in trip patterns. This occurs when the distribution of the interviewed passengers' boarding points is not the same as the distribution of boarding passengers. Passengers boarding during quiet sections of the route and for longer journeys are more likely to be surveyed than those boarding during busier sections of the route and travelling for shorter periods of time. The example shown in Table 5.1 illustrates the problems arising from expanding the interviews across the entire route.

Table 5.1 – Survey Expansion Example – By Route

Stop	Boarders	Surveys	% Pax at Stop	Exp Factor	PAX Exp	% Pax at Stop	PAX Error
1	5	5	6%		13	15%	8
2	8	7	9%		18	21%	10
3	25	7	28%		18	21%	-7
4	20	7	23%		18	21%	-2
5	20	6	23%		16	18%	-4
6	10	2	11%		5	6%	-5
Total	88	34		2.59	88		

** PAX = Passengers; Exp = Expansion/Expanded

5.6.2 In this example, few passengers board at the start of the route whereas the stops in the middle of the route are more popular. Here the distribution of the expanded data is biased towards the start of the route and shows a lower proportion of passengers boarding at the more popular stops.

5.6.3 Ideally the survey data should be expanded at each bus stop, although in reality this is not practical. Firstly, the specific boarding point must be known. Due to the difficulty in collecting onboard surveys, passengers are not generally interviewed at their boarding point and may be some way into their journey at the time of the interview. This information is not collected as part of the interviews due to uncertainty of the exact boarding point. In addition, many more surveys would be required to attain sufficiently small expansion factors.

5.6.4 To reduce the bias in passenger travel patterns, each route was divided into three to five sections and each bus stop was allocated to a particular route section. Each interview was associated with the most likely origin and destination sections of the appropriate route based on the postcode data collected. This enabled the derivation of different expansion factors for different sections of each route. Table 5.2 illustrates how this method reduced the expanded passenger travel pattern bias.

Table 5.2 – Survey Expansion Example – By Route and Route Section

Route Section	Stop	Boarders	Surveys	% Pax at Stop	Exp Factor	PAX Exp	% Pax at Stop	PAX Error
1	1	5	5	6%	1.08	5	6%	0
	2	8	7	9%		8	9%	0
2	3	25	7	28%	3.21	23	26%	-3
	4	20	7	23%		23	26%	3
3	5	20	6	23%	3.75	23	26%	3
	6	10	2	11%		8	9%	-3
	Total	88	34		2.59	88		

** PAX = Passengers; Exp = Expansion/Expanded

5.7 FINAL BUS MATRICES SUMMARY

5.7.1 The bus matrices developed were not adjusted using any matrix estimation techniques. The distribution patterns were defined wholly by the surveys. No infill was used in the development of the bus matrices. The total numbers of bus users in the model are detailed in Table 5.3 below.

Table 5.3 – Bus Matrix Totals

Peak Period	Matrix Total Bus PAX
AM	2323
IP	1866
PM	1369

5.7.2 The PM peak totals look low relative to the AM peak. The PM peak survey exercise yielded fewer responses than the AM peak, however, the assigned PM peak bus matrix still validates well against the bus station boarding and alighting data.

RAIL OBSERVED MATRIX DEVELOPMENT

5.8 RAIL SURVEY DATA

5.8.1 Three railway stations in Warrington, (Warrington Central, Birchwood and Sankey for Penketh stations) had previously been surveyed for the Chapelford Rail Travel Survey at the beginning of 2008. This survey data was used in the development of the rail matrices for these stations.

5.8.2 The other two railway stations in Warrington, (Warrington Bank Quay and Padgate stations) were surveyed in October 2008 over a twelve hour period providing the following data:

- Interviews of boarders at the stations using an agreed questionnaire to gain OD data of passengers using the station plus access mode.
- Numbers of boarders and alighters at the stations throughout the day.

5.9 MODEL ZONES

5.9.1 Each rail survey record was assigned an origin and destination model zone number based upon the Ordnance Survey Grid Reference associated with the postcode details collected. Using a set of logical rules developed for the town, the survey data was cleaned of trip patterns that were deemed to be illogical.

5.10 RAIL EXPANSION FACTORS

5.10.1 The number of interviews obtained at each station was factored up to represent the observed number of passengers (i.e. the number of boarders). Interview survey data by journey purpose from the three hour peak period was used in creating the peak hour demand in order to increase the sample size and reduce the expansion factors.

5.10.2 Due to all passengers being interviewed at a fixed point in their journey at the rail station the interviews could be directly expanded in order to reach passenger boarding numbers at the station.

5.10.3 The interviews at the railway stations were only of those people boarding the trains. As a base assumption, the trip patterns of the alighters were assumed to be the transpose of the boarders. Thus, the AM boarding became the PM alighting data, and the PM boarding data became the AM alighting data, while the Inter Peak was transposed for the same time period. This transposed data was then treated in the same manor and expanded by the number of alighters at the station to build the observed matrix.

5.11 ACCESS MODE TO STATION

5.11.1 Railway passengers typically access the station by car, bus, cycling or walking. The observed matrix needs to be segmented into those accessing the station by car and those accessing the station by other means in order to be able to assign the matrix to the correct transport system on the wider network.

5.11.2 This segmentation of the matrices means that those accessing the railway station by car will also leave by car as the model setup cannot cope with trips accessing the station by car but choosing another mode of transport at the other end of their trip. For this reason it was decided that it was more important to build the matrices based on the Warrington End mode of transport.

5.11.3 Therefore for the Interview direction of boarders at each station, the matrices were built by access mode (car or other). For the non-interview direction the matrices were built by egress mode, (car or other), so that within Warrington passengers would use the correct access mode. This will improve the quality and validation of the model.

5.12 TRANSPORT SYSTEMS TO SUPPORT RAIL MODE

5.12.1 A series of Transport Systems are used within the model to replicate the complete journey for rail users. These include:

- Rail access by car
- Rail access by PT / walk
- Rail.

5.12.2 Care was taken to ensure that each element of the rail journey had the appropriate auxiliary mode and speed applied.

5.13 WARRINGTON AND BIRCHWOOD STATIONS

5.13.1 After assigning a total Rail_Car matrix of all five stations to the model it was realised that this caused problems due to the number of people who travelled between Birchwood and Warrington on the rail network but accessed Birchwood by car. The number of trips making this journey can be seen below in Table 5.4. Assigning these trips together in one matrix resulted in people driving all the way to their destination by car due to the lower costs of this journey.

Table 5.4 – Peak Hour Passengers between Warrington and Birchwood

Rail Car trips only	AM	IP	PM
Warrington - Birchwood	3	2	7
Birchwood - Warrington	16	3	5
Total	19	5	11

5.13.2 In order to overcome this problem the Birchwood Rail_Car matrix was separated from the other four stations. This was assigned as a separate matrix that forces trips onto the rail network at Birchwood rather than allowing them to drive all the way into Warrington. This process does not limit or control the future Birchwood – Warrington demand.

5.14 FINAL RAIL MATRICES SUMMARY

5.14.1 The rail matrices developed to this point have not been adjusted using any matrix estimation techniques. The distribution patterns were as close to the surveys as possible given the matrix development process adopted. The total numbers of rail users in the model are detailed in Table 5.5 below.

Table 5.5– Rail Matrix Totals

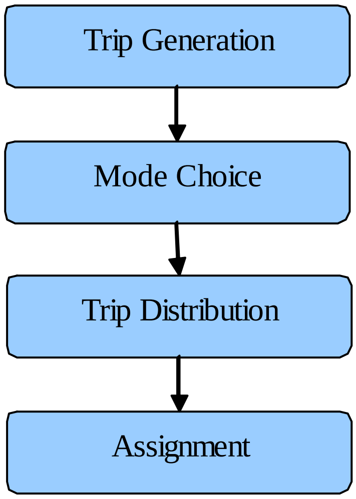
Peak Period	Rail_Car	Rail_Car_Birchwood	Rail_Other	Total
AM	249	131	691	1071
IP	144	25	279	448
PM	262	130	550	942

6 Demand Model Development

6.1 INTRODUCTION

6.1.1 The Demand Model is a stand alone model developed following the Department for Transport guidelines. WebTAG (Department for Transport's Transport Analysis Guidance) stipulates that a traditional four-stage process must be followed in the development of the model; with the order being determined by the order of sensitivity i.e. choices with the least sensitive response are calculated first. This determines that the demand model development must occur in the order as shown below in Figure 6.1.

Figure 6.1 – Demand Model Processes



6.1.2 The Basic steps are:

Stage 1 – Trip Generation

- Population segmentation by person and household type (25 Types)
- Trip purpose segmentation by different purposes (5 Home-Based Types)
- Trips growthed to 2008 using TEMPRO and known housing development in Warrington included
- Apply 24 hour trip rates from the National Transport Model to the different segments
- Trip generation presented as 'Productions' only and aggregated by car availability

Stage 2 – Mode Choice

- Generalised costs compiled by composite costs such as network and public transport costs (from observed model).
- Logit choice model used to split trip generations into modes
- Mode choice proportions applied to trip productions

Stage 3 – Trip Distribution

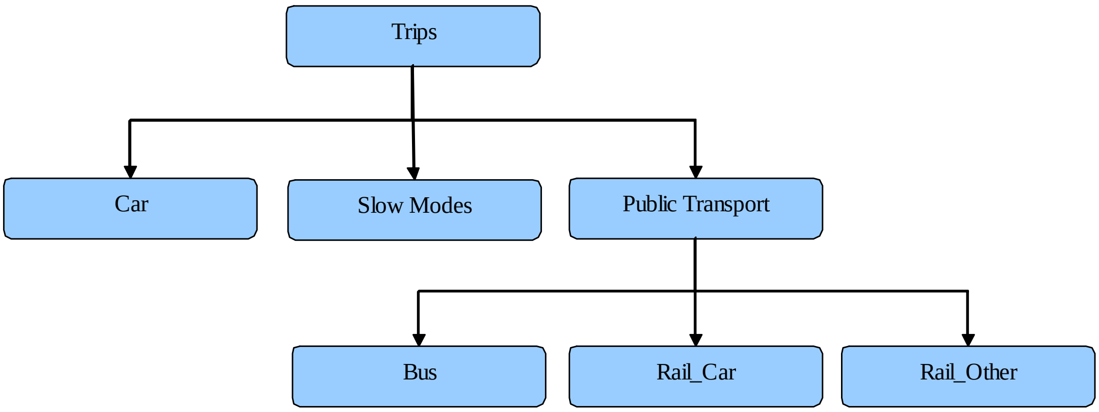
- Further aggregation of segments into trip purposes
- Calculation of Attraction using logit formula
- Attraction is calculated using common measurements of floor space, employment population, school trips and rateable values.
- Productions, in some cases, adjusted to produce Attractions to create a doubly constrained distribution process

Stage 4 - Assignment

- Demand matrices produced for both the observed and demand model assigned within the model by mode

6.1.3 In some cases more than one mode may offer a competitive alternative to car. Therefore the demand model should include a higher level car/public transport modal split mechanism, with a separate split between the available public transport modes below this in the hierarchy (this is known as a nested approach) illustrated in Figure 6.2. The nested approach avoids the so-called "red bus/blue bus problem", in which merely splitting one existing mode into two identical ones will apparently predict mode shift when using a multinomial logit model.

Figure 6.2 – Nested Choice Model Structure



6.1.4 While some of the processes described above can be completed within the VISUM software, many are too complex and the software cannot complete them within the required WebTAG order. VBA scripts have therefore been produced to enable this entire process to be run within VISUM and an Excel interface has been prepared that allows bulk changes to be made for more than one script at a time. This interface enables, not only quick fine tuning of the script, but has also been set up to automatically store the scripts ready to be run from within VISUM.

6.2 TRIP GENERATION

CENSUS DATA PROCESS

6.2.1 The first stage of developing the trip generation for the main study area is to derive the population for each zone in Warrington. This is extracted from the 2001 national population census data and processed to fit the zoning system defined for Warrington.

DEMAND SEGMENTATION

6.2.2 Population segmentation is a key element that enables the model to be behaviourally based, which enables the forecasting of a changing population structure. The population for each zone was extracted from the 2001 Census data in 25 segments as shown in Table 6.1. The table shows the population segmented by age and employment status and by household size and car ownership.

Table 6.1 – Population Segmentation

Person Type	Household Type				
	1 Adult 0 car	1 Adult 1+ car	2+ Adults 0 car	2+ Adults 1 car	2+ Adults 2+ cars
Children (0-15)	1	2	3	4	5
Adults (16-64) not employed	6	7	8	9	10
Adults (16-64) in part time employment	11	12	13	14	15
Adults (16-64) in full time employment	16	17	18	19	20
Pensioners (65+)	21	22	23	24	25

TRIP PURPOSE

6.2.3 The population is segmented further by trip purpose as shown in Table 6.2.

Table 6.2 – Trip Purpose Segmentation

Purpose Segmentation	
1. Home-Based work	HBW
2. Home-Based employer's business	HBEb
3. Home-Based education	HBEd
4. Home-Based shopping/ personal business	HBSh
5. Home-Based other	HBO
6. Non Home-Based employer's business	NHBEB
7. Non Home Based other	NHBO

6.2.4 With 25 population segments and 7 trip purposes per population segments a total of 175 segments are produced.

GROWTH FACTOR 2001-2008

6.2.5 The population from the 2001 census data was extracted for each population segment and uplifted to the base year, 2008. The 2008 population was derived by adjusting the base population information, as contained in the 2001 census, by applying the TEMPRO v 5.4 growth factors for car availability and for population as shown in Table 6.4 and Table 6.5. In Warrington known housing developments were provided by WBC and this data was included as detailed in Table 6.3. TEMPRO growth factor for the area was adjusted accordingly.

Table 6.3 – 2001-2008 Warrington Housing Completions

Warrington Borough Council Ref	Location	2001-2008 Housing Completions	Zone	Ward
120	(The Hamptons) Firs Lane / Field Lane, Appleton	82	144	Appleton
218	GH11 (Regent Square), Grappenhall Heys	87	179	Grappenhall and Thelwell
218	GH11 (Regent Square), Grappenhall Heys	100	79	Grappenhall and Thelwell
259	KW6/7 E (Butts Green), Kingswood	149	7	Westbrook
279	WT 14/15 Barrowhall Lane, Lingley Green Avenue, Whittle Hall	116	51	Whittle Hall
303	Falklands, 11 Greenway, Appleton	89	172	Hatton Stretton & Walton
332	14 Belmont Cresent, Great Sankey, Warrington, WA5 3DT	7	154	Great Sankey North
487	Chapelford Urban Village, Whittle Hall (Remainder)	10	37	Whittle Hall
		28	37	
		210	53	
		74	53	
		79	53	
		94	53	
		68	53	
		161	53	
		52	50	
		12	50	
		63	53	
516	(Elmwood) Former engineering depot, Green Lane, Woolston	92	178	Poulton South
561	125, Wilderspool Causeway, Warrington, WA4 6PX	88	46	Great Sankey South
563	The 2nd Hand Shop, 15 Wash Lane, Warrington, WA1 1HS	64	525	Lymm
566	102/102A Wilderspool Causeway, Warrington, WA4 6PU	122	526	Lymm
568	Land at Winsford Drive, Burtonwood	56	421	Burtonwood & Winwick
573	Land at Gladstone Street, Bewsey	103	106	Bewsey and Whitecross
574	90, Knutsford Road, Grappenhall, Warrington, WA4 2PJ	243	402	Fairfield & Howley
581	Former Brittannia Wire Works, Bewsey Road, Bewsey	149	100	Bewsey and Whitecross
585	Former UU Depot, Thornton Road, Great Sankey	85	32	Great Sankey South
586	Land at Stocks Lane / Liverpool Road, Great Sankey	72	43	Great Sankey North
587	Land at RAF Burtonwood South / Peter Salem Drive/Almer Drive	52	36	Great Sankey South
597	Anson Close / Blenheim Close, Blackbrook	192	70	Poulton North
607	Former bakery, Delamere Street, Whitecross	62	104	Bewsey and Whitecross
614	Land at Oughtrington Lane / Longbutt Lane, Lymm	120	528	Lymm
621	Hubert Jones Tankworks Site, Birchbrook Road, Heatley	198	525	Lymm
1009	Cheshire Lines Warehouse	225	219	Bewsey and Whitecross
1080	Thomas Locker Site, Church Street	153	125	Latchford East
1091	Thelwall Lane, Latchford	74	230	Latchford East
1093	Cantilever Garden Centre	54	215	Latchford East
1094	Thelwall Lane (Former Renault Dealership)	68	81	Latchford East
1097	Former Tinsley Wire Works, Dalton Bank	191	195	Fairfield & Howley
1100	Site at junction of Wilderspool Causeway/Gainsborough Road, V	108	157	Latchford West
1105	Phase 4, Washington Drive	122	36	Great Sankey South
1150	Saxon Park Off Forest Way, Warrington, WA5 1DF	270	29	Bewsey and Whitecross
1239	Land at Mersey Street, Warrington, Thomas Locker Phase 2	64	125	Fairfield & Howley

Table 6.4 – TEMPRO Growth Factor for Car Availability

Car availability Growth Factor (2001 to 2008)	Households with no cars	Households with 1 adult and 1 car	Households with 2+ adults and 1 car	Households with 2+ adults and 2+ cars
GB	0.941	1.24	1.014	1.091
East Midland (Region)	0.95	1.248	1.027	1.101
London (Region)	0.961	1.308	1.021	1.106
North East (Region)	0.884	1.285	1	1.106
North West (Region)	0.928	1.24	1.008	1.075
Scotland (Region)	0.93	1.187	1.004	1.103
South East (Region)	0.967	1.222	1.007	1.077
South West (Region)	0.961	1.235	1.015	1.088
Wales (Region)	0.915	1.225	1.016	1.112
West Midland (Region)	0.913	1.266	1.002	1.074
Yorkshire (Region)	0.929	1.219	1.034	1.122
East (Region)	0.999	1.222	1.02	1.082
Cheshire (County)	0.984	1.27	0.987	1.028
Cumbria (County)	0.986	1.3	0.987	1.042
Greater Manchester (County)	0.928	1.245	1.019	1.095
Lancashire (County)	0.937	1.214	1.003	1.074
Merseyside (County)	0.89	1.213	1.016	1.105
Halton (Authority)	1.012	1.326	0.997	1.028
Knowsley (Authority)	0.861	1.096	1.002	1.105
Liverpool (Authority)	0.877	1.224	1.068	1.244
Manchester (Authority)	0.914	1.403	1.147	1.431
Salford (Authority)	0.945	1.2	1.031	1.124
St Helens (Authority)	0.979	1.181	0.997	1.006
Stockport (Authority)	0.904	1.167	0.97	1.039
Trafford (Authority)	0.935	1.212	0.964	1.039
Warrington (Authority)	1.015	1.201	0.992	0.998
Halton Rural (Zone)	1.212	1.419	1.039	1.063
Runcorn Main (Zone)	1.003	1.315	1.003	1.039
Widnes Main (Zone)	1.018	1.329	0.989	1.011
Liverpool Main (Zone)	0.877	1.224	1.068	1.244
Manchester Main (Zone)	0.929	1.452	1.172	1.479
South Manchester (Zone)	0.829	1.213	1.025	1.216
Warrington Rural (Zone)	1.125	1.273	1.026	0.998
Warrington (Zone)	0.971	1.173	0.959	0.993
Great Sankey (Zone)	1.104	1.183	1.02	1.003
Stockton Heath/ Thelwall (Zone)	1.111	1.254	1.059	0.999
Risley (Zone)	1.042	1.184	0.975	1.015
Lymm (Zone)	1.108	1.228	1.037	0.974
Culcheth (Zone)	1.083	1.26	1.038	1.001
Burtonwood (Zone)	1.054	1.232	1.002	1.009

Table 6.5 – TEMPRO Growth Factor for Population

Population Growth Factor (2001 to 2008)	< 16	16 - 64	65 +
GB	0.966	1.056	1.065
East Midland (Region)	0.981	1.07	1.101
London (Region)	0.979	1.055	0.993
North East (Region)	0.93	1.019	1.047
North West (Region)	0.947	1.044	1.051
Scotland (Region)	0.899	1.056	1.073
South East (Region)	1.001	1.061	1.071
South West (Region)	0.979	1.068	1.087
Wales (Region)	0.899	1.07	1.073
West Midland (Region)	0.967	1.034	1.073
Yorkshire (Region)	0.969	1.067	1.061
East (Region)	1.01	1.068	1.094
Cheshire (County)	0.959	1.029	1.123
Cumbria (County)	0.956	1.035	1.105
Greater Manchester (County)	0.955	1.055	1.024
Lancashire (County)	0.946	1.049	1.054
Merseyside (County)	0.921	1.032	1.021
Halton (Authority)	0.97	1.041	1.09
Knowsley (Authority)	0.884	1.001	0.98
Liverpool (Authority)	0.909	1.064	0.97
Manchester (Authority)	0.937	1.176	0.942
Salford (Authority)	0.942	1.081	0.965
St Helens (Authority)	0.944	1.016	1.069
Stockport (Authority)	0.94	1.013	1.034
Trafford (Authority)	0.984	1.023	0.981
Warrington (Authority)	0.952	1.018	1.127
Halton Rural (Zone)	1.046	1.099	1.13
Runcorn Main (Zone)	0.972	1.043	1.1
Widnes Main (Zone)	0.963	1.034	1.078
Liverpool Main (Zone)	0.909	1.064	0.97
Manchester Main (Zone)	0.956	1.198	0.966
South Manchester (Zone)	0.855	1.065	0.849
Warrington Rural (Zone)	0.978	1.039	1.141
Warrington (Zone)	0.922	0.993	1.101
Great Sankey (Zone)	0.973	1.035	1.165
Stockton Heath/ Thelwall (Zone)	0.983	1.047	1.138
Risley (Zone)	0.955	1.025	1.172
Lymm (Zone)	0.963	1.028	1.132
Culcheth (Zone)	0.977	1.045	1.127
Burtonwood (Zone)	0.969	1.027	1.136

6.2.6 It is noted that the TEMPRO growth for under 65 year olds for Warrington Zone shows a reduction in population. However the new houses built in the intervening period and the associated growth are reflected in population terms.

TRIP GENERATION CALCULATION

6.2.7 The National Travel Survey (NTS) is a rolling programme of surveys containing demographic and travel information for a sample of the population. Travel demand data from these surveys was used to derive the trip rates for the multi model version of the National Trip End Model (NTEM). The NTS enables the variations in travel behaviour as defined by trip purpose, car availability, person type, household size and other demographics to be taken into account.

6.2.8 Trip rates data from the NTS is applied to each of the 150 Home-Based vectors to determine the average number of Home Based trips per person, per day, for each population segment. The NTS trip rate for each Home Based trip purpose by person type is show in Table 6.6. These trip rates are produced from continuous surveys on personal travel behaviour patterns that have been running on an ad hoc basis since 1965 and continuously since 1988. Therefore there is not a defined source year for this data.

Table 6.6 – NTS Trip Rate For Home-Based Trips (24 hour)

Purpose	Car ownership	Children (0-15)	Adults in Full Time Emp (16-64)	Adults in Part-Time Emp (16-64)	Adults Unemployed (16-64)	Pensioners (65+)
HBEb	1 adult / 0 car	0.0052	0.0226	0.031	0.0055	0.0006
HBEb	1 adult / 1+ car	0.0076	0.0884	0.0718	0.0101	0.0141
HBEb	2+ adults / 0 car	0.0024	0.0248	0.0253	0.0016	0.0011
HBEb	2+ adults / 1 car	0.0052	0.056	0.0395	0.0074	0.0058
HBEb	2+ adults / 2+ cars	0.0066	0.1014	0.0545	0.0142	0.0371
HBEd	1 adult / 0 car	0.5382	0.0206	0.1005	0.2281	0.0018
HBEd	1 adult / 1+ car	0.5892	0.0265	0.201	0.2418	0.013
HBEd	2+ adults / 0 car	0.5206	0.0189	0.1218	0.1898	0.007
HBEd	2+ adults / 1 car	0.5929	0.0473	0.2083	0.2524	0.0148
HBEd	2+ adults / 2+ cars	0.5862	0.0405	0.2387	0.3402	0.0126
HBO	1 adult / 0 car	0.3119	0.3593	0.3478	0.4378	0.2598
HBO	1 adult / 1+ car	0.384	0.5173	0.5266	0.5932	0.5144
HBO	2+ adults / 0 car	0.2728	0.2561	0.2654	0.3163	0.2061
HBO	2+ adults / 1 car	0.34	0.3744	0.3759	0.4255	0.3507
HBO	2+ adults / 2+ cars	0.3875	0.4107	0.4482	0.5144	0.3989
HBSh	1 adult / 0 car	0.3309	0.3136	0.4643	0.5885	0.45
HBSh	1 adult / 1+ car	0.3152	0.3524	0.5344	0.6757	0.6603
HBSh	2+ adults / 0 car	0.282	0.2441	0.3944	0.5098	0.4599
HBSh	2+ adults / 1 car	0.3278	0.3363	0.4683	0.5496	0.5739
HBSh	2+ adults / 2+ cars	0.3375	0.3268	0.5259	0.5515	0.512
HBW	1 adult / 0 car	0.0111	0.7113	0.6463	0.03	0.0116
HBW	1 adult / 1+ car	0.0291	0.7048	0.4998	0.0448	0.0589
HBW	2+ adults / 0 car	0.0164	0.7792	0.6308	0.0558	0.0163
HBW	2+ adults / 1 car	0.0611	0.7836	0.6143	0.1159	0.0521
HBW	2+ adults / 2+ cars	0.037	0.7146	0.5384	0.1319	0.0903

AGGREGATION OF TRAVEL DEMAND FOR INPUT TO MODE CHOICE

6.2.9 The 'Home-Based' trip generation results were aggregated into 15 segments. For each trip purpose, trips are categorised by the car availability of the household in which the traveller resides. The definitions adopted are:

- NC – No Car households are those without cars
- PC – Part Car households are those with 1 car and 2+ adults

- FC – Full Car households are those with 1 adult and 1 car or 2+ adults and 2+ cars

6.2.10 These trip generation aggregations are input to the mode choice stage.

6.3 MODE CHOICE

6.3.1 The mode choice element of the model is the second stage in the 4-stage process following on from the trip generation stage. It defines the probability of travelling by a mode (in this case car, public transport or slow modes) from each zone in the model. The probability is defined for all users at a person level based upon their generalised cost of travel.

GENERALISED COSTS

6.3.2 The calculation of the generalised cost of travel by mode between each origin and destination is a key input to the mode choice and trip distribution stages. The generalised cost components of travel by car and PT are shown below in Table 6.7.

Table 6.7 – Generalised Cost Components

Generalised Cost Component	Calculation	Unit	Car	PT
Walk time	VISUM assignment	Time		●
Wait Time	VISUM assignment	Time		●
In Vehicle Time (IVT)	VISUM assignment	Time	●	●
Vehicle Operating Costs Fuel Maintenance	 Distance Fixed	£	●	
Fare	Distance	£		●
Car Parking Charge	Fixed by zone	£	●	

6.3.3 The Highway generalised cost (u_p^{car}) is calculated using the following formulae:

$$u_p^{car} = tcur_p + \frac{dist_p(voc_p)}{vot} + \frac{parking}{vot}$$

where voc_p - Vehicle operating costs

$dist_p$ - Distance

vot - Value of Time

$parking_p$ - Parking cost

$tcur_p$ - Time

6.3.4 Public transport generalised cost (u_p^{put}) is calculated using the following formula:

$$u_p^{put} = acct_p + egrt_p + owt_p + jt_p + \frac{fare_p}{vot} + I$$

Where:

$fare_p$ - Fare

vot - Value of time

jt_p - Journey time

$acct_p$ - Access time

$egrt_p$ - Egress time

owt_p - Origin wait time

I - Interchange penalty

6.3.5 The individual elements that are used to calculate generalised cost for each mode are described in detail in the remaining of this chapter.

6.3.6 The generalised cost for each mode is calculated and feeds into the calculation for the composite cost. This formula can be seen below and is effectively the log sum of all individual costs from each zone ***i*** to each destination zone ***j***.

$$u_i^{mode} = -\frac{1}{\vartheta}\ln\left(\sum_j \exp\left(-\vartheta u_{ij}^{mode}\right) + z_i^{mode}\right)$$

Where: u_{ij}^{mode} is the generalised cost (disutility) of travel between zones i and j by mode.

ϑ is the destination choice parameter for a given traveller type / trip purpose

z_i^{mode} is any origin / mode specific constant required to calibrate the model

6.3.7 Factors to account for discomfort (sometimes applied to public transport) are not included in the calculation. Walk, Wait (at bus stop) and In Vehicle Time (IVT) are all obtained from the assigned models. This is the travel time between all ***ij*** pairs in the network.

6.3.8 The range of values for ϑ and those used in the WMMTM are shown in Table 6.8 below . These values come from WebTAG 3.10.3 and show the sensitivity of main mode choice relative to destination.

Table 6.8 – Mode Choice Theta Values

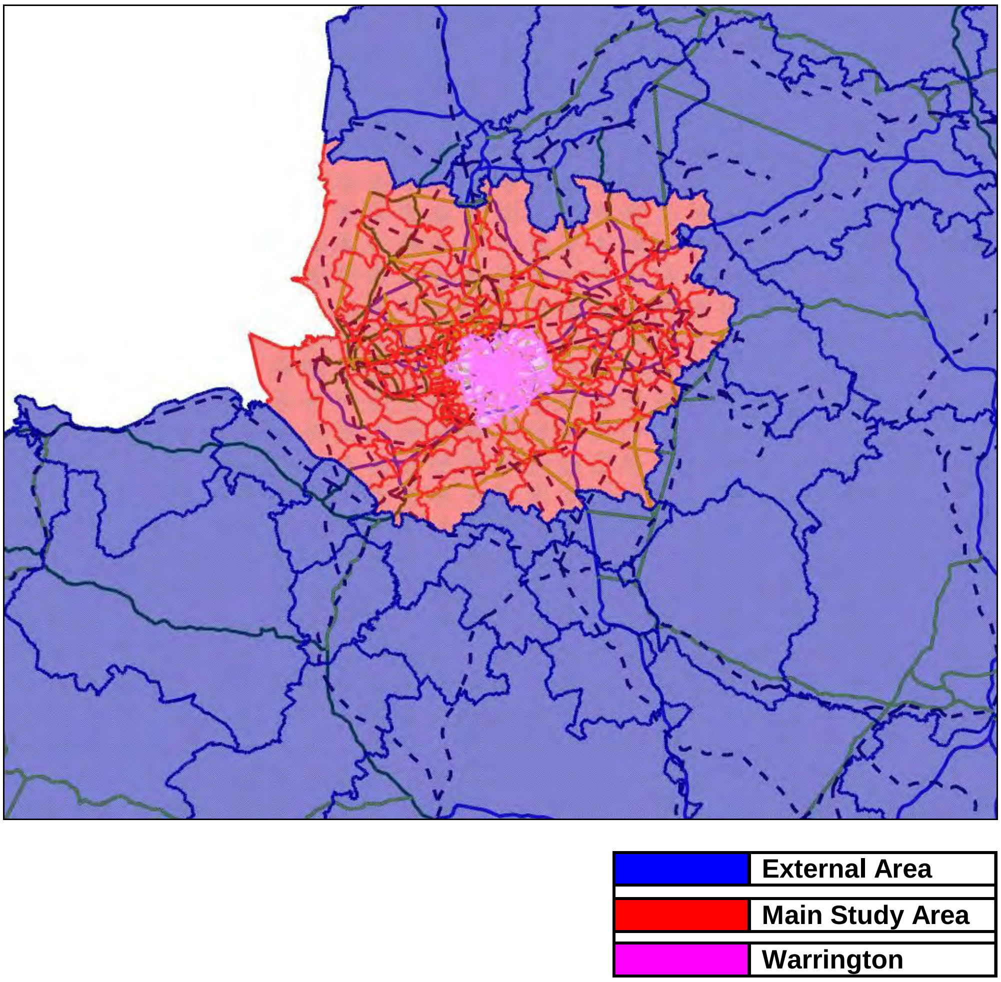
Trip Purpose	Minimum	Median	Maximum	In Warrington MMTM
Home-based work	0.5	0.68	0.83	0.5
Home-based employers business	0.26	0.45	0.65	0.26
Home-based other	0.27	0.53	1	0.27

6.3.9 The z_i^{mode} values were validated to local data to reflect the local strengths of the choice mechanisms as required in WebTAG. The z value is a value used to produce the correct mode share response and it makes up a number of ‘unknowns’ including a propensity to use one mode over another regardless of cost. The z values within this model are based on three areas; the simulation area covering Warrington, the main study area including Manchester and Liverpool, and the rest of the model. These sectors are illustrated in Figure 6.3 and the z factors used are detailed in Table 6.9.

Table 6.9 – Mode Choice Z Value Ranges

	Car	PuT	Slow
Simulation Area	0	85 to 110	20 to 70
Main Study Area	0 to 80	90 to 150	0 to 35
External	0 to 670	0 to 720	0

Figure 6.3 – Z Value Sectors



VEHICLE OPERATING COSTS (WEBTAG UNIT 3.5.6)

6.3.10 Vehicle Operating Costs (VOC) are broken down into two elements:

- Fuel
- Maintenance

Fuel

6.3.11 Fuel consumption is estimated using a function of the form:

$$L = a + b.v + c.v^2 + d.v^3$$

Where: L = cost expressed as pence per kilometre;
v = average speed in kilometres per hour; and
a, b, c, d are parameters defined for each vehicle category as shown in Table 6.10.

6.3.12 The fuel cost parameters used in the model are for 2008 shown in Table 6.10 these have been derived using WebTAG guidance.

Table 6.10 – Fuel Cost Parameters – Average Car 2008

Parameter	a	b	c	d
Average Car	5.085	-0.116	0.001	0

6.3.13 The average speed is a function of time and distance, obtained from the models as skim matrices. Once calculated, the cost per km is multiplied by the distance skim to produce the cost per ***ij*** pair.

6.3.14 The Vehicle Operating Costs (VOC) are portrayed in pounds (£), but for use in the mode choice model need to be converted into time (see Table 6.18).

Non-Fuel Vehicle Operating Costs

6.3.15 The elements making up non-fuel VOC include oil, tyres, maintenance, depreciation and vehicle capital saving (only for vehicles in working time). The non-fuel elements of VOC are combined in a formula of the form;

$$C = a1 + b1/V$$

Where: C = cost in pence per kilometre travelled,
V = average link speed in kilometres per hour,
a1 is a parameter for distance related costs defined for each vehicle category, and b1 is a parameter for vehicle capital saving defined for each vehicle category. (This parameter is only relevant to working vehicles).

6.3.16 The parameters needed to calculate the non-fuel vehicle operating costs are shown below. These parameters are in pence per kilometre at 2002 prices.

Table 6.11 - Non- Fuel VOC Formulae Parameters (pence per km, 2002 prices)

Vehicle Category	Resource Cost Parameters		Perceived Cost Parameters	
	a1	b1	a1	b1
Car				
Average Car	3.308	19.048	3.765	19.048
LGV				
Average LGV	5.91	33.97	6.035	33.97
OGV1	5.501	216.165	5.501	216.165
OGV2	10.702	416.672	10.702	416.672
PSV	24.959	569.094	24.959	569.094

6.3.17 These costs are converted into Value of Time (VoT) using the relations shown in Table 6.18.

BUS FARES

6.3.18 Bus fares are input into the model based on a relationship between cost and distance travelled. Warrington Borough Transport (WBT) provided information regarding the fare structure used, Table 6.12 shows the information WBT provided.

Table 6.12 - Warrington Borough Transport Fare Structure

Distance (kms)	Adult single (p)
1	80
2	100
3	125
4	135
5	150
6	175
7	195
8	205
9	230
10 – 11	245
12 – 14	255
15 – 18	265
19 - 22	275
23 and above	285

6.3.19 Table 6.12 formed the basis of the bus fare for the demand model. However, the fare per distance in the table is an ‘Adult single’ fare. This fare does not take into account the mixture of different passengers using the bus service such as OAPs and children who travel at reduced fares. To take this into account analysis was completed on the electronic ticket machines (ETM) data extracted from WBT system for the average weekday (Tuesday-Thursday). The ETM data contained the type of ticket purchased and it was possible to derive the percentage split of ticket types using bus services in Warrington throughout the day. Table 6.13 shows the percentages as derived from the ETM data.

Table 6.13 – Percentage Split between Ticket Types used in Warrington

Ticket Type	% of People
Adult Returns	3.70%
Adult Rovers	7.10%
Adult Singles	35%
Free Travel (OAPs, Staff)	43%
Half Fare	11%

6.3.20 Using the percentages in Table 6.13, a weighted cost was calculated for each distance, these are shown in Table 6.14. These figures were input into the demand model.

Table 6.14 – Warrington Bus Fare Structure for Demand Model

Distance (km)	Cost
1	£0.40
2	£0.50
3	£0.64
4	£0.68
5	£0.74
6	£0.85
7	£0.98
8	£1.02
9 - 11	£1.12
11 - 14	£1.18
14 - 18	£1.22
18 - 22	£1.26
22 - 23	£1.30
23+	£1.34

6.3.21 The bus fares above are then converted into units of time using the values in Table 6.18, taken from WebTAG (Unit 3.5.6).

CAR PARKING CHARGES

6.3.22 Car parking charges are part of the generalised cost calculations for car trips and input into the demand model, this section explains how these costs have been calculated.

6.3.23 All the car parks in Warrington town centre, shown in Figure 6.5 were allocated to the relevant zone in the WMMTM. The car parks were then separated by those that are free and those that charge, using information provided by WBC. Table 6.15 shows the car parks where payment is required.

Table 6.15 – Charging Car Parks in Warrington

Zone Number	Car Park Number	Car Park Name	Operator/Owner
190	CP22	Bank Quay Station	Network Rail
191	CP1	Museum Street South	Private
191	CP3	Museum Street South	WBC
210	CP6	Old Road	WBC
219	CP20	Winwick Street	NCP
219	CP21	Winwick Street Central	WBC
219	CP26	Central Station	Network Rail
222	CP17	Cockhedge Shopping Park	Cockhedge Shopping Park
222	CP18	Prince Henry Square	Cockhedge Shopping Park
222	CP11	Golden Square Ground Level	Golden Square
222	CP12	Golden Square MSCP	Golden Square
222	CP14	Time Square	Private
222	CP24	Market MSCP	WBC

6.3.24 From the table above it was possible to identify 5 zones where car park charging occurs within Warrington town centre; zones 190, 191, 210, 219 and 222. Car parking charges were not applied to HBW, HBEb and HBEd trip purposes because the RSI surveys commissioned as part of this study indicated that very few trips that park in Warrington town centre actually incur a charge to park. Therefore car parking charges were only applied to HBO and HBSh trip purposes and it has been assumed that these trips will be predominantly park in Warrington for a short time period.

6.3.25 The car park charge to be applied to HBO HBSh by zone is shown in Table 6.16. It was assumed the trip purposes of HBO and HBSH would not use the two town centre rail station car parks so no parking fee has been set.

Table 6.16 – Car Park Charges included in the Demand Model

Zones that need costs	Car Parks	Short Stay
190	Bank Quay Station	Free
191	Museum Street South	£0.55
210	Old Road	£0.70
219	Winwick Street Winwick Street Central Station	Free
222	Cockhedge Shopping Park Prince Henry Square Golden Square Ground Level Golden Square MSCP Time Square Market MSCP	£1.58

6.3.26 The zones in which car park costs have been added are shown below in Figure 6.4. As with the bus fares, VoT values will be used to convert the monetary parking charges into units of time.

Figure 6.4 – VISUM Car Park Zones

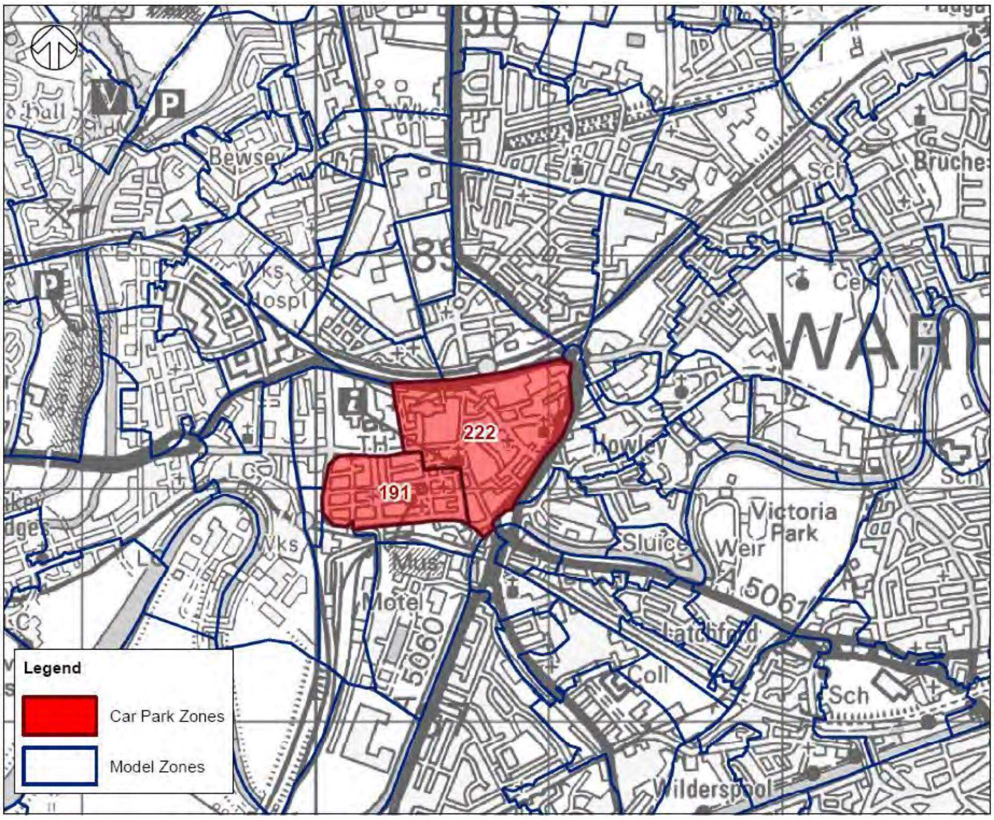
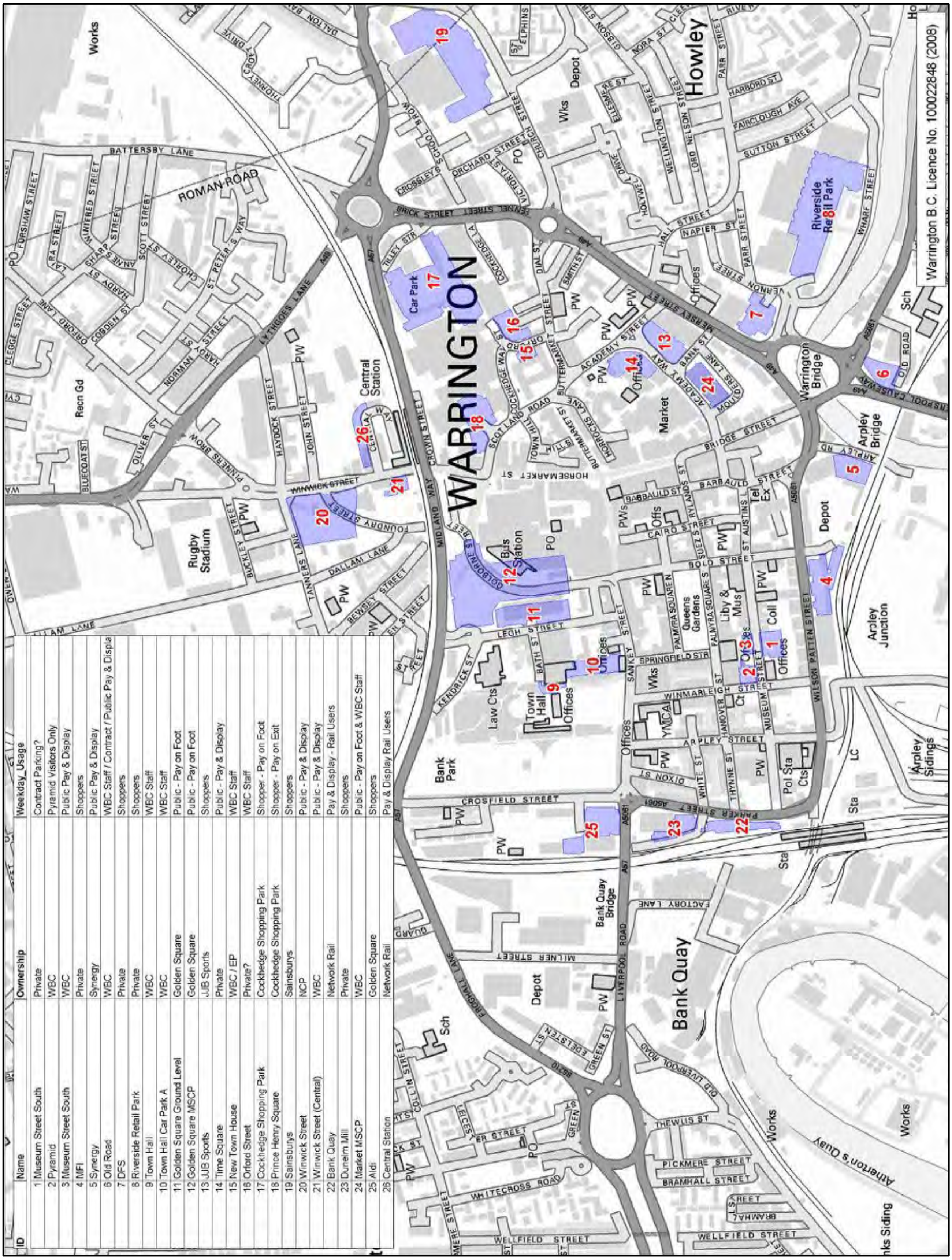


Figure 6.5 – Warrington Town Centre Car Parks



ID	Name	Ownership	Weekday_Usage
1	Museum Street South	Private	Contract Parking?
2	Pyramid	WBC	Pyramid Visitors Only
3	Museum Street South	WBC	Public Pay & Display
4	MFI	Private	Shoppers
5	Synergy	Synergy	Public Pay & Display
6	Old Road	WBC	WBC Staff / Contract / Public Pay & Displa
7	DFS	Private	Shoppers
8	Riverside Retail Park	Private	Shoppers
9	Town Hall	WBC	WBC Staff
10	Town Hall Car Park A	WBC	WBC Staff
11	Golden Square Ground Level	Golden Square	Public - Pay on Foot
12	Golden Square MSCP	Golden Square	Public - Pay on Foot
13	JJB Sports	JJB Sports	Shoppers
14	Time Square	Private	Public - Pay & Display
15	New Town House	WBC / EP	WBC Staff
16	Orford Street	Private?	WBC Staff
17	Cockhedge Shopping Park	Cockhedge Shopping Park	Shopper - Pay on Foot
18	Prince Henry Square	Cockhedge Shopping Park	Shopper - Pay on Exit
19	Sainsburys	Sainsburys	Shoppers
20	Winwick Street	NCP	Public - Pay & Display
21	Winwick Street (Central)	WBC	Public - Pay & Display
22	Bank Quay	Network Rail	Pay & Display - Rail Users
23	Dunelm Mill	Private	Shoppers
24	Market MSCP	WBC	Public - Pay on Foot & WBC Staff
25	Aldi	Golden Square	Shoppers
26	Central Station	Network Rail	Pay & Display Rail Users

VALUE OF TIME (WEBTAG UNIT 3.5.6)

6.3.27 WebTAG VoT is based upon a base of 2002, therefore adjustments to the VoT values is required to correct 2002 values to 2008 (base year). The growth factors used to convert the 2002 VoT are shown below.

Table 6.17 – Value of Time Growth Factors

Range of Years	Work VOT Growth (%pa)	Non-Work VOT Growth (%pa)
2002-2003	1.98	1.58
2003-2004	2.22	1.78
2004-2005	3.21	2.57
2005-2006	2.96	2.37
2006-2007	2.46	1.97
2007-2011	2.2	1.76
2011-2021	1.94	1.55
2021-2031	1.55	1.24
	Work VOT Growth (%)	**Non-Work VOT Growth (%)**
2002 - 2008	15.03	12.03

6.3.28 Relevant Values of Time are presented for 'working people' and 'non working' people. Note that commuters are classed as 'non working'. The following are taken directly from WebTAG taking into account growth adjustments taken from above. The yellow shaded VoT are those adopted in the modelling process.

Table 6.18 - Values of Working Time per person (£ per hour)

	2002	2008
Average working person	26.73	30.97

Table 6.19 – Values of Non-Working Time per person (£ per hour)

Purpose	2002	2008
Commuting	5.04	5.68
Other	4.46	5.02

MODE CHOICE PROBABILITY

6.3.29 With the composite costs of each mode (car, PT and Slow) for each zone calculated, the probability of travelling by car, public transport or slow modes ($prob_i^{mode}$) is calculated using the following logit based formula.

$$prob_i^{mode} = \frac{\exp\left(-\lambda u_i^{mode}\right)}{\sum_k \exp\left(-\lambda u_i^k\right)}$$

Where u_i^{mode} is the composite cost (disutility) of mode in trip production zone i.

k is the set of modes being modelled

λ is the mode choice parameter for a given traveller type / trip purpose

6.3.30 The result is mode choice proportions for each zone. The proportions are applied to the total population calculated in the trip generation stage to produce persons by mode travelling ***from*** each zone.

6.3.31 In summary the application of the composite cost and probability logit formulae produces an origin based mode choice vector (i.e. matrix row totals in persons at a 24 hour total) for every zone in the model. The vectors are then taken forward to the distribution stage.

6.4 TRIP DISTRIBUTION

6.4.1 Essentially the mode choice model produces the origin trip end by mode for each zone but not the destination end of the trip. The destination end of a trip is identified by calculating the probability of the destination zone being an attractor relative to the attractiveness of all the other zones.

6.4.2 At this point in the process the model is only distributing the car vectors produced. This is because it is not necessary to distribute the slow mode as this is never assigned in the model, and the public transport vectors are taken out of the Tier 1 model to be transferred into the Tier 2 model.

6.4.3 The logit choice model function used in the calculations is shown below.

$$prob_{j|i}^{mode} = \frac{\alpha_{ij}^{mode} S_{ij} \exp\left(-\vartheta u_{ij}^{mode}\right)}{\sum_k \alpha_{ik}^{mode} S_{ik} \exp\left(-\vartheta u_{ik}^{mode}\right)}$$

Where: $prob_{j|i}^{mode}$ - Probability of origin / destination pairs by mode

α_{ij}^{mode} - Alpha value specific to any origin / destination pair by mode

S_{ij} - Attraction rate of the destination zone

ϑ - Theta value

u_{ij}^{mode} - Generalised Cost between all origin / destination pairs by mode

6.4.4 Table 6.20 shows the trip distribution theta value ranges taken from WebTAG, the median values were used in the Warrington MMTM demand model.

Table 6.20 – Trip Distribution Theta Values

Trip Purpose	Minimum	Median	Maximum
Car			
Home-based work	0.054	0.065	0.113
Home-based employers business	0.038	0.067	0.106
Home-based other	0.074	0.09	0.16
Public Transport			
Home-based work	0.023	0.033	0.043
Home-based employers business	0.03	0.036	0.044
Home-based other	0.033	0.036	0.062

6.4.5 Table 6.21 shows the range of alpha values used in the demand model. Alpha values were firstly applied at a zonal level and determined by a distance relationship between OD pairs and then adjusted at a sector to sector level in order to achieve validation.

Table 6.21 – Range of Alpha Values

Alpha Value	Car				Bus				Rail			
	HBW	HBEB	HBED	HBO	HBW	HBEB	HBED	HBO	HBW	HBEB	HBED	HBO
Minimum	0.00	0.67	0.50	1.00	0.00	0.00	0.01	0.01	0.00	0.50	0.01	0.01
Maximum	63000	2384	100	110	2500	100	7	50	1000	1000	500	10

6.4.6 Further aggregation of the population segments takes place before trip distribution. The differentiation between car availability is now taken out of the model to leave just five Home-Based journey purpose segments.

6.4.7 The trip distribution is calculated separately for the different trip purposes; Home-Based Work (HBW), Home-Based Employers Business (HBEb), Home-Based Education (HBEd), Home-Based Shopping (HBSh) and Home-Based Other (HBO).

6.4.8 Attractor rates are taken from different sources for each different purpose and then normalised so that the total attraction across all destination zones adds up to a total to 100%.

6.4.9 The attraction weights used for each purpose are:

- HBW/ HBEb – workplace population for each zone
- HBEd – number of pupils on the roll at all the schools in each zone
- HBSh – calculated using the floor space rateable values from the Valuation Office Agency
- HBO – a combination of the proportion of the number of households within each zone and the home-based shopping attraction rates

6.4.10 In the case of Home-Based Work and Home-Based Education trips the process needs to be doubly constrained as both the production and destination zones are pre-determined by the location of housing, workplaces and schools. Therefore the attractors in this case go through another process where they are normalised to equal the productions thus doubly constraining the matrices.

NON HOME-BASED TRIPS

6.4.11 Non Home-Based trips are by definition trips from place other than home and are part of a trip chain where one trip follows on from another.

6.4.12 To generate Non Home-Based productions a trip rate factor is applied to the number of Home-Based trips arriving in the area. The Home-Based productions are therefore taken through the mode choice and trip distribution stages of the model to produce a Home-Based productions and attractions matrix. The trip rate factors shown in Table 6.22 are then applied to the Home-Based attractions to produce Non Home-Based productions, these factors have been derived from NTS.

Table 6.22 – Non Home-Based Trip Rate Factors (Secondary Ratio to Home-Based Trip)

Follow on trip purpose	Previous Trip Purpose				
	HBW	HBEB	HBEd	HBPB/Shop	HBRec/Hol
NHBEB	0.0789	0.5993	0.00244	0.00409	0.00604
NHBO	0.17558	0.77502	0.15193	0.2504	0.32569

6.5 ASSIGNMENT

6.5.1 The demand model matrices are primarily used to infill the RSI matrix to produce the Prior matrix. Data from the demand model is used wherever there is a lack of information in the RSI matrix. Where information is available from Roadside Interviews the demand model trips are removed before infilling to avoid the possible replication of trips.

6.6 TIME SLICE

6.6.1 Trips produced by the demand model are 24 hours totals and are converted to an AM, IP or PM peak hour total via the application of scaling factors prior to an assignment. These scaling factors are summarised in Table 8.17.

6.7 TIER 2 DEMAND MODEL

6.7.1 The second tier demand model runs through the exact same process as the Tier 1 Demand Model except this derives Bus and Rail trips from the Public Transport demand. The trip generation process is therefore not needed as the trip productions are taken from the Tier 1 trip vectors for public transport as defined by the Tier 1 mode choice calculations. Tier 2 Mode Choice then splits the productions down further into the different public transport options and these are distributed in the same manner as the car vectors using the same attractor weights.

7 Assignment Calibration and Validation Procedures

HIGHWAY CALIBRATION AND VALIDATION PROCEDURES

7.1 HIGHWAY CALIBRATION PROCEDURE

7.1.1 The calibration procedure involved the following activities:

- Adjustment and checking of the network to ensure plausible and realistic routing of traffic in the model through monitoring RSI matrix assignments
- Comparison of modelled flows against observed that were used explicitly in the creation of the demand matrix (including those used for developing the RSIs and those used in matrix estimation) across screenlines, cordons and at other locations

7.2 HIGHWAY VALIDATION PROCEDURE

7.2.1 The validation procedure involved the following activities:

- Network validation, in terms of range checking and routing
- Checking assignment model convergence
- Comparison of observed and modelled journey time routes
- Comparison of modelled flows against independent observed flows (i.e. those not used in the matrix building process), across screenlines and at other locations
- Checks to ensure that speed/flow calculations on network links and delay calculations at junctions were operating as expected
- Comparison of sector to sector movements after the matrix estimation process between the prior observed model and the observed model for internal to external and external to internal movements between Warrington and the surrounding areas

7.3 HIGHWAY RANGE CHECKING

7.3.1 Range checking of the network parameters was undertaken and any suspicious data was verified against relevant source data. The parameters checked included:

- Link length and speeds
- Junction type
- Signal timings
- Saturation flows
- Number of lanes

7.4 HIGHWAY ROUTE CHOICE

7.4.1 A check on the validity of route choice within the model was undertaken by visual inspection of modelled routes through the study area.

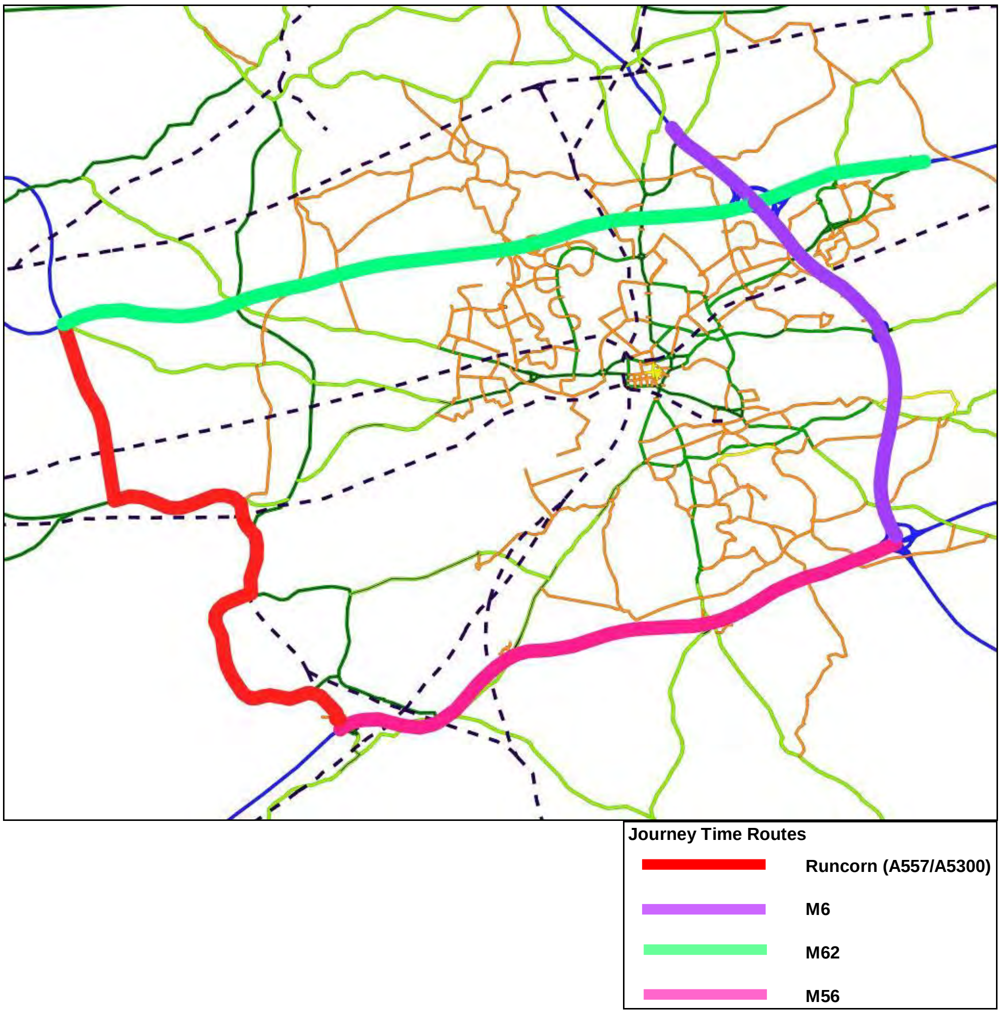
7.5 HIGHWAY ROUTE JOURNEY TIME VALIDATION

7.5.1 Journey times provide a good indication of the ability of a model to represent impedance and route choice accurately, both in the base year and forecast year. Journey time surveys provide an independent check of the validity of the model and the ability of the chosen software to replicate junction delays accurately. Eight one way journey time surveys covering the main motorway routes around Warrington were carried out and can be viewed in Figure 7.1. A total of 26 town centre journey time routes were used in addition to these four main strategic journey time routes. The town centre journey time routes can be found in Appendix C.

7.5.2 The motorway journey time surveys were commissioned for this study and at least six observations in each direction during each time period were taken. The town centre journey time routes also had at least this number of observations meeting the sample size criteria recommended by DMRB to enable representative journey time validation.

7.5.3 Following DMRB guidance, the total modelled journey time should be within ±15% of the observed average time for at least 85% of the journey time routes.

Figure 7.1 – Strategic Journey Time Routes



7.6 HIGHWAY GEH STATISTIC

7.6.1 The GEH statistic was adopted as the main indicator of 'goodness of fit', i.e. the extent to which modelled flows match corresponding observed values. The GEH statistic is a form of the chi-squared statistic described in Traffic Appraisal in Urban Areas - Chapter 4 (DMRB Vol. 12a). It is defined as

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

Where M = modelled flow

C = observed flow (or count)

7.6.2 A GEH value can be calculated for individual links or screenlines. A GEH value of less than 5 indicates a satisfactory fit between observed and modelled flows, while links with a GEH statistic greater than 10 probably require closer attention. It is generally accepted that a GEH value of less than 5 should be obtained on at least 85% of all links. For screenlines or other combinations of links a GEH value of less than 4 is sought. A further flow comparison measurement was also made as explained below in Table 7.1.

Table 7.1 – Assignment Validation: Acceptability Guidelines

Criteria and Measures	Acceptability Guideline
Assigned Hourly Flow* Compared with Observed Flows:	
1. Individual flows within 15% for flows 700 – 2700 vph 2. Individual flows within 100 vph for flows < 700 vph 3. Individual flows within 400 vph for flows > 2700 vph	> 85% of cases
4. Total Screenline flows (normally > 5 links) to be within 5%	All (or nearly all) screenlines
5. GEH Statistic: ♦ Individual flows: GEH < 5 ♦ Screenline** totals: GEH < 4	> 85% of cases All (or nearly all) screenlines

* links or turning movements
** Screenlines containing high flow routes such as Motorways should be presented both including and excluding such routes
(Source: Table taken from DMRB Vol 12a, Table 4.2)

7.7 HIGHWAY SCREENLINE FLOWS

7.7.1 Observed and modelled VISUM flows across five screenlines were compared, ensuring that the modelled trips between particular geographical sectors corresponded to those observed.

- Outer cordon calibration screenline (purple on Figure 7.2)
- Inner cordon calibration screenline (green on Figure 7.2
- North-South calibration screenline (red on Figure 7.2)
- East West validation screenline (blue on Figure 7.3)
- Validation screenline (pink on Figure 7.3)

Figure 7.2 – Highway Calibration Screenlines & Cordons

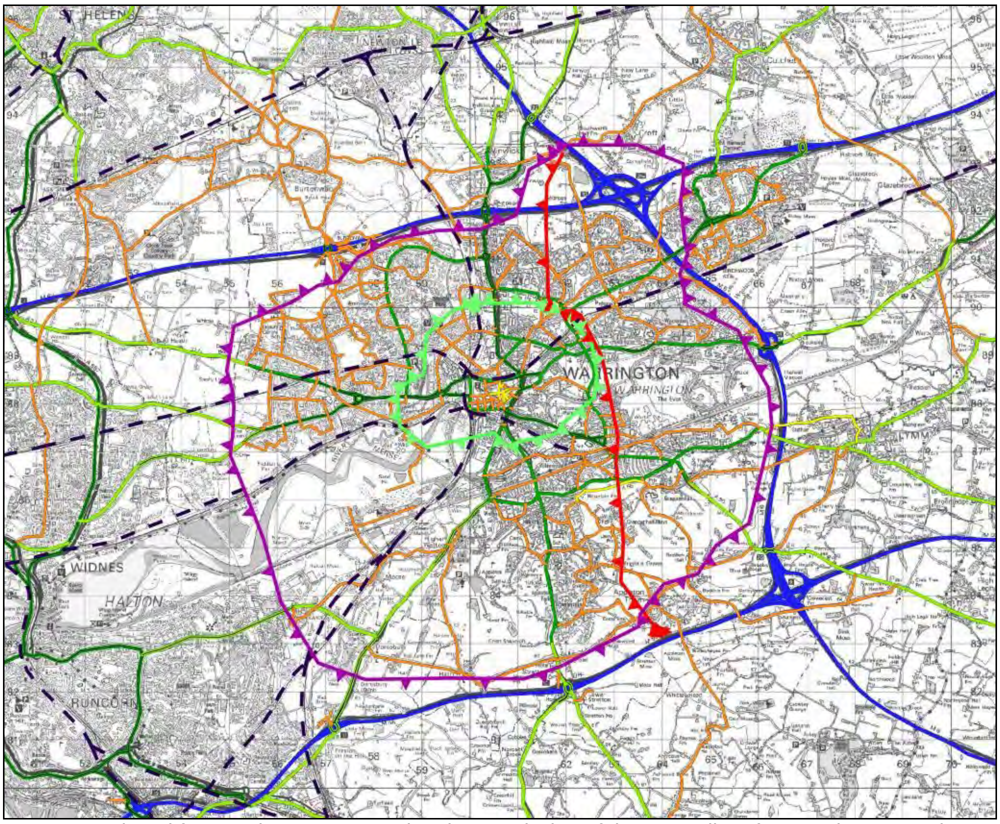
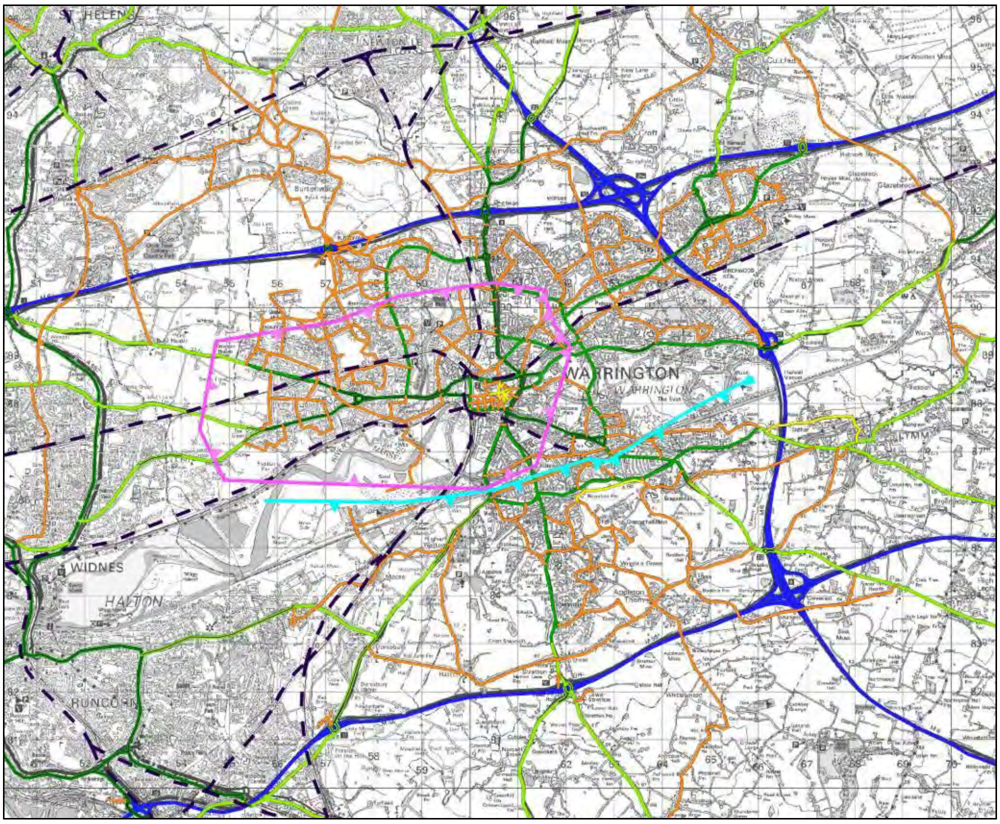


Figure 7.3 – Highway Validation Screenlines & Cordons



7.8 PUBLIC TRANSPORT CALIBRATION PROCEDURE

7.8.1 The calibration procedure involved the following activities:

- Adjustment and checking of the bus and rail network to ensure plausible and realistic routing of passengers in the model. This included walking access to and from the bus stops and railway stations, interchange between services and monitoring public transport matrix assignments
- Comparison between modelled and observed bus patronage levels on surveyed services by route
- Comparison between modelled and observed rail patronage levels at surveyed railway stations

7.9 PUBLIC TRANSPORT VALIDATION PROCEDURE

7.9.1 The validation procedure involved the following activities:

- Comparison of modelled bus stop boarders and alighters against those observed in independent counts at Warrington Central Bus Station
- A validity check on route choice within the model was undertaken by visual inspection of modelled routes through the study area

7.10 PUBLIC TRANSPORT VALIDATION CRITERIA

7.10.1 WebTAG Unit 3.11.2 provides guidance on the Validation of Public Transport Passenger Assignment Models. It states that the Validation of a public transport passenger assignment model should involve three kinds of check:

- Validation of the trip matrix
- Network and service validation
- Assignment validation

7.10.2 The public transport results in Chapter 12 presents the public transport results inline with WebTag Criteria. m

7.11 DEMAND MODEL VALIDATION PROCEDURES

7.11.1 The demand model validation procedures involved the following activities:

- Comparison of the Home-Based Work (HBW) demand model trip productions against Travel To Work (TTW) census data
- Comparison of the HBW demand model trip productions by mode against the TTW census data by mode
- Comparison of mode split of all trip purposes against National Travel Survey (NTS) data countrywide and at a local Warrington level
- Maps showing the distribution of trips within Warrington by each trip purpose
- Comparison of observed and demand model journey time routes
- Comparison of modelled trip lengths by trip purpose against NTS trip lengths countrywide
- Matrix sector comparison between demand model and TTW data
- Comparison motorway turning proportions against ANPR proportions

7.12 FURTHER MODELLING CHECKS

7.12.1 Additional checks of the modelling procedure were made by comparing the demand and observed models. These comparisons included the following:

- Comparison between the observed model and demand model mode split proportions between car and public transport
- Comparison of sector to sector movements between the observed and demand models for internal to external and external to internal movements between Warrington and the surrounding areas

7.13 DEMAND MODEL VALIDATION EXPECTATIONS

7.13.1 It should be noted that there are no set DMRB criteria that a demand model must meet for validation purposes. Therefore the validation checks will be used to provide confidence that the model is working intuitively. Further evidence of the model's reliable behaviour is measured through three proving tests as presented in the Model Testing Report. In addition, WebTAG stipulates a range of realism tests to be undertaken and these results are presented in Chapter 10.

8 Demand Model Validation Results - Tier 1

8.1 INTRODUCTION

8.1.1 WebTAG does not provide a clear and concise method for demonstrating demand models are validated in the same manner DMRB does for observed models. Therefore validation benchmarks have to be drawn from existing datasets to allow model versus observed validation comparisons to be made. By validating each of the four stages of model against observed data, it is possible to ensure that the demand model produces results that can be trusted and relied upon.

8.1.2 Results from the following demand model validation procedures are shown within this chapter:

Trip Generation

- Comparison of the Home-Based Work (HBW) demand model trip productions against Travel To Work (TTW) census data

Mode Choice

- Comparison of the HBW demand model trip productions by mode against the TTW census data by mode
- Comparison of all the trip purposes mode split against National Travel Survey (NTS) data countrywide and at a local Warrington level

Trip Distribution

- Maps showing the distribution of trips within Warrington by each trip purpose
- Comparison of modelled trip lengths by trip purpose against NTS trip lengths countrywide
- Matrix sector comparison between demand model and TTW data
- Comparison motorway turning proportions against ANPR proportions

Assignment

- Comparison of observed and demand model journey time routes
- Matrix sector comparison between demand model and observed model

8.2 TRIP GENERATION

8.2.1 At the trip generation stage the Home-Based Work trips produced by the demand model are compared directly with the Travel to Work census data (2001). At the local Warrington area some model zones are a disaggregation of census output areas thereby making the data for direct comparisons difficult to obtain accurately from the census. Also the amount of information at a zonal level to compare is large, so the comparisons have been made at sector, or main zone, level. Table 8.1 below presents the demand model person trip generations against the census outputs. The trip generations at this stage are person based and represent a weekday 24 hour period.

Table 8.1 – Home-Based Work Trip Productions 24Hrs

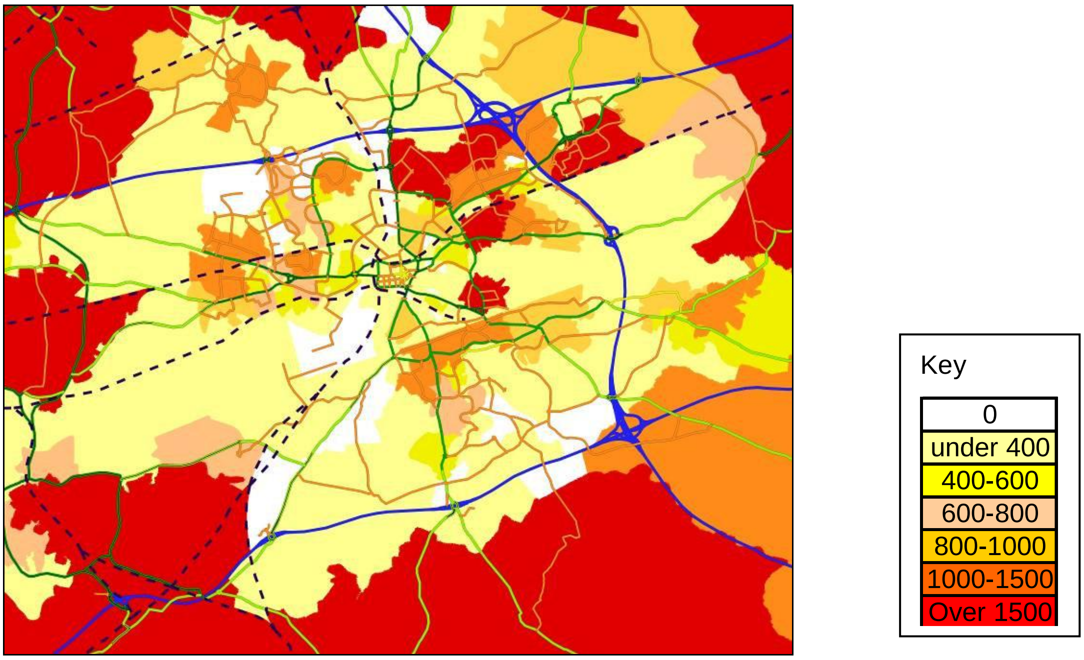
Main Zone	Description	TTW Trip Production	DM HBW Trip Production	Difference	% Difference
1	South of England and Wales	14054130	12357604	-1696526	-12.07%
2	Scotland and North of England	2047761	1787342	-260419	-12.72%
3	West Midlands	2717213	2391077	-326136	-12.00%
4	North Wales	368408	336640	-31768	-8.62%
5	Manchester and environs	835499	731329	-104169	-12.47%
6	Liverpool and environs	554410	473837	-80573	-14.53%
7	Chester and environs	223995	190100	-33895	-15.13%
8	Macclesfield and environs	144855	124996	-19860	-13.71%
9	South East Warrington	10408	9402	-1006	-9.66%
10	South West Warrington	2514	2237	-277	-11.03%
11	North East Warrington	27522	23274	-4248	-15.44%
12	North West Warrington	24147	22250	-1897	-7.86%
TOTAL		21010863	18450089	-2560774	-12.19%

8.2.2 As the table above shows, the demand model trip production is lower compared to the Travel to Work census. There is a valid reason for this; census data is a statement of how people travel to work on an average day. This does not take into account the likelihood of people not travelling to work on any given day due to holidays, bank holidays, sickness, work at home or other reasons. Part-time workers are also not taken into account and for this reason Travel to Work data statistics will be higher than what actually occurs on an average day. Across the UK and within Warrington the full census data is 12% greater than the demand model results. It is not unreasonable to assume that the difference is made up from some workers not travelling on any given day.

8.2.3 This Trip Generation stage within the demand model represents a 24 hour period and at this level there is only one validation measure possible and that is measuring the HBW generations against the 2001 TTW census data.

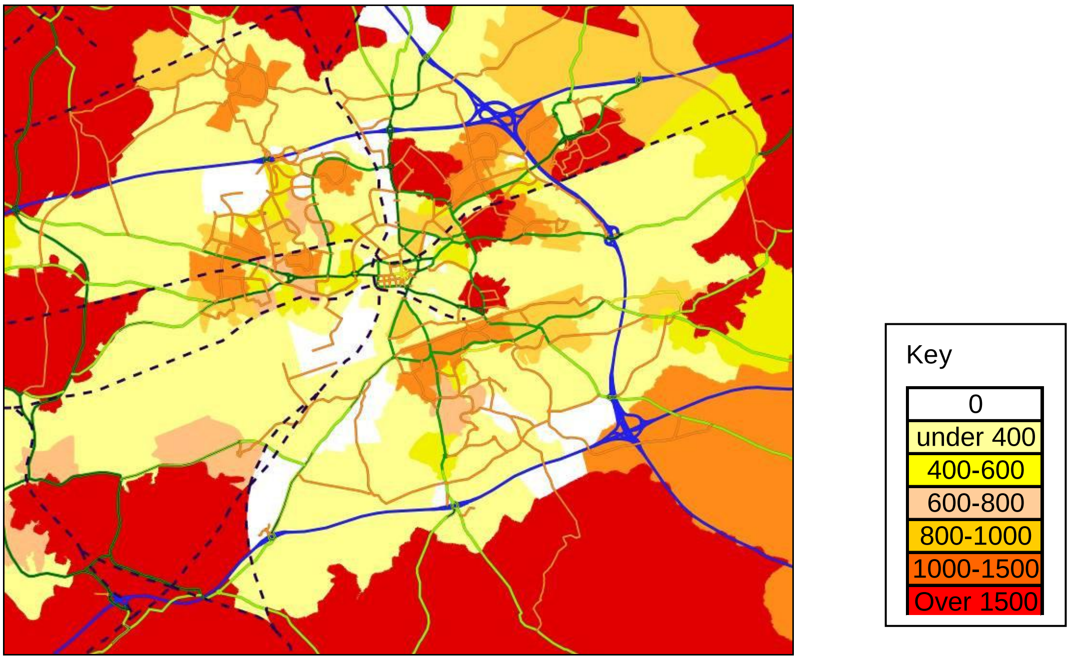
8.2.4 Figure 8.1 shows a map of the Travel to Work person trip productions at a 24 hour all mode level. This has been adjusted down by 12% so it is directly comparable to the demand model for the reasons explained previously.

Figure 8.1 - Adjusted 2001 Census TTW Person Trip Productions (All Modes)



8.2.5 Figure 8.2 shows the 24hour HBW trip production from the Demand Model.

Figure 8.2 – Demand Model HBW Person Trip Productions (All Modes)



8.2.6 The trip production patterns are very similar to those in Figure 8.1 which provides confidence that at a zonal level in Warrington the Demand Model is producing the correct number of HBW trips. Areas where change is evident, such as Chapelford, is supported by the knowledge that significant housing development has occurred in these areas.

SUMMARY

8.2.7 Overall this section demonstrates that at the trip generation stage the Warrington Demand Model compares well with the Travel to Work data giving confidence that the number of HBW trips being produced in the Demand Model is accurate. There is no benchmark for measuring the other journey purposes or population segmentation, but the process demonstrated for HBW gives confidence that the model building procedures are correct and by association confidence can be drawn that the model building process for the other purposes (using NTS trip rates by population segmentation) is correct.

8.3 MODE CHOICE TIER 1

HOME-BASED WORK

8.3.1 Mode choice, the splitting of person trips into the available modes (Car, Public Transport and Slow) is produced at a 24 hour level just like the trip generation stage. However the demand model is split into the three separate time period models at the mode choice stage. This is because observed peak hour costs are required to derive Generalised Costs for each time period demand model. It is these generalised costs that are used to calculate the mode split for each peak hour, albeit the calculation is undertaken for all persons travelling in a 24 hour period. Different time periods produce varying costs for the same routes and it is these costs that are being fed into the mode choice algorithms.

8.3.2 TTW census data is also categorised by travel mode allowing a comparison of the modal breakdown of the HBW trip purpose to be made. Table 8.2 shows the TTW mode split for each main zone within the model. The location of the main zones within the model is shown in Figure 8.3 and Figure 8.4.

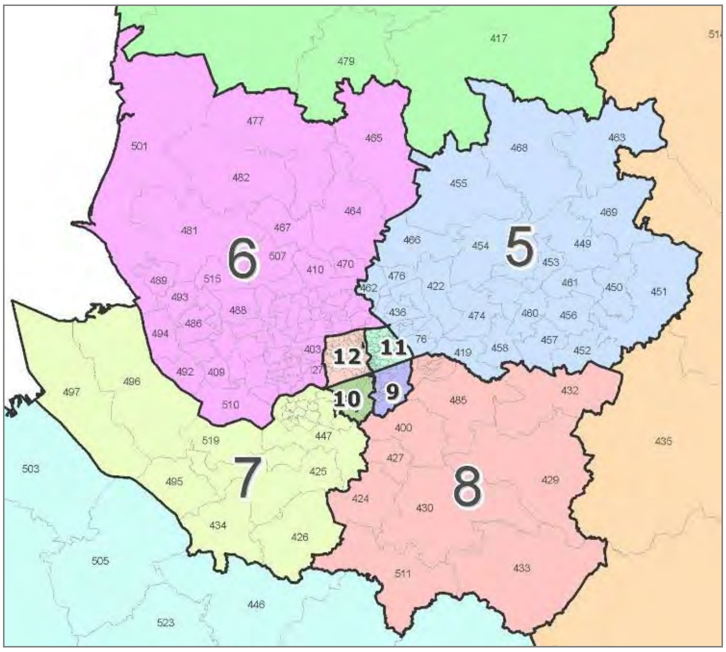
Table 8.2 – Census Travel to Work Mode Split by Main Zones

	Mode Split Proportions		
Main Zone	**Car**	**PuT**	**Slow**
1	68%	18%	14%
2	72%	11%	16%
3	73%	13%	14%
4	80%	5%	14%
5	71%	16%	13%
6	72%	15%	13%
7	76%	12%	12%
8	84%	5%	11%
9	88%	5%	7%
10	89%	4%	7%
11	76%	9%	16%
12	82%	8%	10%
All Zones	69.47%	16.20%	14.33%
Warrington	80.83%	7.35%	11.82%

8.3.3 The census data above shows the wide variation in mode splits in the different sectors and hence the difficulty in validating mode choice to census data within the model as every zone sector has varying mode choice proportions.

Figure 8.3 – Main External Zones

Figure 8.4 – Main Internal Zones



8.3.4 In the Demand Model the highway and public transport network are only included in detail within the Warrington area. For this reason the validation of the demand model at the mode choice stage focuses on the Warrington area to ensure that mode choice is accurate for the study area.

8.3.5 As TTW trip production is approximately 12% higher in the Warrington area than an average day (and therefore the demand model). For ease of comparison with the demand model the census data in the Warrington zones has been adjusted accordingly.

Table 8.3 – HBW Car Person Trip Productions 24 Hrs

Main Zone	Description	Warrington TTW -12%	DM HBW Trip Production	Difference	% Difference
9	South East Warrington	8097	8291	194	2.40%
10	South West Warrington	1974	1987	13	0.67%
11	North East Warrington	18373	17727	-646	-3.51%
12	North West Warrington	17497	18298	801	4.58%
TOTAL		45941	46303	362	0.79%

Table 8.4 – HBW Public Transport Person Trip Productions 24 Hrs

Main Zone	Description	Warrington TTW -12%	DM HBW Trip Production	Difference	% Difference
9	South East Warrington	425	430	5	1.22%
10	South West Warrington	83	84	1	1.05%
11	North East Warrington	2068	2134	66	3.18%
12	North West Warrington	1604	1610	6	0.36%
TOTAL		4180	4258	78	1.86%

Table 8.5 – HBW Slow Mode Person Trip Productions 24 Hrs

Main Zone	Description	Warrington TTW -12%	DM HBW Trip Production	Difference	% Difference
9	South East Warrington	637	682	44	6.94%
10	South West Warrington	155	166	10	6.63%
11	North East Warrington	3778	3412	-366	-9.69%
12	North West Warrington	2148	2342	194	9.03%
TOTAL		6719	6601	-117	-1.75%

8.3.6 It is important to note that the total person trips in Warrington as taken from the census does not exactly match the total person trips as produced in the demand model. This will slightly skew the percentage differences especially when looking at Main Zone level and where the person trips are low. With this in mind the focus has been on ensuring the proportions of person trips within each sector relative to each other are of the right order.

8.3.7 Overall the tables above show that the mode choice split in the demand model for the Warrington area is accurate with all demand model modes being within 2% of the census totals.

8.3.8 Main Zones 11 and 12, that lie north of the canal, have a greater population and therefore person trips than sectors 9 and 10 that lie south of the canal. The rank and order of the person trips by mode at a sector level is representative of the population spread.

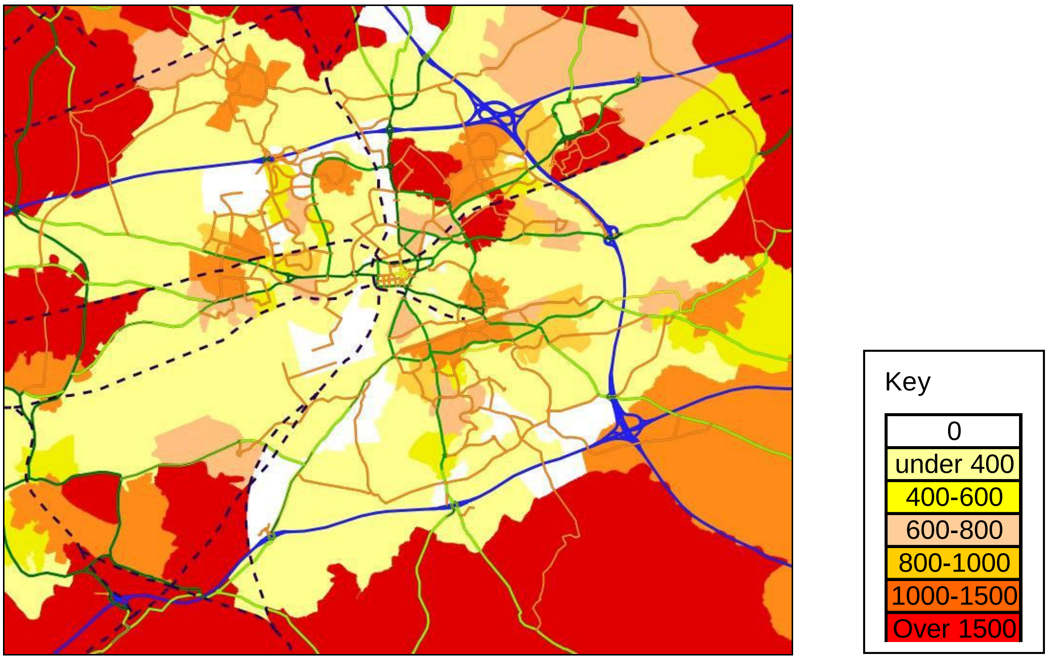
8.3.9 The demand model car person trips at a Main Zone level compare very closely with the census data.

8.3.10 The mode choice for the Home-based work trips from the demand model are deemed to validate accurately against census data across Warrington as a whole and at sector level for car person trips. This data can be confidently taken forward to the trip distribution stage.

8.3.11 To provide greater confidence in the validation of the mode choice stage TTW data and HBW trip productions from the demand model can be illustrated at a Warrington zonal level within VISUM. This allows easy comparison and demonstrates a clear identification of where HBW trips by mode are being produced within Warrington. This can be further validated as areas of high HBW trip productions should be residential areas.

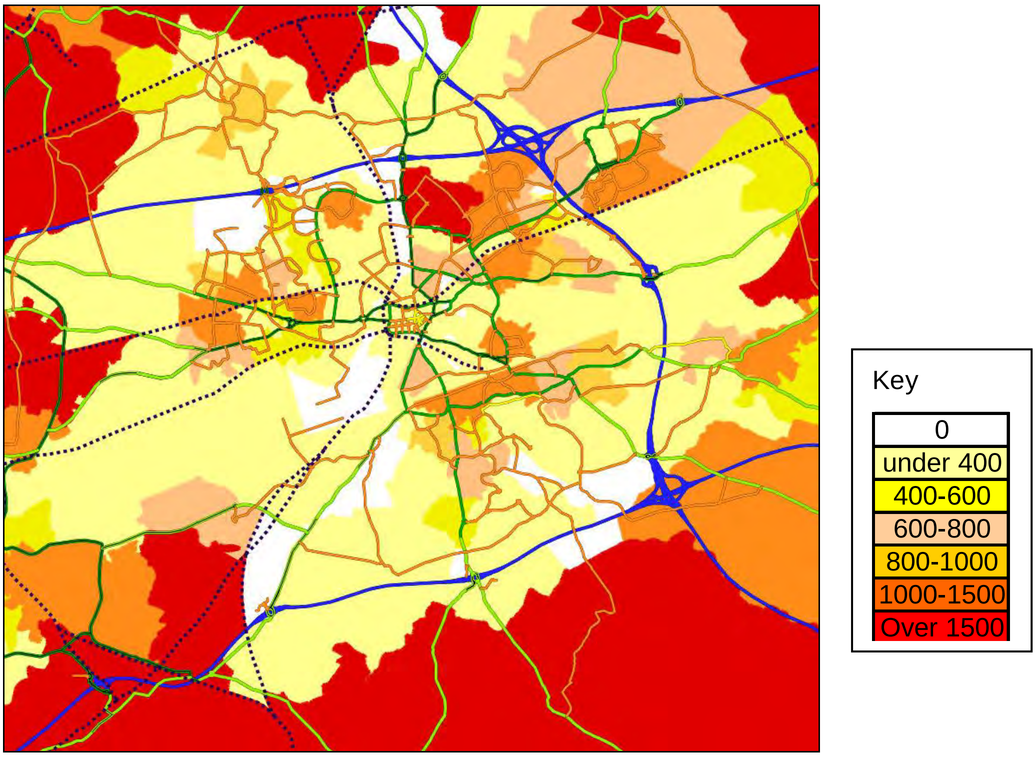
8.3.12 Figure 8.5 shows a map of Warrington illustrating the car person production trip from the travel to work census data. The key alongside the map shows the number of person trips produced for each zone. This map can be directly compared to the demand model HBW productions. Note the travel to work data has been adjusted downwards by 12%.

Figure 8.5 – Adjusted TTW 24 Hour Car Person Trip Productions



8.3.13 Figure 8.6 shows the demand model HBW car person trip productions during a 24 hour time period.

Figure 8.6 – Demand Model HBW 24 Hour Car Person Trip Productions



8.3.14 Figure 8.7 and Figure 8.8 show scatter graphs comparing the 2001 TTW and 2008 HBW car productions for the Warrington area and the main study area respectively. In Figure 8.7 the Chapelford development zone is highlighted as an outlier as houses have been built in this area between 2001 and 2008. All other zones show a reasonable correlation.

Figure 8.7 – TTW and HBW Car Productions Warrington Area

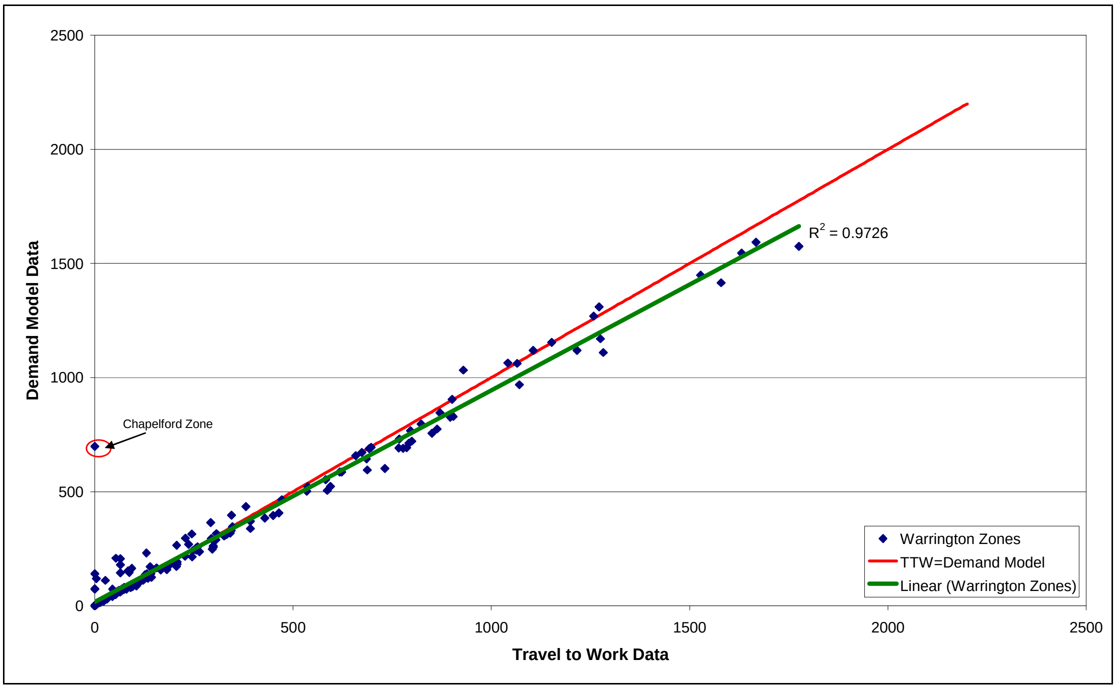
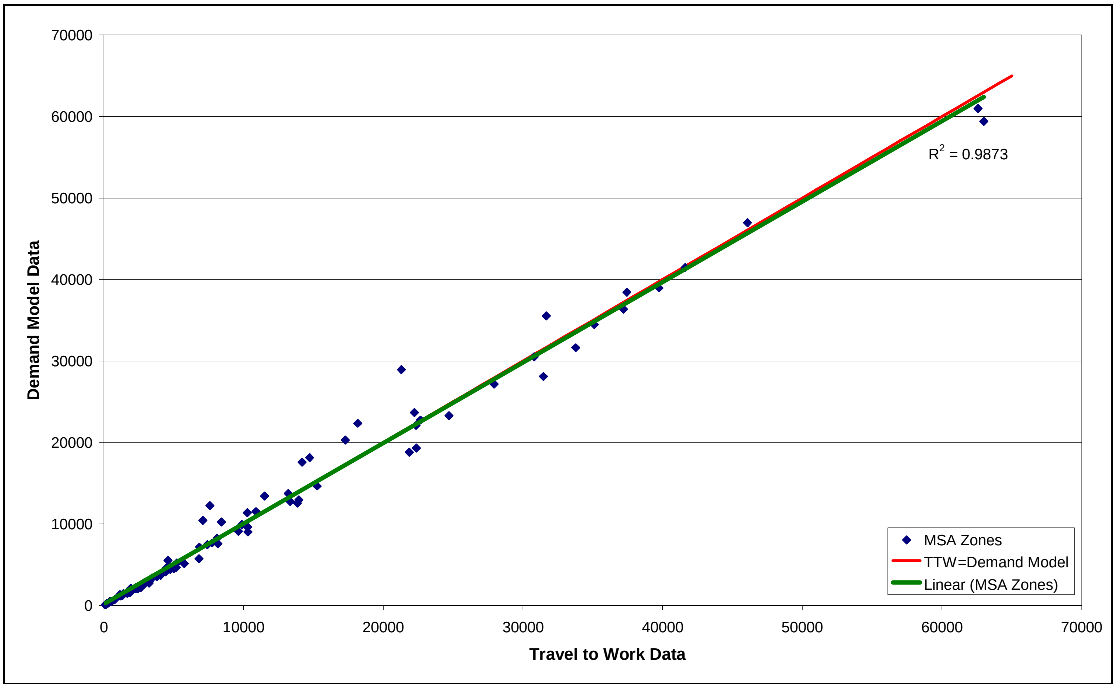


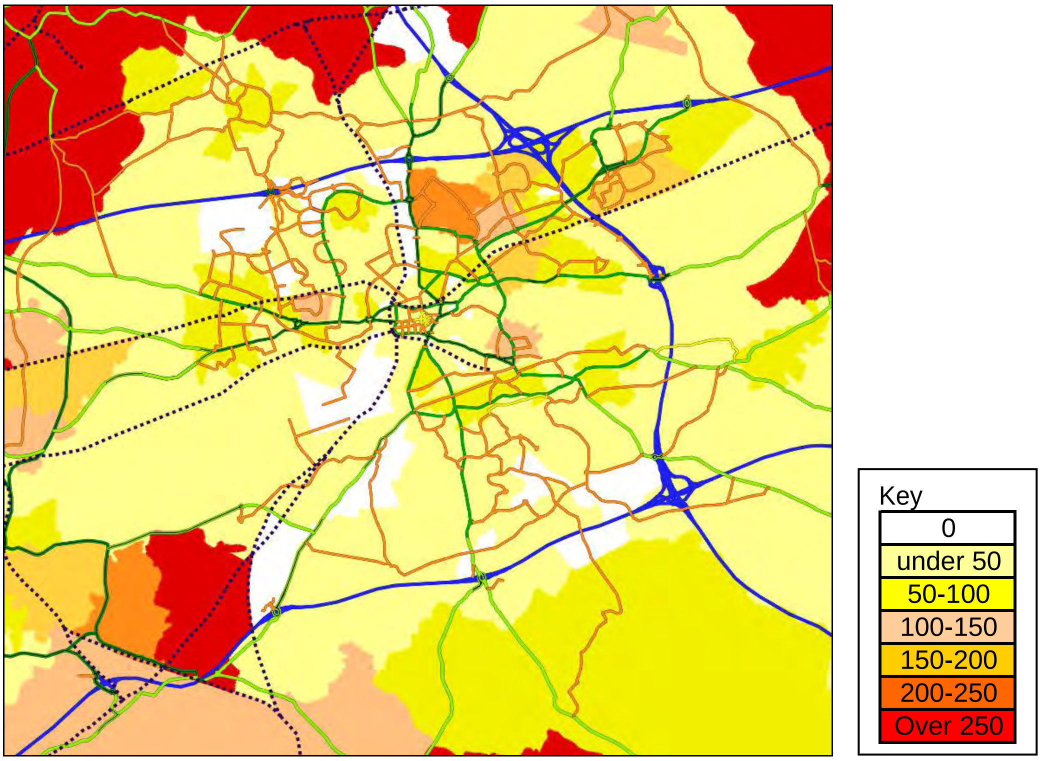
Figure 8.8 – TTW and HBW Car Productions Main Study Area



8.3.15 The figures above show that the demand model is very similar to the 2001 TTW data. There are a few variations between the maps and where they occur it is within one colour band. The scatter graphs also demonstrate a good correlation between the TTW and HBW data. Overall at a zonal level the mode choice for car validates well against the census data.

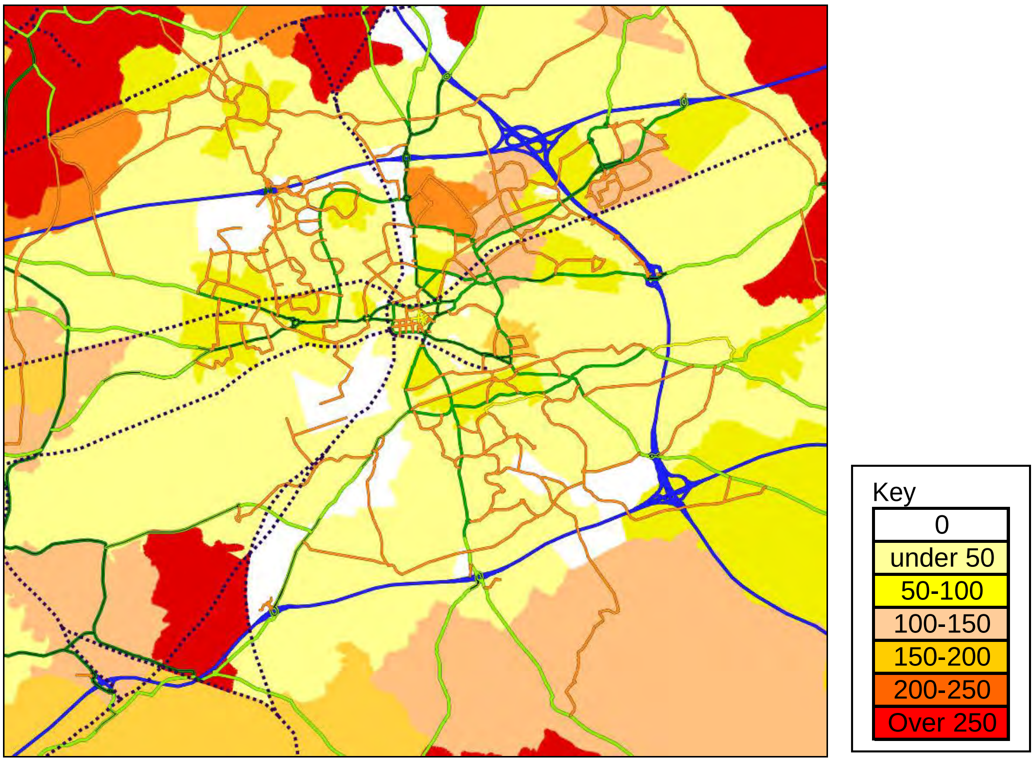
8.3.16 Figure 8.9 shows the adjusted public transport person trip productions from the travel to work data for zones within Warrington.

Figure 8.9 – Adjusted TTW 24 Hour PT Person Trip Productions



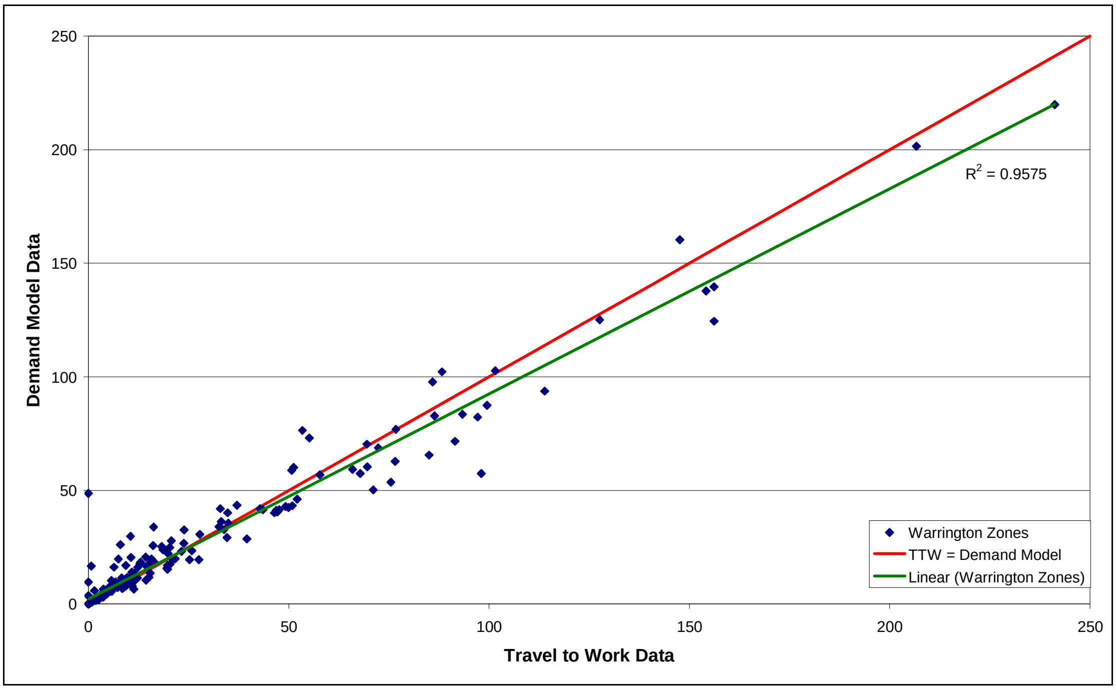
8.3.17 Figure 8.10 shows the public transport person trip productions at a 24 hour level from the demand model.

Figure 8.10 – Demand Model HBW 24 Hour PT Person Trip Productions



8.3.18 Figure 8.11 shows a scatter graph of the TTW and demand model PT trip productions. The graph shows that there is generally good correlation between the sets of data, however it is important to note that since the 2001 TTW data was collected significant improvement in public transport services, including the new bus station, have occurred and this accounts for some of the differences on this graph.

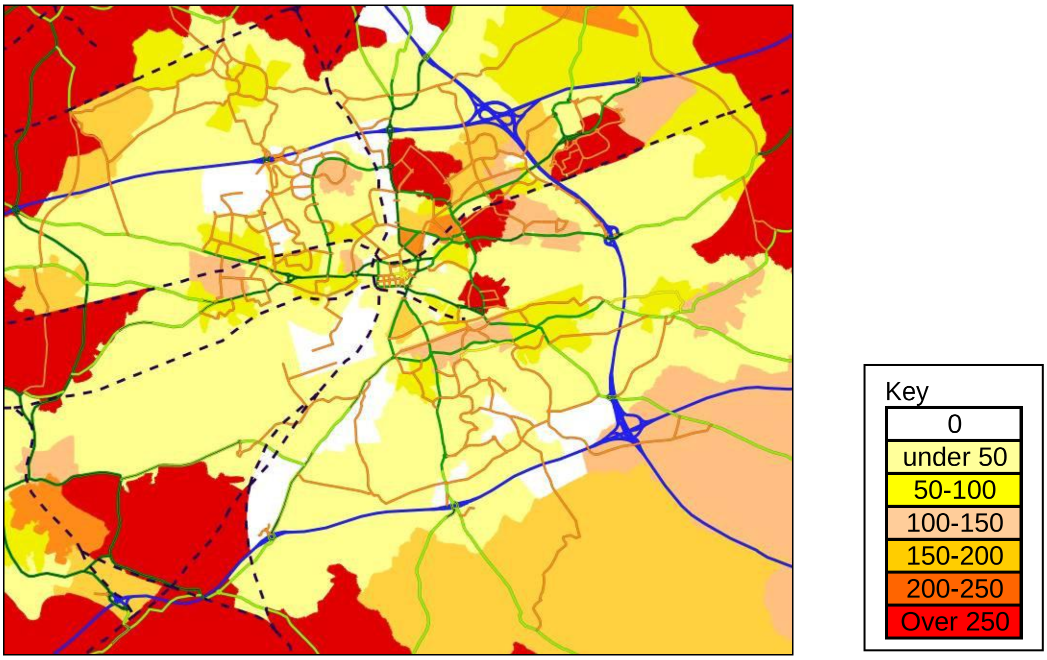
Figure 8.11 – TTW and HBW PT Productions Warrington Area



8.3.19 The figures show that at a zonal level in Warrington the demand model productions compare well to the travel to work census data providing confidence in the mode choice exercise.

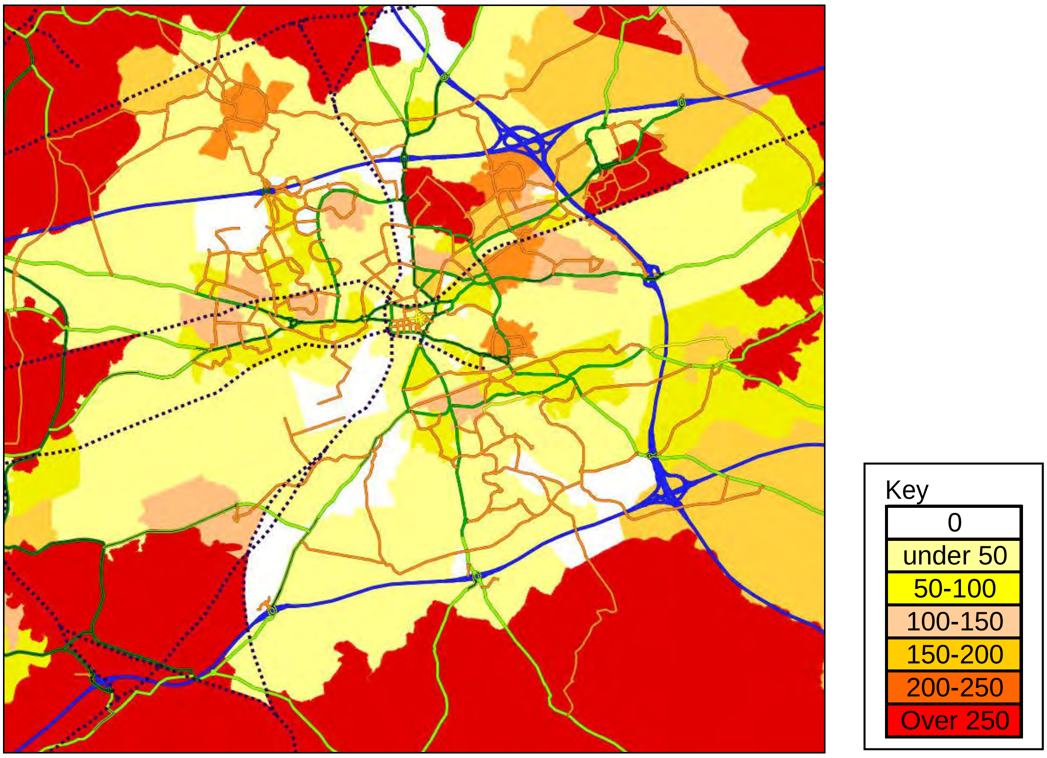
8.3.20 Figure 8.12 shows the travel to work census slow mode person trip productions at a zonal level in Warrington.

Figure 8.12 – Adjusted TTW 24 Hour Slow Mode Person Trip Productions



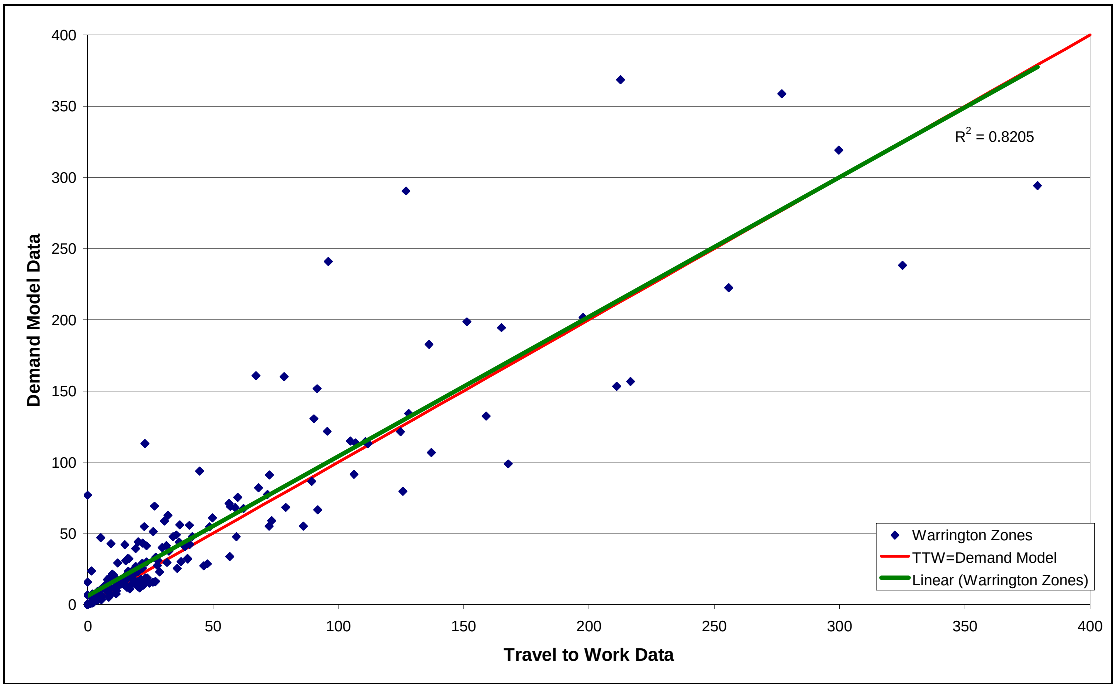
8.3.21 Figure 8.13 shows the slow mode person trip production for the demand models, it shows that all the productions are very similar to the travel to work census data.

Figure 8.13 – Demand Model HBW 24 Hour Slow Mode Person Trip Productions



8.3.22 Figure 8.14 shows a scatter graph of the TTW and demand model Slow mode trip productions.

Figure 8.14 – TTW and HBW Slow Productions Warrington Area



8.3.23 Of the three modes presented this shows the lowest R^2 comparison however this is affected by a small number of zones where the TTW zone totals are above 200 person trips. Collectively the correct number of slow mode trips is produced across Warrington and it is worth noting that these productions are over a 24 hour period, so once peak hour factors are considered the differences will be small.

SUMMARY

8.3.24 Overall this section of the report has compared the TTW census data by mode with the HBW demand model data at a sector level and a zonal level within Warrington. This has illustrated that at a 24 hour level, the mode choice stage of the demand model compares well against to the TTW data. This provides confidence that at the mode choice stage the HBW demand model data is validated.

OTHER TRIP PURPOSES

8.3.25 National Travel Survey (NTS) data is available that provides a breakdown of mode split for the whole country for each trip purpose. It is necessary to use these figures with caution as there are discrepancies between Warrington mode choice patterns and the rest of the country.

8.3.26 The NTS data for Home-Based education, Home-Based shopping and Home-Based other has been aggregated into one trip purpose (Home Based other). This is because the modelling process for mode choice for these purposes is identical and therefore they are aggregated in the model at this stage.

8.3.27 As the travel to work census data for the Warrington area was different to the UK wide data, the Home-Based employer business (HBEB) NTS data has been adjusted in line with this change. Warrington travel to work data showed that the proportion of car trips was 10% higher than country wide and the proportion of public transport trips was 10% lower than countrywide. Table 8.6 contains the adjusted NTS mode proportions.

Table 8.6 – NTS Home-Based Employers Business, Adjusted Warrington Proportions by Mode

	HBEB		
	CAR	PUT	SLOW
Observed Data NTS %	**71.2%**	**15.0%**	**13.8%**
Adjusted NTS %	**81.2%**	**5.0%**	**13.8%**

8.3.28 Table 8.7 shows the NTS mode split proportions and compares them with the mode split in the demand model. Note, this data is at 24 hour level and the NTS proportions have been altered for HBEB as described above.

Table 8.7 – NTS Mode Split by Trip Purpose for the UK

	HBEB			HBO		
	CAR	PUT	SLOW	CAR	PUT	SLOW
Observed Data NTS %	**81.2%**	**5.0%**	**13.8%**	**65.2%**	**8.4%**	**26.4%**
Modelled Data	81.3%	8.5%	10.2%	68.2%	10.5%	21.3%
Difference %	0.1%	3.5%	-3.6%	3.0%	2.1%	-5.1%

8.3.29 The table above shows that the mode choice proportions for HBEB and HBO compares accurately against NTS data (within 5.1%).

SUMMARY

8.3.30 Overall this section of the report has demonstrated that the mode choice for HBO and HBEB trips is accurate when compared to NTS data. This provides confidence that the mode choice in the demand model for these purposes validates well.

8.4 TRIP DISTRIBUTION

8.4.1 Using VISUM it is possible to illustrate where trips are being distributed to within the demand model for different trip purposes. This can be compared to expected distributions based upon knowledge of retail, commercial and industrial zones along with school locations within the town. This has been undertaken for the demand model to ensure that it is producing correct distributions.

8.4.2 Home-Based Work trip distribution patterns are validated against census TTW as well as against known Warrington employment areas. Figure 8.15 shows the TTW car person trip destinations over a 24 hour period, a similar map for the demand model follows on.

Figure 8.15 – TTW Car Person Trip Destinations, 24 hour

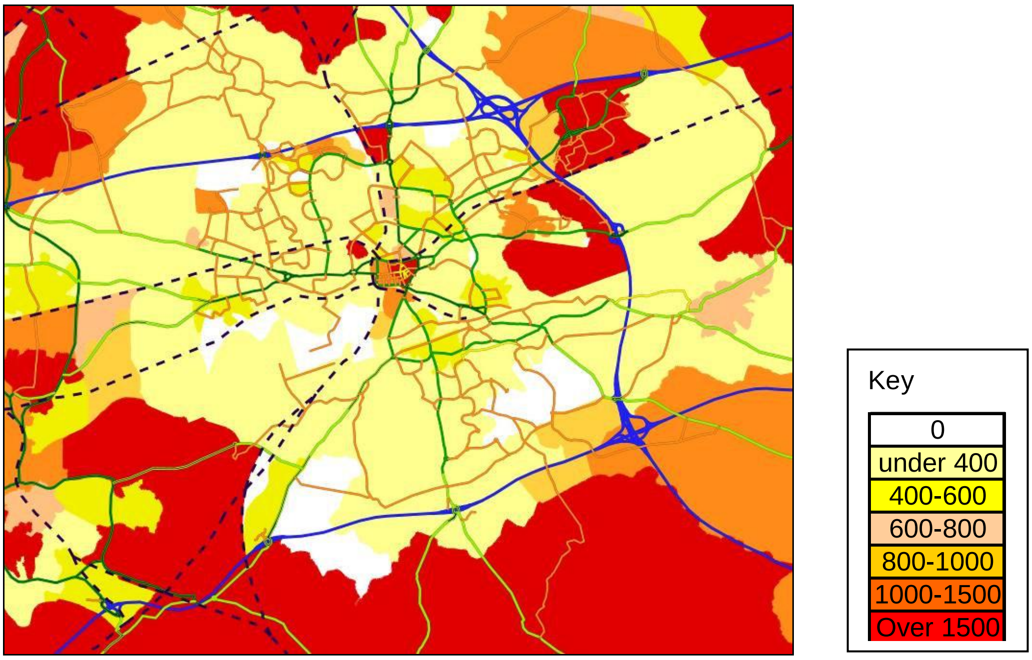
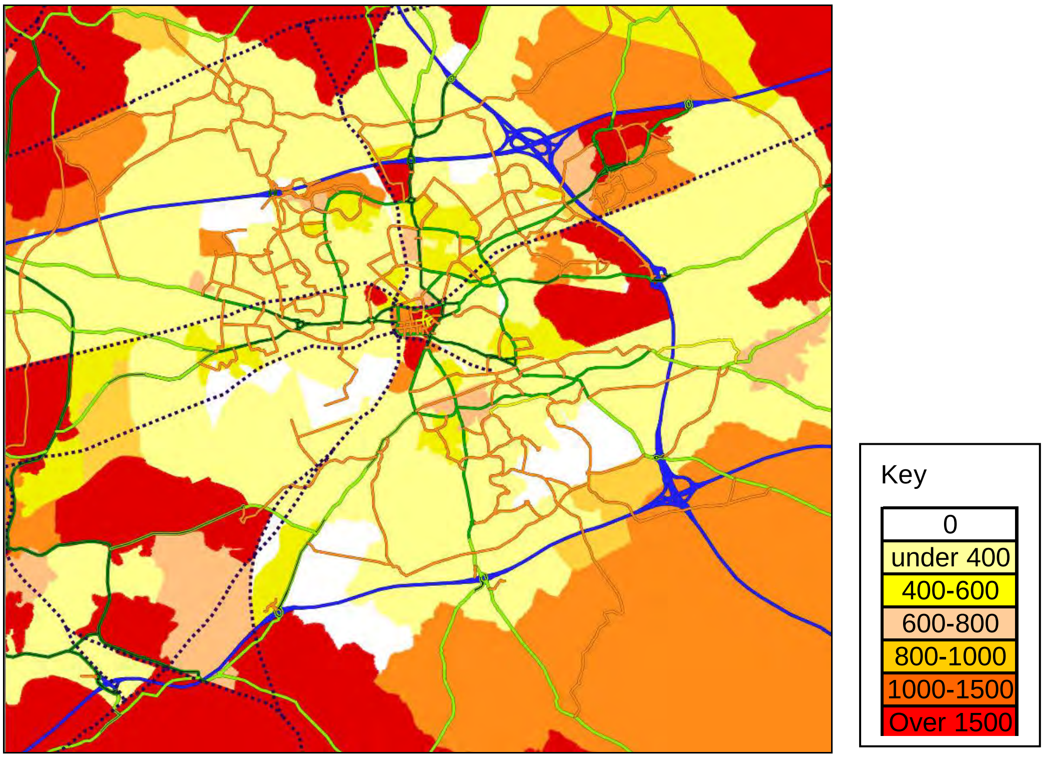


Figure 8.16 – Demand Model HBW Car Person Trip Destinations, 24 hour



8.4.3 From Figure 8.15 to Figure 8.16, it is clear that the HBW trips are travelling to known employment areas; the town centre, Woolston Grange Industrial Park, Centre Parks, Birchwood, Warrington hospital and Gemini Retail Park. This provides confidence in the HBW trip distribution patterns.

8.4.4 Figure 8.17 and Figure 8.18 show scatter graphs of the car destinations at a zonal level for Warrington and the main study area respectively. The figures illustrate a good correlation between TTW and HBW destinations at a zonal level.

Figure 8.17 – TTW and HBW Car Destinations Warrington

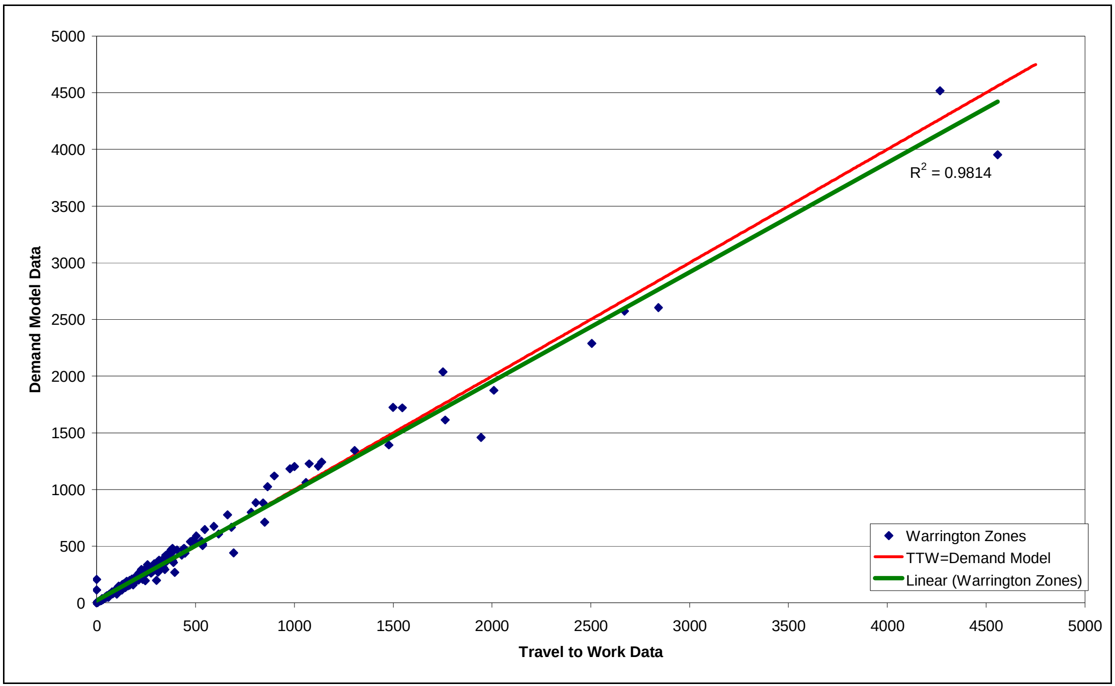
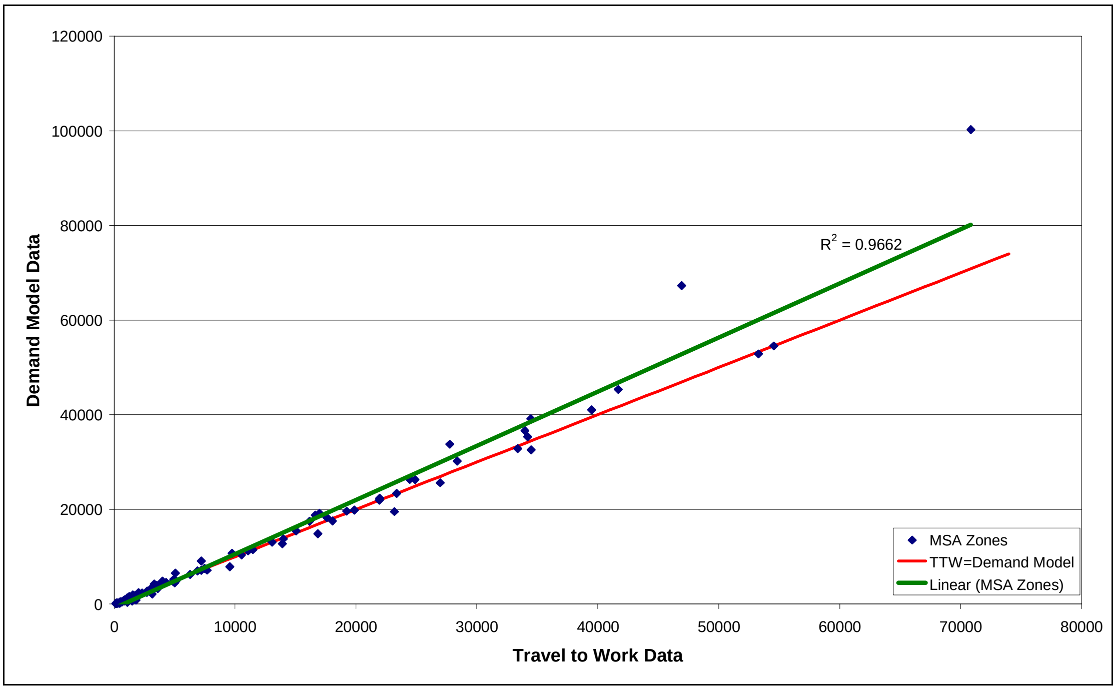
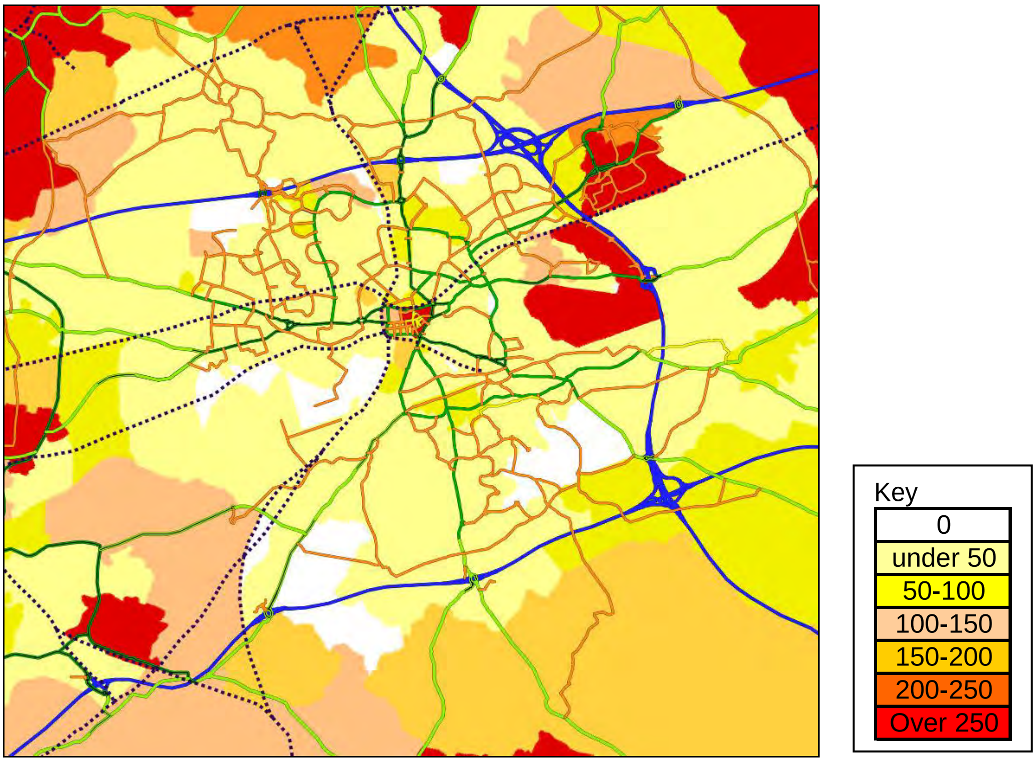


Figure 8.18 – TTW and HBW Car Destinations Main Study Area



8.4.5 Figure 8.19 illustrate the HBEB car person trip destinations for the demand models.

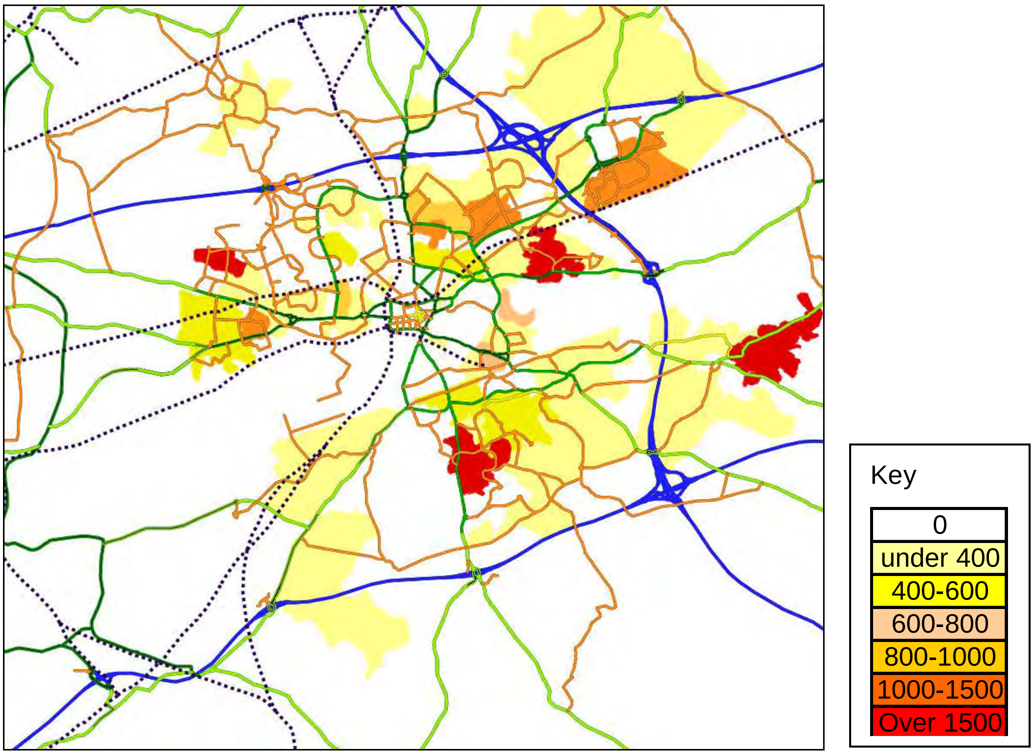
Figure 8.19 – Demand Model HBEB Car Person Trip Destinations 24 hour



8.4.6 As expected the figure illustrates that HBEB trip destinations patterns are very similar to HBW. Areas that have high number of HBEB trips going to them are Birchwood, Woolston Grange Industrial park, Town Centre and Gemini Retail Park.

8.4.7 Figure 8.20 illustrate the HBED car person trip destinations in the demand model.

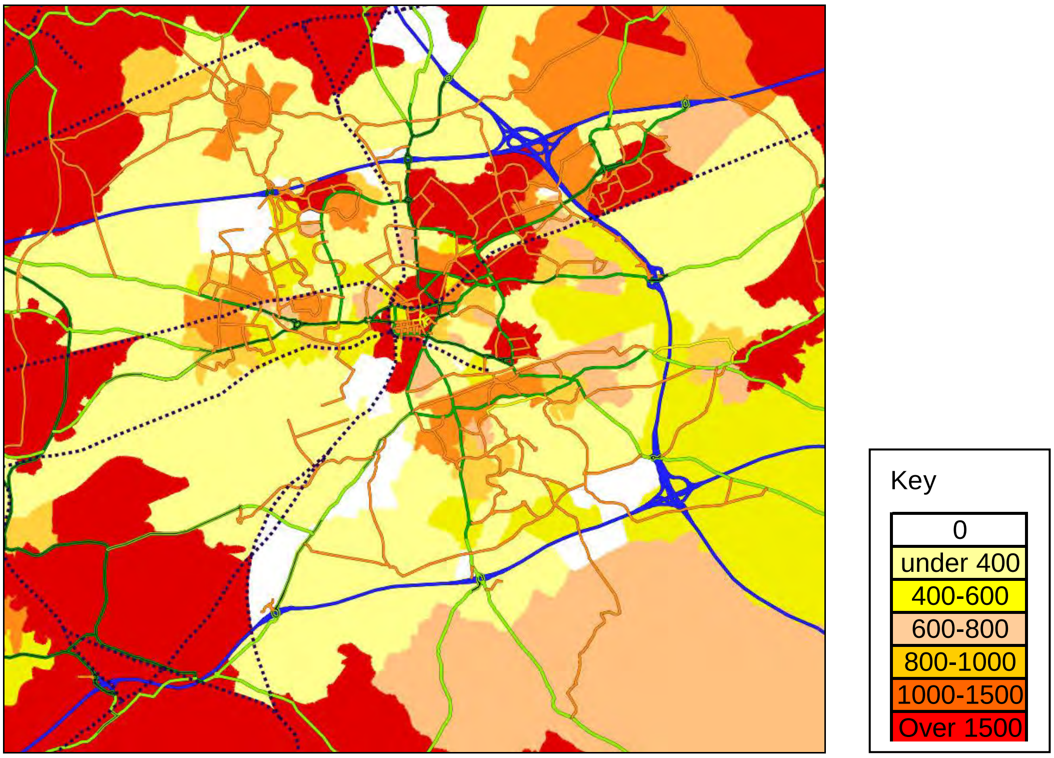
Figure 8.20 – Demand Model HBEd Car Person Trip Destinations 24 hour



8.4.8 The figure above shows that HBEd person trips are distributed into the zones where there are schools and colleges matching up with the school and college locations within Warrington.

8.4.9 Figure 8.21 illustrates the HBO car person trip destinations in the demand model.

Figure 8.21 – Demand Model HBO Car Person Trip Destinations 24 hour



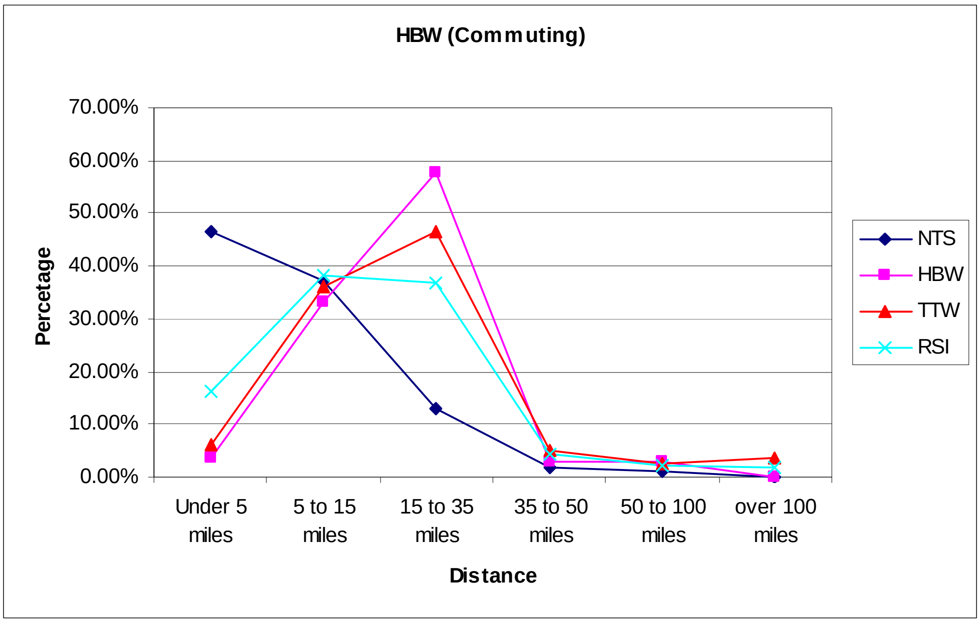
8.4.10 HBO trips are predominantly made up of trips to retail and residential areas. Therefore, as the figure above shows, HBO trips are typically distributed to retail zones such as the town centre, Gemini Retail Park and Birchwood shopping centre as well as residential zones such as Fearnhead, Padgate and Great Sankey.

CAR TRIP LENGTHS

8.4.11 Car trip lengths between the demand model, National Travel Survey data, TTW (HBW only) and the observed RSIs are compared at trip purpose level. This provides confidence that the trip distribution is accurate and ensures that the balance between the attractiveness of the zones and the travel distance to the zone reflects reality. The comparison is made between trips travelling to and from Warrington.

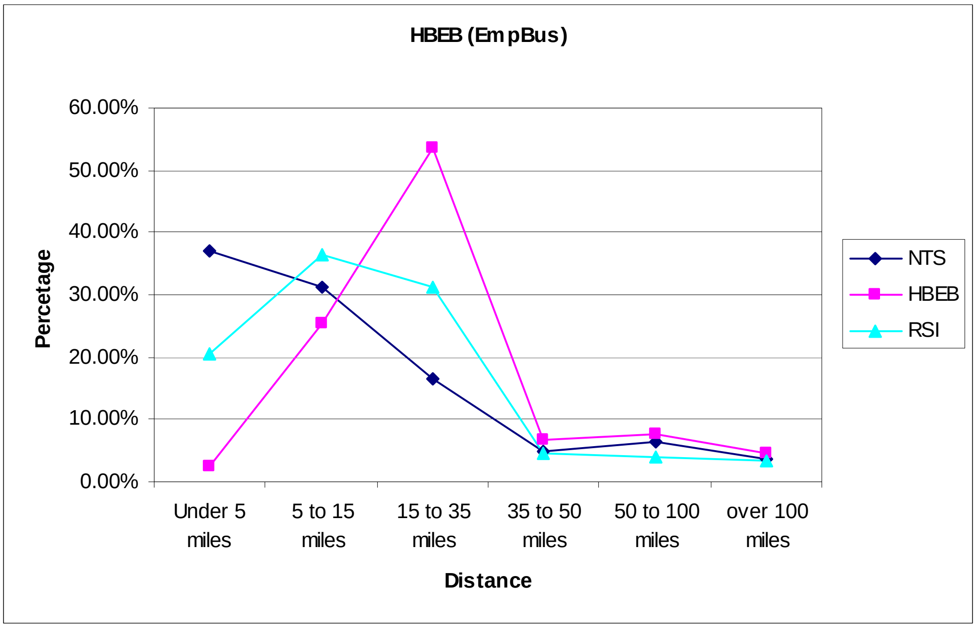
8.4.12 Figure 8.22 shows the trip length distribution of HBW trips the graphs show that the trips lengths produced by the demand model are in line with the TTW and RSI data which is Warrington specific.

Figure 8.22 – Demand Model Trip Lengths HBW 24 hour



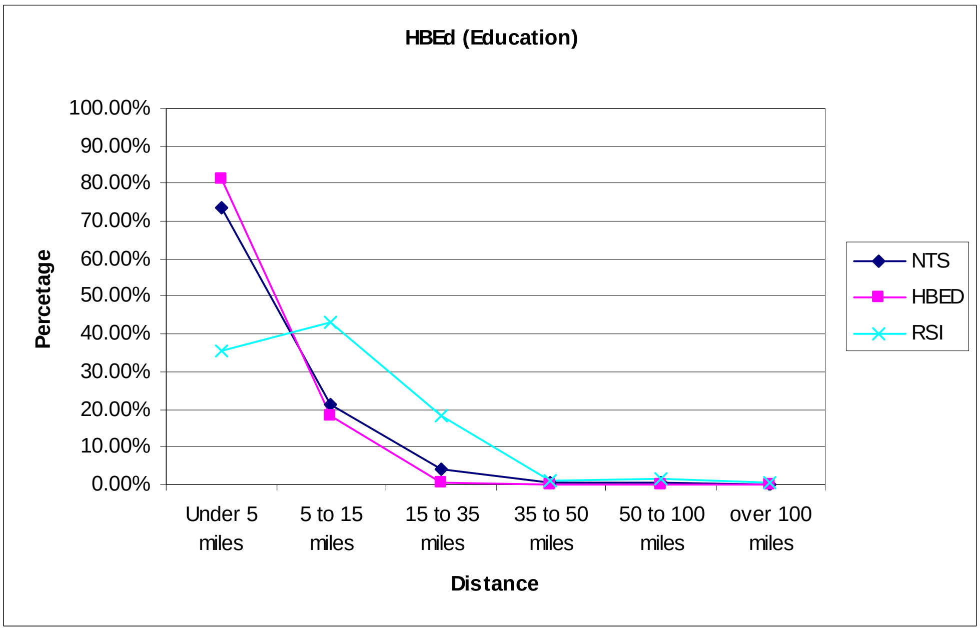
8.4.13 Figure 8.23 shows that the HBEB trip lengths have slightly too few short trips under 5 miles and slightly too many trips between 15 and 35 miles. However, the profile of the graph is similar to the RSI data which is Warrington specific.

Figure 8.23 – Demand Model Trip Lengths HBEB 24 hour



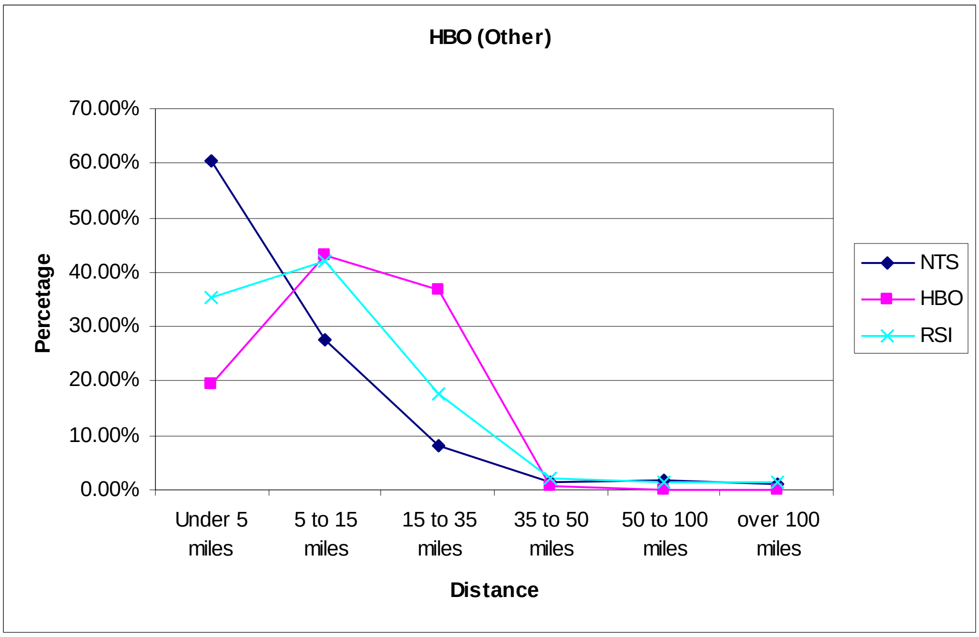
8.4.14 Figure 8.24 shows that the HBEd trip length distribution is in line with the NTS observed proportions. A proportion of Warrington HBEd trips will not have been captured at the RSI sites due to their positioning which explains the low proportion of RSI HBEd trips travelling under 5 miles. This analysis provides confidence in the HBEd trip distribution.

Figure 8.24 – Demand Model Trip Length HBEd 24 hour



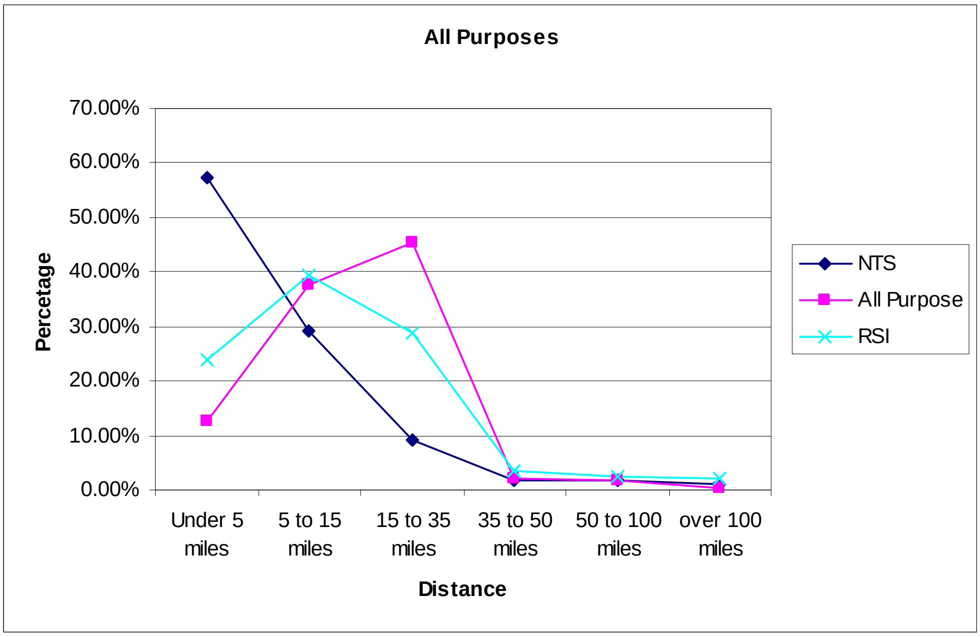
8.4.15 Figure 8.25 compares the HBO trip length distribution against NTS and RSI data. It shows that the trip length distribution within the demand model is accurate compared to RSI data which is Warrington specific.

Figure 8.25 – Demand Model Trip Length HBO 24 hour



8.4.16 Figure 8.26 compares all the purposes trip length distribution against NTS data, and as shown with some of the other trip purposes there is some difference between the two. However, compared to the RSI data which is observed data accurate to Warrington, the trip lengths within the demand model are accurate.

Figure 8.26 – Demand Model Trip Length All Purposes 24 hour



8.4.17 The figure above shows that trip length distribution is not very accurate when comparing it to NTS data trip length distribution data. However, when compared to specific Warrington data in the form of RSI data the results are accurate.

CAR SECTOR TO SECTOR MOVEMENTS

8.4.18 Car trip movements between the main zones, known as sector to sector matrices, are created from the distributed trips for each trip purpose. These represent 24 hour trip totals.

8.4.19 HBW trips are compared at a sector to sector level against the TTW census data matrix.

8.4.20 Table 8.8 shows the adjusted sector to sector movements for the TTW data.

HBW SECTOR – SECTOR MOVEMENTS

Table 8.8 – TTW Sector to Sector Movements 24 hour

13452623	1	2	3	4	5	6	7	8	9	10	11	12
1	8679535	6054	44515	11347	5815	2340	955	1792	26	8	278	306
2	16503	1236675	77326	594	19353	13191	655	1173	109	12	375	741
3	66274	46099	1639720	16991	41148	2323	867	13889	81	20	344	405
4	14698	721	13106	214917	3012	2389	15021	8528	80	17	328	431
5	6615	12243	16065	1355	459476	20438	2622	21348	616	93	3070	3711
6	4794	17886	1963	1738	29578	286488	11102	2862	617	110	3410	7121
7	2468	692	767	13637	4736	20145	106553	3769	341	130	1034	1953
8	2471	684	9703	6673	27670	2589	4178	55297	393	85	860	1272
9	201	117	119	116	1799	850	682	819	1112	181	1000	1484
10	46	26	31	38	415	272	295	180	198	57	197	313
11	259	210	142	138	4030	1635	951	835	676	114	5258	4996
12	303	167	155	154	3039	3630	1242	677	423	80	2176	6279

8.4.21 Table 8.9, shows the demand sector to sector movements.

Table 8.9 – HBW Sector to Sector Movements 24 hour

13452623	1	2	3	4	5	6	7	8	9	10	11	12
1	8829934	17	174510	62088	1490	455	1292	2796	94	13	193	102
2	52056	1071538	164666	1104	32871	13256	4968	1568	209	25	151	130
3	113075	33377	1378398	26367	52056	6265	1160	8098	87	11	249	165
4	20366	68	22363	169306	3536	1888	15342	6714	459	46	380	302
5	5451	5000	5600	4890	451602	35427	4791	20714	286	12	3286	5477
6	925	2534	514	1325	35320	284974	11547	2290	303	44	3932	9564
7	3411	177	429	6485	4389	27090	90867	1137	917	165	1177	3920
8	4113	62	6418	3325	13117	2619	2732	59560	683	275	952	890
9	123	5	15	305	2233	529	1615	261	846	149	1194	1016
10	27	1	7	20	413	125	817	34	112	39	171	222
11	263	19	103	1084	3267	1175	2357	855	532	105	4622	3347
12	415	18	16	91	4222	2851	2449	244	271	80	1779	5861

8.4.22 Table 8.10 shows the GEH value between the HBW and adjusted TTW sector to sector movements. Generally, movements within, to or from Warrington show a good match and only a few external to external sectors do not match. However, these do not have any impact on the Warrington area and can therefore be discounted. It is fair to say that trips within the model that will impact on the Warrington area are validated against TTW data.

Table 8.10 - HBW GEH Compared to TTW

	1	2	3	4	5	6	7	8	9	10	11	12
1									4	1	3	7
2									4	1	7	15
3									0	1	3	7
4									12	3	1	3
5						45	18	2	8	6	2	13
6					16		2	6	7	4	4	13
7					3	23		27	12	1	2	18
8					51	0	12		6	7	2	6
9	3	7	6	6	5	6	14	12	4	1	3	7
10	2	4	3	2	0	5	11	7	3	1	1	3
11	0	9	2	19	6	6	17	0	3	0	5	13
12	3	8	8	3	10	7	14	10	4	0	4	3

8.4.23 TTW census data is approximately 12% higher than HBW trip productions. For ease of comparison with the demand model the census data in the Warrington zones has been adjusted accordingly. Table 8.11 shows the proportions comparisons.

Table 8.11 – Proportions of trips travelling within the study area 24 hour

	TTW Proportions	DM Proportions
Warrington - Warrington	32%	25%
Warrington - External	31%	32%
External - Warrington	37%	43%

HBEB SECTOR – SECTOR MOVEMENTS

8.4.24 Table 8.12 shows the demand model sector to sector movements for HBEB trip purpose.

Table 8.12 –HBEB Sector to Sector Movements 24 hour

1598333	1	2	3	4	5	6	7	8	9	10	11	12
1	1060372	1704	22892	1589	8994	1498	394	1145	32	5	103	129
2	4064	103917	37423	887	2001	1384	906	1721	49	7	241	379
3	13498	4064	173961	217	953	190	148	563	6	1	23	28
4	3193	1000	1610	16650	1865	752	1651	1599	35	6	93	115
5	210	2628	1075	222	48521	1431	861	738	25	3	134	160
6	620	301	733	690	6078	24390	198	1192	58	11	330	807
7	464	166	561	919	1562	4046	7408	863	56	16	122	282
8	147	216	689	921	4346	670	1148	3121	76	11	164	189
9	35	12	14	18	229	122	92	72	50	9	98	136
10	8	2	3	4	41	33	39	14	10	3	21	40
11	44	18	42	118	378	215	318	205	22	4	184	210
12	31	25	19	12	315	580	205	70	18	5	118	444

HBED SECTOR – SECTOR MOVEMENTS

8.4.25 Table 8.13 shows the demand model sector to sector movements for HBEd trip purpose.

Table 8.13 –HBEd Sector to Sector Movements 24 hour

27360	1	2	3	4	5	6	7	8	9	10	11	12
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	1915	31	0	371	75	5	392	148
6	0	0	0	0	64	217	0	178	49	6	291	540
7	0	0	0	0	6	2	0	125	91	23	72	62
8	0	0	0	0	1	0	0	631	778	0	8	3
9	0	0	0	0	28	6	0	584	2668	19	262	132
10	0	0	0	0	14	4	0	221	207	189	146	110
11	0	0	0	0	156	40	0	533	227	17	7290	382
12	0	0	0	0	51	33	0	217	149	14	407	7169

HBO SECTOR – SECTOR MOVEMENTS

8.4.26 Table 8.14 shows the demand model sector to sector movements for HBO trip purpose.

Table 8.14 –HBO Sector to Sector Movements 24 hour

2805230	1	2	3	4	5	6	7	8	9	10	11	12
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	1214804	35491	1436	19314	352	45	5727	4777
6	0	0	0	0	69824	768079	23140	2084	319	77	3445	10787
7	0	0	0	0	3498	128751	232088	4741	728	301	823	2664
8	0	0	0	0	85914	8645	9295	70573	1627	204	2616	3524
9	0	0	0	0	595	261	502	973	4337	716	3137	5379
10	0	0	0	0	117	121	383	135	597	211	453	1679
11	0	0	0	0	2430	1050	208	239	988	165	16812	15020
12	0	0	0	0	709	3977	431	67	356	100	3496	23895

8.4.27 Sector to sector movements for other journey purposes do not have a data set that they can be easily compared to such as TTW census data. However, they have been sanity checked for unusual movements and are presented for information.

8.5 MOTORWAY TURNING MOVEMENTS

8.5.1 As well as ensuring the demand model is producing the correct trip volumes between sectors of the model comparisons can be drawn between the motorway trip movements against the ANPR Surveys. This ensures that along the motorway network that may have a direct impact on traffic flows within Warrington the model reflects the correct traffic patterns.

8.5.2 Figure 8.27 to Figure 8.29 compare the turning proportions produced within the demand model for the peak hours against the ANPR surveyed turning proportions. These are shown for the two motorway crossroads in the study area between the M6 and the M62 and between the M6 and the M56.

Figure 8.27 – AM Peak ANPR and Demand Model Motorway Trips

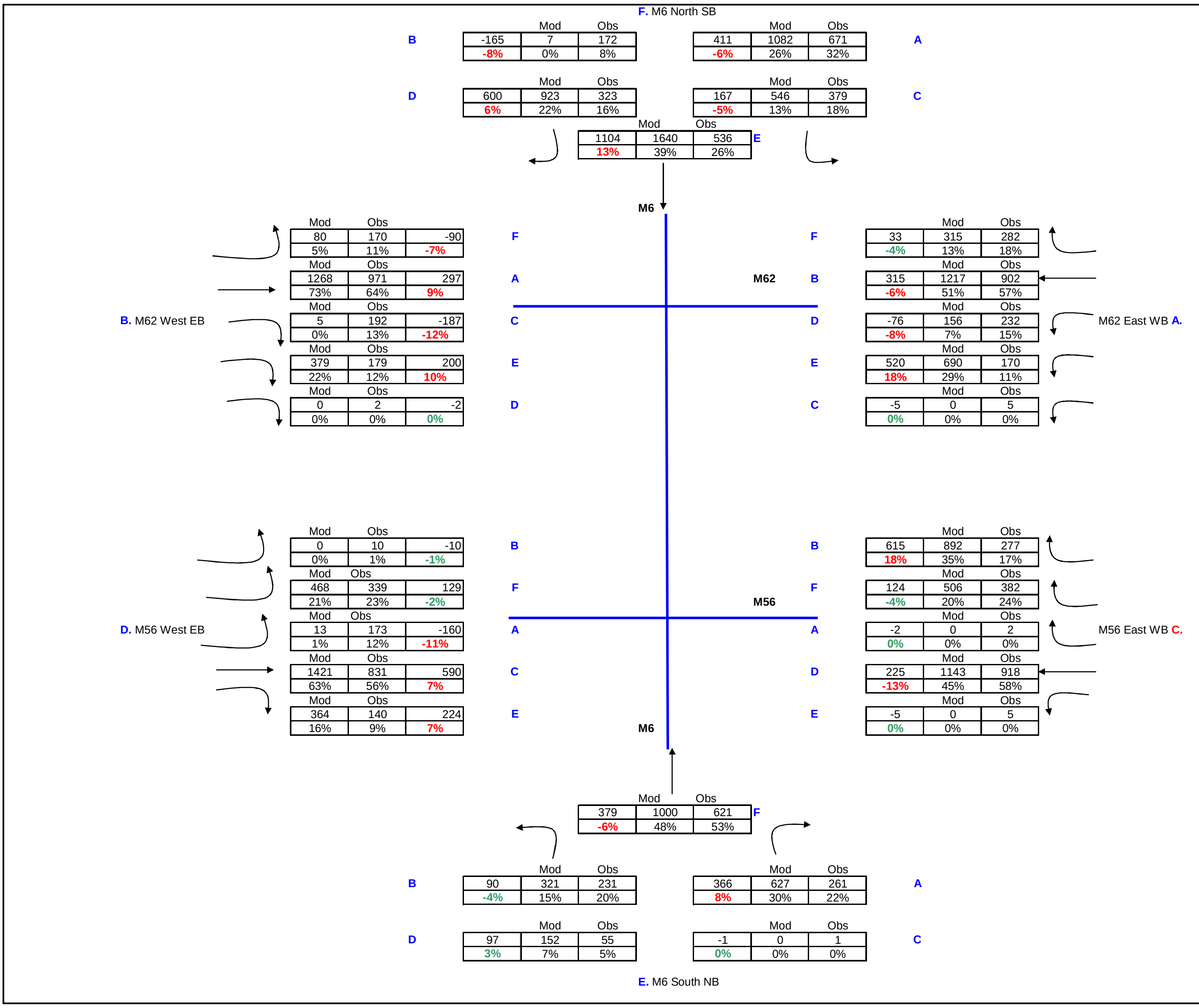


Figure 8.28 – IP ANPR and Demand Model Motorway Trips

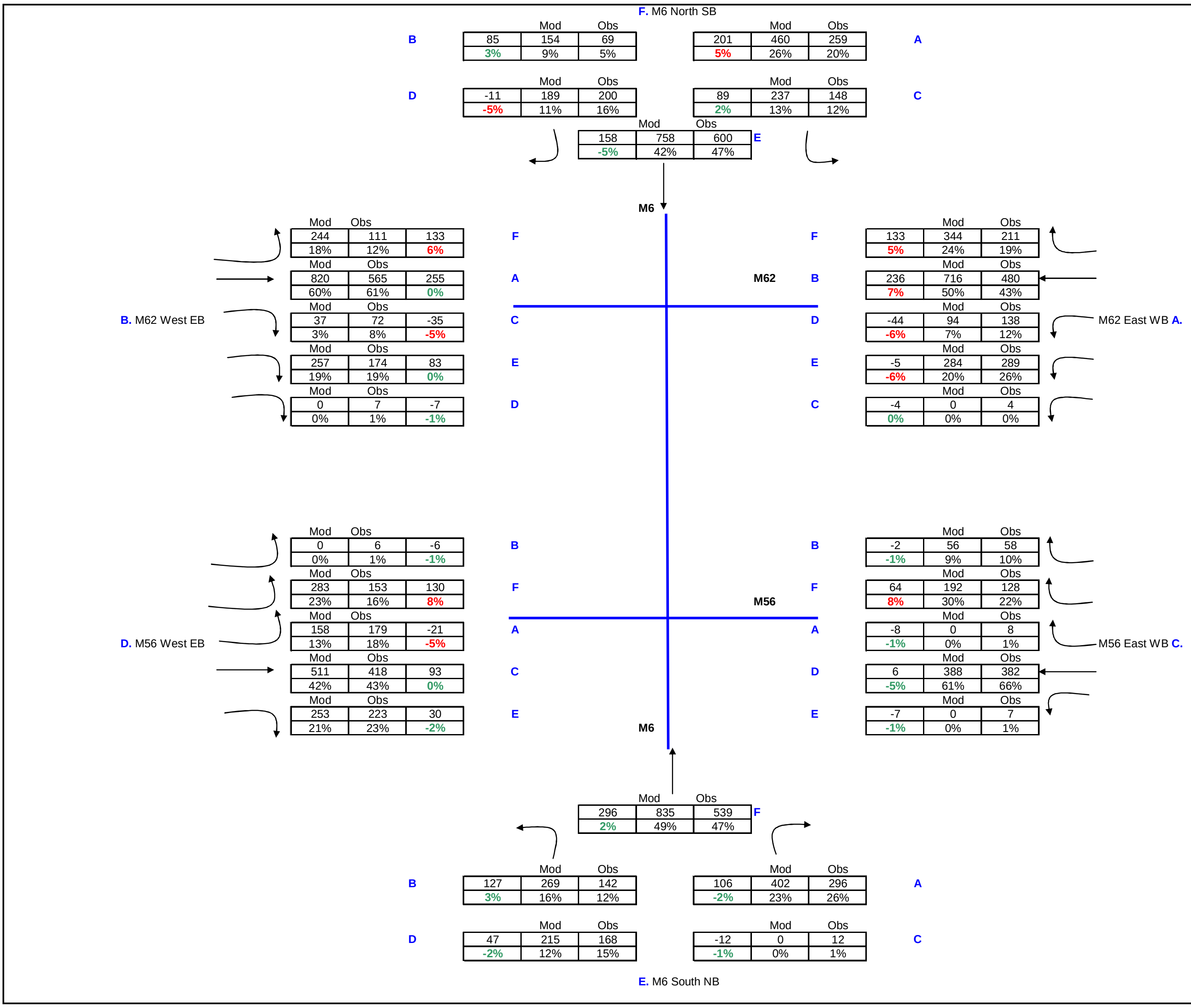
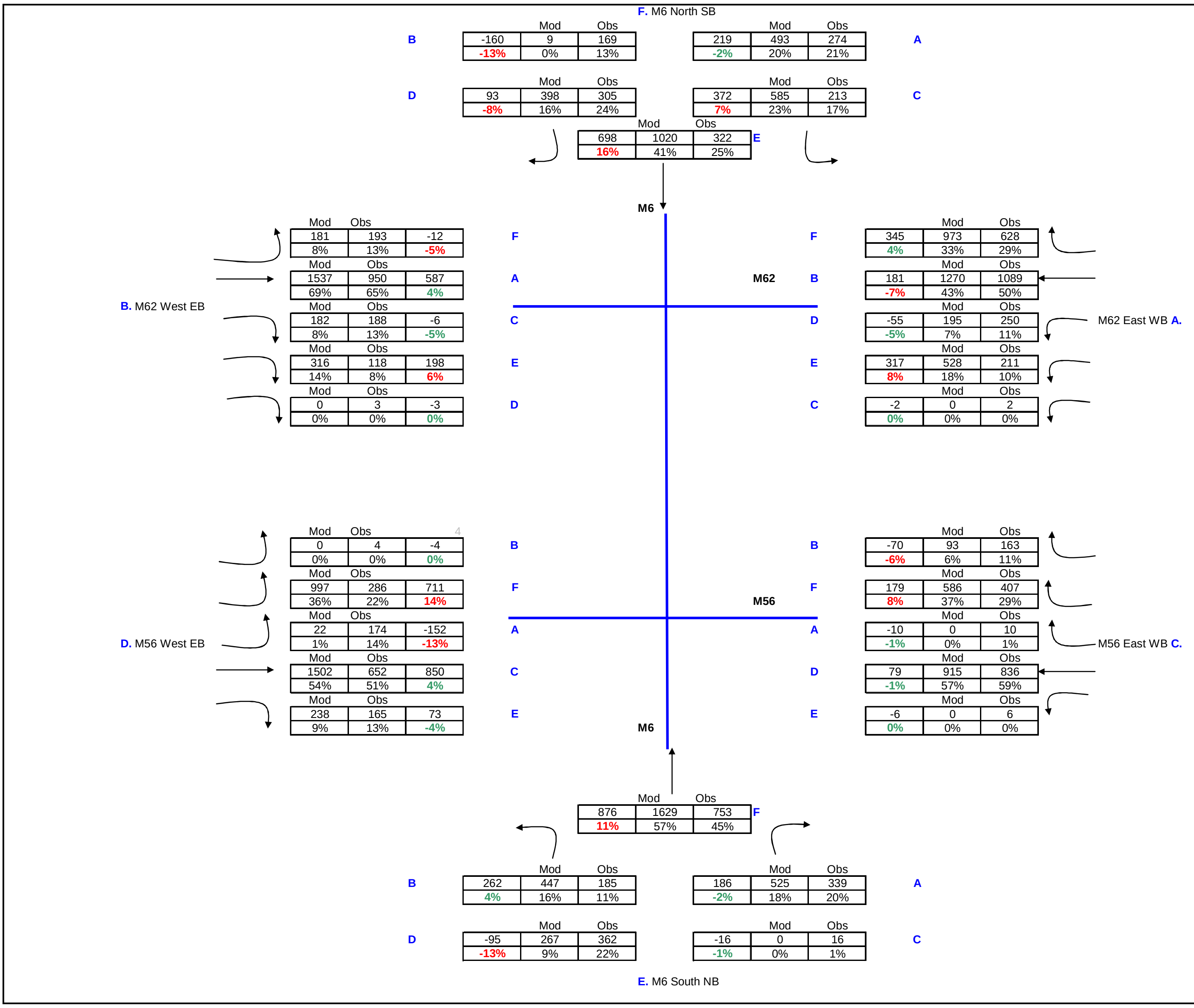


Figure 8.29 - PM ANPR and Demand Model Motorway Trips



8.5.3 The majority of the demand model motorway trips are within 5% of the ANPR proportions and no through routes show a difference greater than 18%. There is confidence that the demand model is producing the correct proportions of long distance trips in the demand model.

8.6 VEHICLE OCCUPANCIES

8.6.1 Following the validation of mode choice and trip distribution at the 24 hour level the demand matrices have to be converted from production and attractions (persons), to origins and destinations (vehicles).

8.6.2 The trip generation, mode choice and trip distribution stages of the model are calculated as person trips. At assignment stage the person trips are converted into vehicle trips by applying vehicle occupancy factors by trip purpose.

8.6.3 The WMMTM vehicle occupancy rates were derived from the RSI surveys and are summarised in Table 8.15. Generally the occupancy levels as observed at the RSI sites are lower than NTS values shown in Table 8.16.

Table 8.15 – Car Occupancy

		Int Direction				
	AM	HBW	HBEB	HBED	HBO	NHB
Car Occupancy	AM 8-9	1599.00	349.00	254.00	282.00	91.00
	Int No.	1445.00	300.00	188.00	219.00	83.00
	Factor	**1.11**	**1.16**	**1.35**	**1.29**	**1.10**
		0.9037	0.8596	0.7402	0.7766	0.9121
		Int Direction				
	IP	HBW	HBEB	HBED	HBO	NHB
Car Occupancy	IP 11-2	1151.00	1530.00	157.00	2325.00	510.00
	Int No.	996.00	1220.00	121.00	1696.00	430.50
	Factor	**1.16**	**1.25**	**1.30**	**1.37**	**1.18**
		0.8653	0.7974	0.7707	0.7295	0.8441
		Int Direction				
	PM	HBW	HBEB	HBED	HBO	NHB
Car Occupancy	PM 5-6	1200.00	312.00	101.00	651.00	125.00
	Int No.	1072.00	259.00	71.00	434.00	94.00
	Factor	**1.12**	**1.20**	**1.42**	**1.50**	**1.33**
		0.8933	0.8301	0.7030	0.6667	0.7520

Table 8.16 – 2008 National Travel Survey Car Occupancies

Journey Purpose	Car Occupancy
Commuting	1.2
Business	1.2
Education	2
Shopping	1.7
Personal Business	1.5
Leisure	1.8
Holiday/ day trip	2
Other	2
Total	1.6

8.7 TIME SLICE

8.7.1 Trips produced by the demand model are 24 hours totals and prior to an assignment need to be converted to an AM, IP or PM peak hour via the application of scaling factors. These are derived from NTS data (for 24 hour to 3 hour conversion) and RSI survey data (for 3 hour to 1 hour peak conversion). The combined 24 hour to 1 hour time slice factors are summarised in Table 8.17.

Table 8.17 – AM, IP and PM Time Scaling Factors

Trip Purpose	Direction	AM	IP	PM
HBW	From Home	0.267	0.020	0.027
	To home	0.020	0.028	0.238
HBEB	From Home	0.173	0.052	0.035
	To home	0.015	0.046	0.163
HBEd	From Home	0.366	0.029	0.007
	To home	0.051	0.078	0.103
HBO	From Home	0.031	0.068	0.055
	To home	0.014	0.057	0.055
NHBEB	NHB	0.052	0.096	0.043
NHBO	NHB	0.034	0.096	0.056

8.8 ASSIGNMENT

8.8.1 The Tier 1 trip generation, mode choice and trip distribution stages produce synthetic production and attraction demand matrices representing all person trips by journey purpose undertaken by car during a single weekday 24 hour period. Car occupancy factors (by purpose) and time slice factors are used to convert the 24 hour production/ attraction matrices into origin/ destination matrices ready for assignment. At this stage the journey purpose matrices are aggregated into a single car matrix per peak hour.

8.8.2 Although the demand matrix is assigned to demonstrate the motorway distribution patterns and other routing sanity checks, the demand matrix is never assigned for DMRB validation / calibration purposes. Elements of the demand matrix are extracted and fed into the Prior matrix. These include trips not captured in the RSI surveys which are typically the strategic motorway through trips and trips internal to Warrington. These elements are referred to as the demand infill.

8.8.3 The RSI matrix with the demand infill, the Prior matrix, when assigned generates the time and distance costs that feed back into mode choice and trip distribution stages. This process is repeated thus refining the quality and synergy of the two models until the synthetic model satisfies demand / supply convergence criteria. This process is illustrated in Figure 4.2. At this point the generalised costs of travel for all modes are consistent between the demand and observed models.

8.9 DEMAND / SUPPLY CONVERGENCE

WEBTAG COMPLIANCE

8.9.1 WebTAG Unit 3.10.4 Draft for Consultation (issued September 2009) states that "convergence is a key to achieving good modelling practice. High levels of convergence should be achieved in any assignment modelling."

8.9.2 The recommended criterion for measuring convergence between demand and supply models is the demand/ supply gap defined by:

$$\frac{\sum_{ijctm} C(X_{ijctm})\left|D(C(X_{ijctm})) - X_{ijctm}\right|}{\sum_{ijctm} C(X_{ijctm})X_{ijctm}} * 100$$

Where:

X_{ijctm} is the current flow vector or matrix from the model

$C(X_{ijctm})$ is the generalised cost vector or matrix obtained by assigning that matrix

$D(C(X_{ijctm}))$ is the flow vector or matrix output by the demand model, using the costs $C(X_{ijctm})$ as input

$ijctm$ represents origin I, destination j, demand segment/ user class c, time period t and mode m

8.9.3 This is a measure of how far the current flow is from the equilibrium point and will be zero in a perfectly converged model. This statistic is chosen given that it is easily calculated and is not dependant on the precise form of demand-supply modelling undertaken. It is referred to as the % GAP, reflecting its relative nature.

8.9.4 WebTAG states that "tests indicate that gap values of less than 0.1% can be achieved in many cases, although in more problematic systems this may be nearer to 0.2%."

8.10 WARRINGTON MODEL DEMAND/ SUPPLY CONVERGENCE

8.10.1 Within the Warrington model the assignment used within the demand model is taken partially from the observed model instead of wholly from the last iteration of the demand model. This method was used to ensure that more accurate assignments were used to produce the next iteration of the demand model. Instead of using the demand model matrix to assign for the next iteration some ij pairs of the demand model were replaced by the RSI flows. However, this should not affect the GAP calculation significantly as the majority of the ij pairs are obtained from the demand model and the RSI flows will remain the same for each iteration.

8.10.2 The following tables show the levels of convergence achieved after 2 iterations of the demand model in the AM, Inter and PM peak hours.

Table 8.18 – Demand Model Convergence AM Peak Hour

	Generalised Cost*(Current Matrix-New Matrix)	Generalised Cost*Old Matrix	Final Convergence	
HBW	-203679	661814798	-0.0003	-0.0308%
HBEB	13	25920487	0.0000	0.00005%
HBEd	2	79206	0.0000	0.003%
HBO	28	2190977	0.0000	0.001%
All Purposes	-203634.3752	690005468.2	-0.0003	-0.030%
Non HBW	44	28190670	0.0000	0.000%

Table 8.19 – Demand Model Convergence Inter Peak Hour

	Generalised Cost*(Current Matrix-New Matrix)	Generalised Cost*Old Matrix	Final Convergence	
HBW	-32449	105590721	-0.0003	-0.0307%
HBEB	6	12417473	0.0000	0.00005%
HBEd	1	21302	0.0000	0.002%
HBO	75	5768290	0.0000	0.0013%
All Purposes	-32367	123797784.6	-0.0003	-0.03%
Non HBW	81	18207064	0.0000	0.00%

Table 8.20 – Demand Model Convergence PM Peak Hour

	Generalised Cost*(Current Matrix-New Matrix)	Generalised Cost*Old Matrix	Final Convergence	
HBW	-186063	605993055	-0.0003	-0.03070%
HBEB	13	26290963	0.0000	0.00005%
HBEd	0	19872	0.0000	0.002%
HBO	60	4626477	0.0000	0.0013%
All Purposes	-185989.8072	636930366.5	-0.0003	-0.03%
Non HBW	73	30937311	0.0000	0.00%

8.10.3 The tables above show that the demand model converges within the WebTAG guidelines following 2 iterations of the model.

8.11 SUMMARY

8.11.1 Overall in all peak time periods the model has converged to acceptable levels with regards WebTAG guidance. For this reason it is deemed that these models have reached a stable conclusion between iterations that can be confidently taken into the forecasting process.

9 Demand Model Validation Tier 2

9.1 INTRODUCTION

9.1.1 The development of Tier 1, as documented in Chapter 8, considers the mode choice between Car, PT and slow modes and the then follows on with the trip distribution for car only. Having derived the proportion of trips to be made by PT in Tier 1, Tier 2 considers the breakdown of these PT trips into Bus and Rail with the Rail trips broken down further into accessibility to rail stations by car and Bus/walk.

9.1.2 This section of the report sets out the validation completed for the Demand Model Tier 2. WebTAG does not provide a clear and concise method for demonstrating demand models are validated in the same manner DMRB does for observed models. Therefore, as for Tier 1, validation benchmarks have to be drawn from existing datasets to allow model versus observed validation comparisons to be made. By validating each of the four stages of the model against observed data, it is possible to ensure that the demand model produces intuitive results that can be trusted and relied upon.

9.1.3 Results from the following demand model validation procedures are shown within this chapter:

Trip Generation

- Comparison of the Home-Based Work (HBW) demand model trip productions against Travel To Work (TTW) census data

Mode Choice

- Comparison of the HBW demand model trip productions by mode against the TTW census data by mode
- Comparison of HBO and HBEB against NTS data

Trip Distribution

- Maps showing the distribution of trips within Warrington by each trip purpose
- Comparison of modelled trip lengths by trip purpose against NTS trip lengths countrywide
- Matrix sector comparison between demand model and TTW data

Assignment

- Comparison of observed and demand model demand

9.1.4 Mode choice in Tier 1 of the validation model separates the total trips produced into different modes of transport namely, private vehicle, public transport and slow modes. More than one public transport mode is available in the model and to further refine the mode choice into these types of public transport the number of public transport trips produced in Tier 1 Mode Choice stage is taken into the Tier 2 model.

9.1.5 The Tier 2 model runs through the same processes as Tier 1 by splitting the trips by mode choice (in this case Public transport options) and then distributing them, but has no need for the first stage of trip generation as these trips are taken from Tier 1.

9.2 TRIP GENERATION

9.2.1 As in Tier 1, Tier 2 also a demand models replicating the costs of travel for each of the 24 hour period. The public transport trip productions for Tier 2 are generated at the mode choice stage of Tier 1, however, in order to ensure the correct demand is being generated HBW trips can be compared directly with the TTW census data (2001). Table 9.1 below presents the demand model person public transport trip generations against the census outputs. The trip generations at this stage represent a weekday 24 hour period.

Table 9.1 –Home-Based Work Public Transport Trip Productions 24Hrs

Main Zone	Description	TTW Trip Production	DM HBW Trip Production	Difference	% Difference
1	South of England and Wales	1887800	1855673	-32128	-1.70%
2	Scotland and North of England	208819	270620	61801	29.60%
3	West Midlands	336993	206819	-130174	-38.63%
4	North Wales	19478	24828	5350	27.47%
5	Manchester and environs	118420	56471	-61949	-52.31%
6	Liverpool and environs	83422	35014	-48408	-58.03%
7	Chester and environs	25519	13966	-11553	-45.27%
8	Macclesfield and environs	7286	8458	1172	16.08%
9	South East Warrington	463	430	-33	-7.17%
10	South West Warrington	92	84	-8	-8.64%
11	North East Warrington	2340	2134	-206	-8.80%
12	North West Warrington	1802	1610	-192	-10.67%
TOTAL		2692435	2476107	-216328	-8.03%

9.2.2 The demand model PT trip production is slightly lower compared to the Travel to Work census. Within Warrington the census data is approximately 9% lower than the demand model.

9.2.3 This Trip Generation stage within the demand model represents a 24 hour period and at this level there is only one possible validation measurement and that is measuring the HBW generations against the 2001 TTW census data. Bearing this in mind the focus is on ensuring the right balance of PT trip generations between the Warrington sectors is achieved.

SUMMARY

9.2.4 This section demonstrates that the trip generation stage of the Tier 2 Warrington Demand Model compares well with the Travel to Work data giving confidence that the number of HBW trips being produced in the Tier 1 Demand Model is accurate. There is no benchmark for measuring the other purposes, but the process demonstrated for HBW gives confidence that the production of the HBW trips in the Tier 2 model reflects existing conditions and by association confidence can be drawn that the production of the other purposes in the Tier 2 model is correct.

9.3 MODE CHOICE

9.3.1 Mode choice, the splitting of person trips into the available modes (Bus, Rail_Car and Rail_Other) is also calculated at a 24 hour level - like the trip generation stage. See section 5.11 to 5.13 for details on the breakdown of rail trips.

HOME-BASED WORK

9.3.2 Travel to Work census data is also categorised by travel mode allowing a comparison of the modal breakdown of the HBW trips to be made. Table 9.2 shows the TTW PT mode split for each main zone within the model. The location of the main zones within the model is shown in Figure 8.3 and Figure 8.4. Note the four Warrington Main Zones are 9-12.

Table 9.2 – Census Travel to Work PT Mode Split by Main Zones

	Mode Split Proportions	
Main Zone	**Bus**	**Rail**
1	55%	45%
2	90%	10%
3	89%	11%
4	86%	14%
5	88%	12%
6	78%	22%
7	69%	31%
8	58%	42%
9	71%	29%
10	60%	40%
11	86%	14%
12	83%	17%
All Zones	64.73%	35.27%
Warrington	83.19%	16.81%

9.3.3 The census data above shows the wide variation in mode splits in the different Warrington sectors and hence the difficulty in validating mode choice to census data within the model as each sector has varying mode choice proportions.

9.3.4 The highway and public transport network are only included in detail within the Warrington area. For this reason the validation of the demand model at the mode choice stage focuses on the Warrington area to ensure that mode choice is accurate for the study area.

9.3.5 TTW trip production is approximately 16% higher in the Warrington area than an average day (and therefore TTW can be assumed to be approximately 16% higher than the demand model). For ease of comparison with the demand model the census data in the Warrington zones has been adjusted by -16% to bring it more into line with the demand model for comparison purposes.

Table 9.3 – 24 Hour Home-Based Work Bus Person Trip Productions

Main Zone	Description	Warrington TTW - 9%	DM HBW Trip Production	Difference	% Difference
9	South East Warrington	303	308	5	1.61%
10	South West Warrington	50	50	0	0.09%
11	North East Warrington	1847	1845	-2	-0.12%
12	North West Warrington	1373	1343	-31	-2.25%
TOTAL		3573	3545	-28	-0.79%

Table 9.4 – 24 Hour Home-Based Work Rail Person Trip Productions

Main Zone	Description	Warrington TTW - 9%	DM HBW Trip Production	Difference	% Difference
9	South East Warrington	121	122	2	1.26%
10	South West Warrington	34	34	0	-0.37%
11	North East Warrington	293	289	-4	-1.20%
12	North West Warrington	275	267	-7	-2.64%
TOTAL		722	713	-9	-1.30%

9.3.6 It is important to note that the total person trips in Warrington as taken from the census does not exactly match the total person trips as produced in the demand model. This will slightly skew the percentage differences especially when looking at Main Zone level and where the person trips are low in either the census or the demand model. With this in mind the focus has been on ensuring the proportions of person trips within each sector relative to each other are of the right order.

9.3.7 Overall the tables above show that the mode choice split in the AM demand model for the Warrington area is accurate with both demand model modes being within 2% of the census totals.

9.3.8 The demand model rail person trips at a Main Zone level compare very closely with the census data.

SUMMARY

9.3.9 Overall this section of the report has compared the TTW census mode share data by PT mode with the HBW demand model data at a sector level within Warrington. This has illustrated at a 24 hour level, the mode choice stage of the demand model compares well against the TTW data. This provides confidence that at the mode choice stage the HBW demand model data is validated.

OTHER TRIP PURPOSES

9.3.10 For the other trip purposes, HBO and HBEB, a combination of observed data from the public transport surveys and NTS data were used to validate mode splits between rail and bus.

9.3.11 Both the NTS and observed data for Home-Based education, Home-Based shopping and Home-Based other has been aggregated into one trip purpose. This is because the modelling process for mode choice for these purposes is identical and therefore they are aggregated in the model at this stage.

9.3.12 Table 9.5 shows the NTS mode split proportions and compares them with the mode split in the demand model. Note this data is at 24 hour level.

Table 9.5 – NTS Mode Split by Trip Purpose for the UK

	HBEB		HBO	
	Bus	Rail	Bus	Rail
Observed Data NTS %	**49.8%**	**50.2%**	**80.7%**	**19.3%**
Modelled Data	49.0%	51.0%	79.4%	20.6%
Difference %	-0.8%	0.8%	-1.3%	1.3%

9.3.13 The table above shows that the mode choice for HBEB and HBO is within 2% of the NTS data.

9.3.14 Table 9.6 shows how the mode split from the demand model compares to the observed split derived from the public transport surveys in Warrington. This comparison is also broken down into the three household types based upon car availability. On the whole the tables shows the three time period models reflect the Warrington mode split well between Bus, Rail Car and Rail Other.

Table 9.6 – Observed Mode Split by Trip Purpose for Warrington

		HBEB			HBO		
		Bus	Rail Car	Rail Other	Bus	Rail Car	Rail Other
Observed Data							
Observed %	Full Car	**17.2%**	**56.9%**	**25.9%**	**51.6%**	**26.4%**	**22.0%**
	Part Car	**42.6%**	**24.1%**	**33.3%**	**80.9%**	**4.8%**	**14.3%**
	No Car	**55.2%**	**19.2%**	**25.6%**	**76.6%**	**3.3%**	**20.0%**
Modelled Data							
	Full Car	17.5%	58.1%	24.3%	52.9%	24.8%	22.3%
	Part Car	43.0%	23.5%	33.5%	80.7%	5.4%	13.9%
	No Car	54.2%	19.5%	26.3%	76.6%	3.7%	19.8%
Difference %	Full Car	0.4%	1.2%	-1.6%	1.2%	-1.6%	0.3%
	Part Car	0.4%	-0.6%	0.2%	-0.2%	0.6%	-0.4%
	No Car	-1.0%	0.2%	0.7%	-0.1%	0.3%	-0.3%

SUMMARY

9.3.15 Overall this section of the report has demonstrated that the PT mode split for HBO and HBEB trips is accurate when compared to NTS data and when measured against the public transport surveys undertaken for this study. This provides confidence that the mode choice the demand model for these purposes validate well.

9.4 TRIP DISTRIBUTION

9.4.1 To ensure that the bus and rail trips within Tier 2 are distributed correctly trip length comparisons are made against observed data, and sector to sector comparisons are made against TTW data.

9.4.2 The same attractors are used in the Tier 2 trip distribution model as in the Tier 1 model. The attractiveness of each zone remains the same regardless of the type of transport.

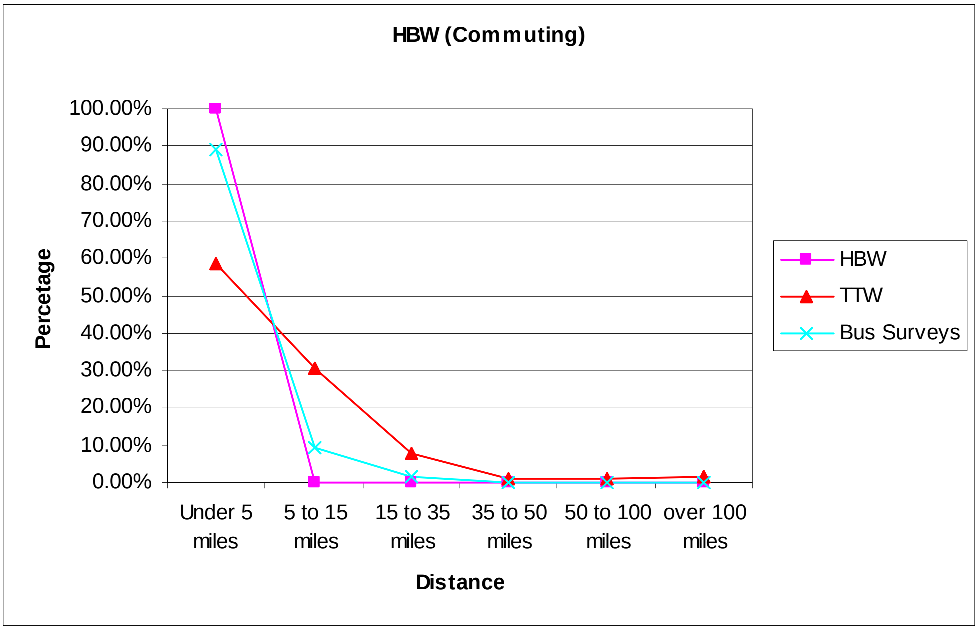
TRIP LENGTHS

Bus Trip Length Distribution

9.4.3 Bus and rail trip lengths between the demand model, TTW (HBW only) and the observed surveys are compared at trip purpose level. This provides confidence that the trip distribution is accurate and ensures that the balance between the attractiveness of the zones and the travel distance to the zone reflects reality. The comparison is made between trips travelling to, from and within Warrington.

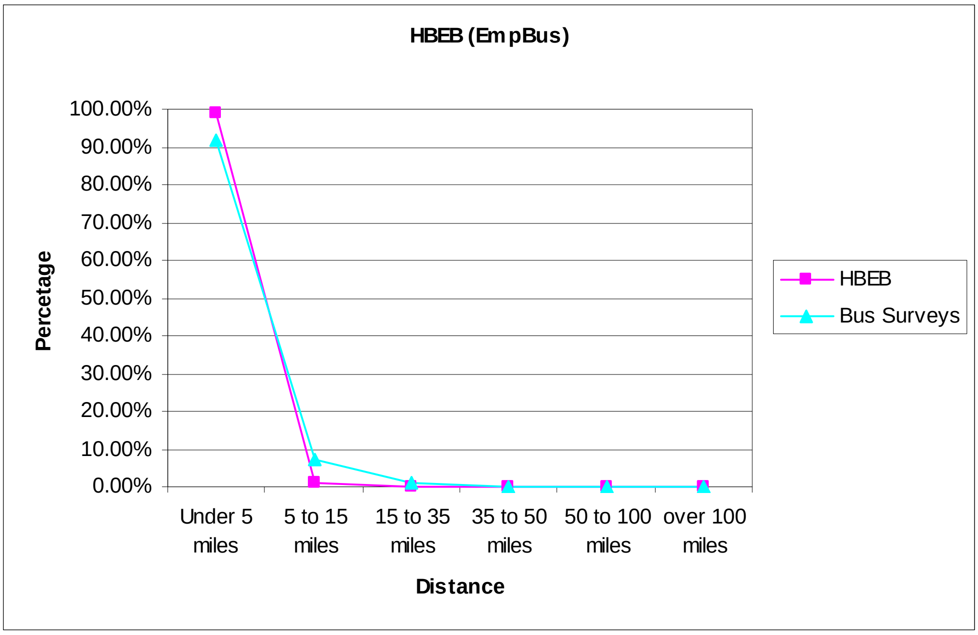
9.4.4 Figure 9.1 shows the bus trip length distribution of HBW trips for the 24 hour demand model. The graph shows that the trips lengths produced by the demand model are more in line with the TTW data than the bus survey data. The survey scope concentrated on local bus services in and around Warrington, the majority of which would be within 5km of Warrington. Whilst a few longer distance bus routes were targeted in the surveys, those routes connecting Warrington with towns greater than 5km away were, in the main, not surveyed. The lack of data from these routes distorts the trip length distribution suggesting the majority of bus trips are less than 5km in length.

Figure 9.1 – Bus Demand Model Trip Lengths HBW 24 hour



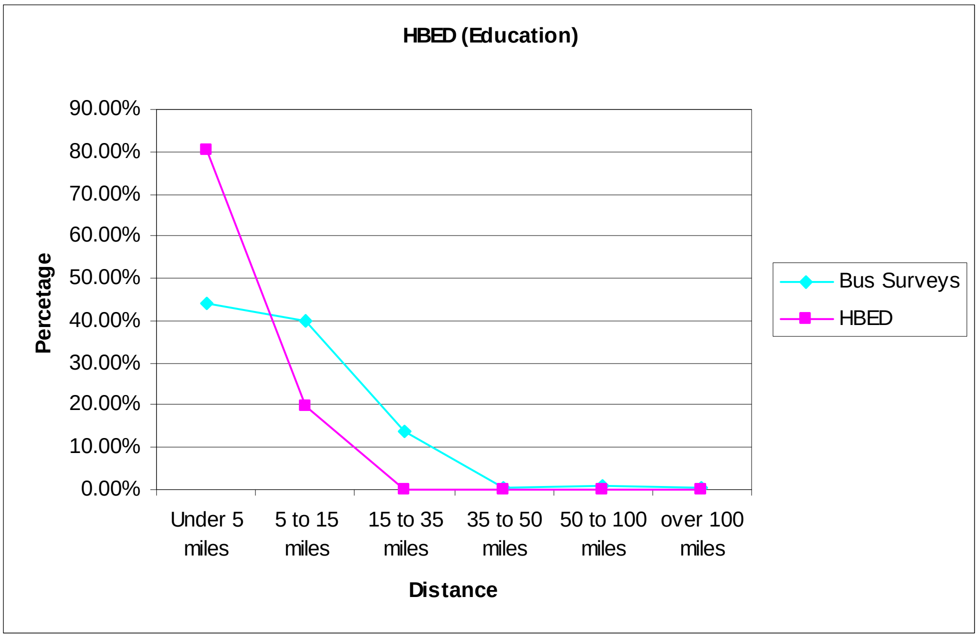
9.4.5 Figure 9.2 shows that the bus trip lengths of HBEB trips have slightly too few short trips under 5 miles and slightly too many trips between 15 and 35 miles. However, the shape of the graph is correct in comparison to survey data available.

Figure 9.2 – Bus Demand Model Trip Lengths HBEB 24 hour



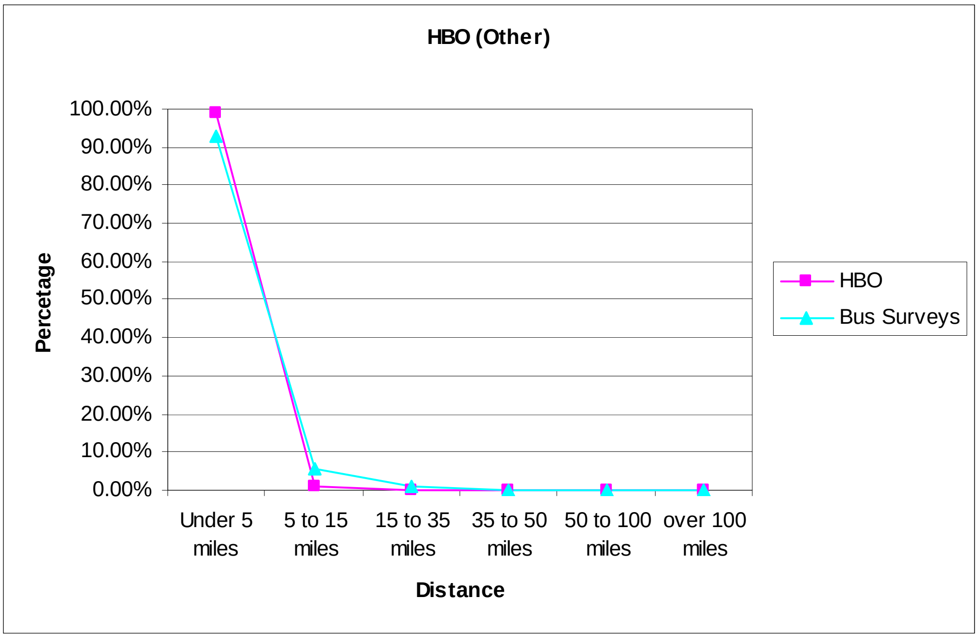
9.4.6 Figure 9.3 shows that the bus HBEd trip lengths have too many short trips under 5 miles and slightly too few trips between 15 and 35 miles. This is because HBEd trips within the model were only produced for the study area meaning that longer distance trips were note produced within the model. The shape of the graph is still in line with the survey data providing confidence in the HBEd trip distribution.

Figure 9.3 – Bus Demand Model Trip Length HBEd 24 hour



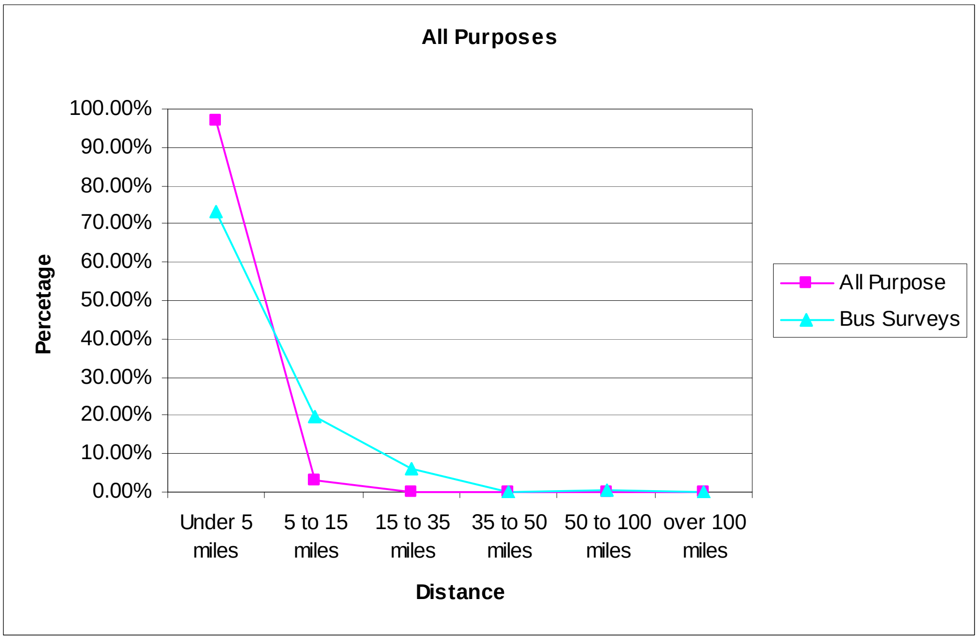
9.4.7 Figure 9.4 compares the trip length distribution for bus HBO trips against survey data. It shows that the trip length distribution within the demand model is accurate compared to survey data.

Figure 9.4 – Bus Demand Model Trip Length HBO 24 hour



9.4.8 Figure 9.5 compares the trip length distribution for all the bus journey purposes against survey data and as shown the trip lengths within the demand model are very accurate.

Figure 9.5 – Bus Demand Model Trip Length All Purposes 24 hour

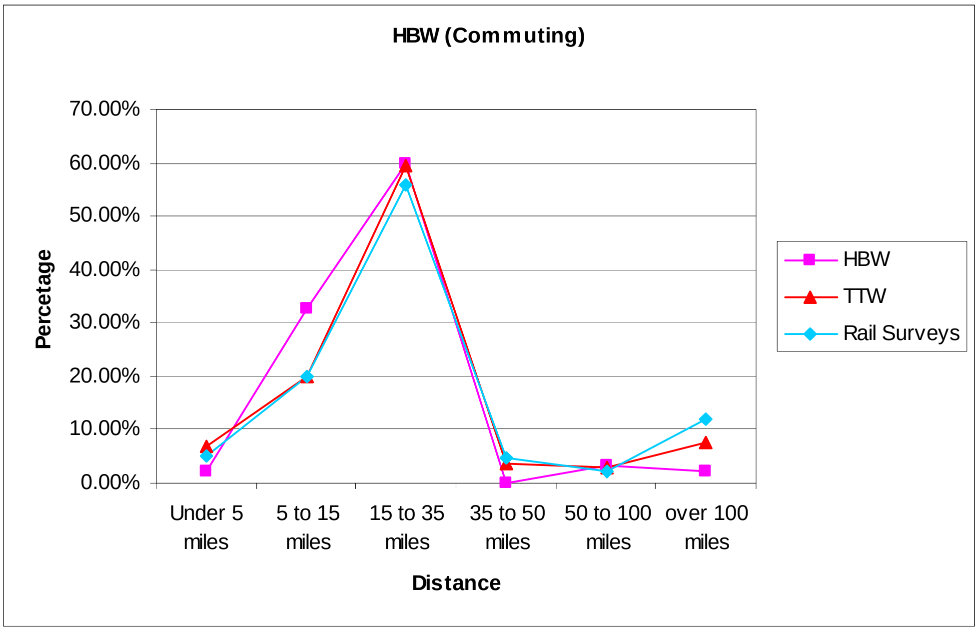


9.4.9 The figures above show that trip length distribution is accurate when compared against survey data. This is Warrington specific data and therefore lends confidence that the bus trip lengths are reflecting reality within the study area.

Rail Trip Length Distribution

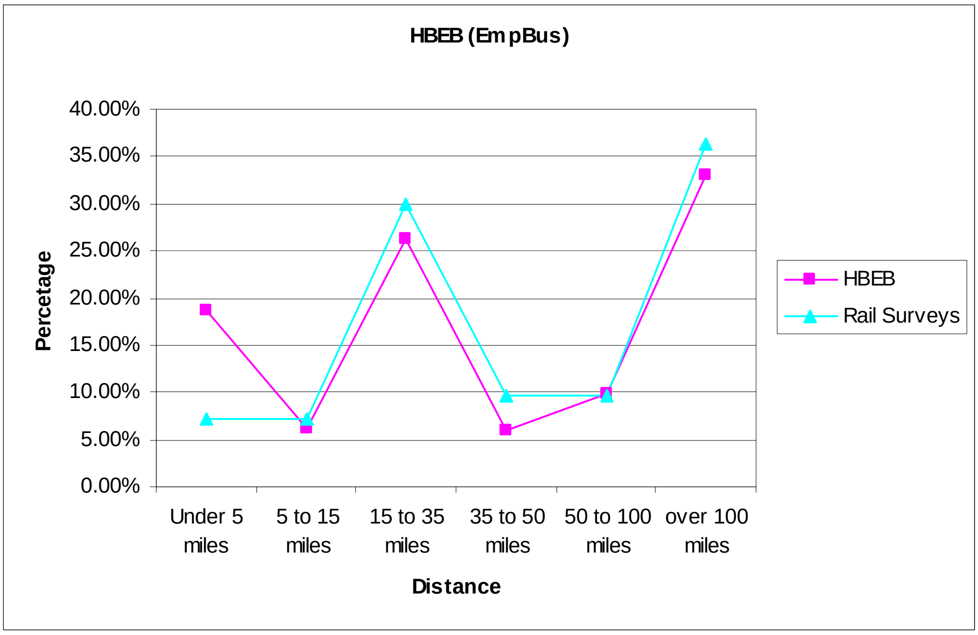
9.4.10 Figure 9.6 shows the rail trip length distribution of HBW trips for the demand model. The graphs show that the trips lengths produced by the demand model are in line with the TTW and survey data which is Warrington specific.

Figure 9.6 – Rail Demand Model Trip Lengths HBW 24 hour



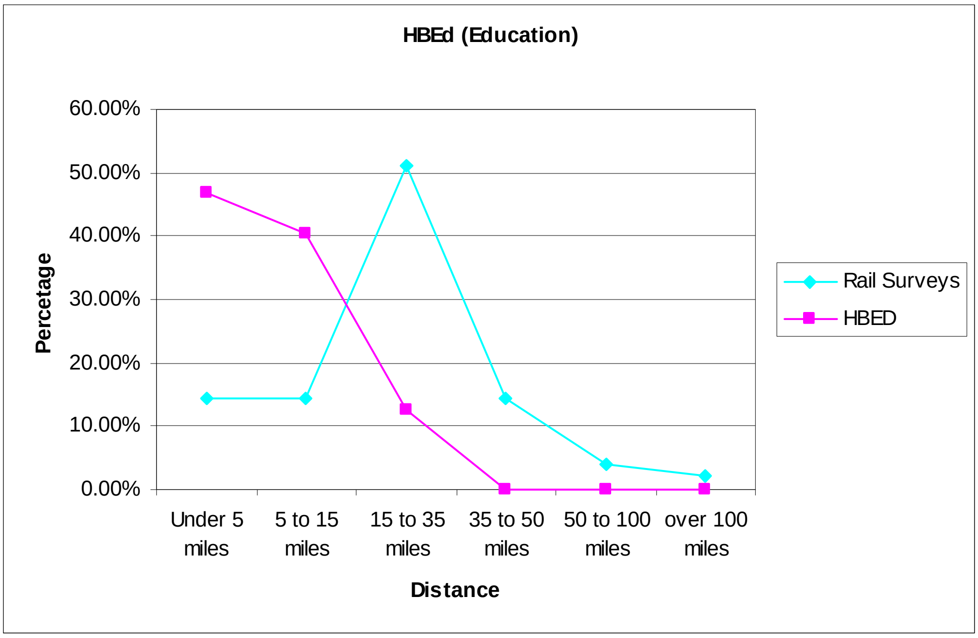
9.4.11 Figure 9.7 shows that the rail trip lengths of HBEB trips have slightly too many short trips under 5 miles. However, the shape of the graph is correct in comparison to survey data available and given the complexity of the graph profile this gives confidence that the trip lengths being produced are correct.

Figure 9.7 – Rail Demand Model Trip Lengths HBEB 24 hour



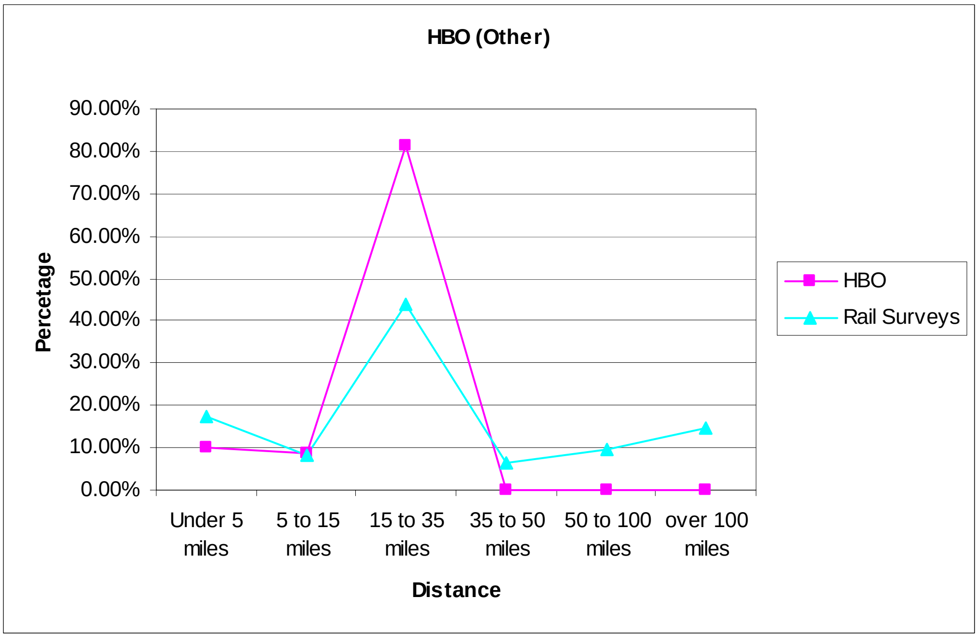
9.4.12 Figure 9.8 shows that the rail HBEd trip lengths have too many short trips under 5 miles and too few trips for distances over 15 miles. This is because HBEd trips within the model were only produced for the study area meaning that no longer distance trips were produced within the model. The approximate shape of the graph is still in line with the survey data providing confidence in the HBEd trip distribution.

Figure 9.8 – Rail Demand Model Trip Length HBEd 24 hour



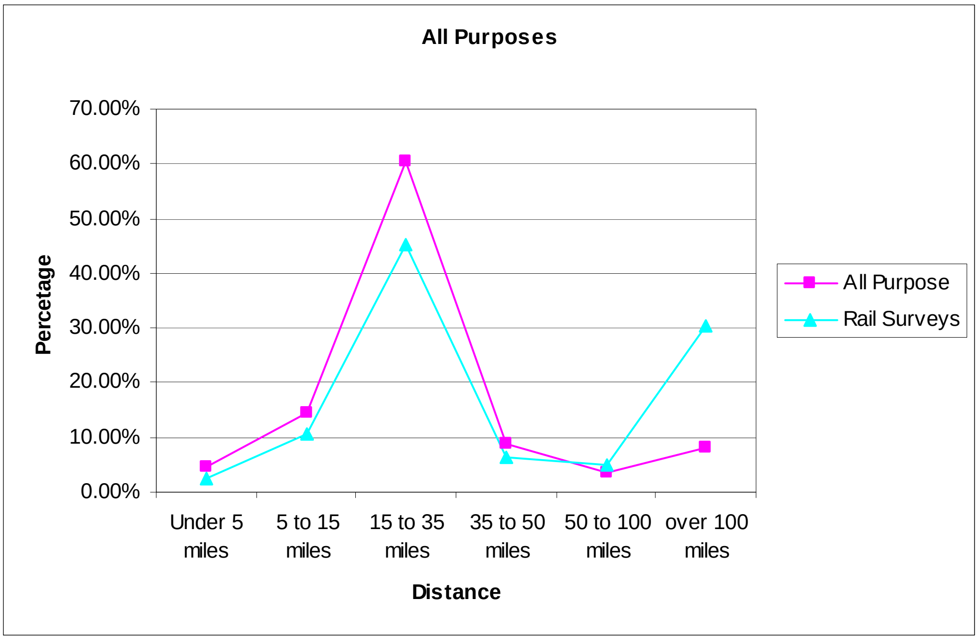
9.4.13 Figure 9.9 compares the trip length distribution for HBO trips against survey data. No HBO trips were produced in the model for distances over 35 miles resulting in the graphs showing the modelled results being lower than the survey data for trip lengths over this distance. However the shape of the graph shows that the trip length distribution within the demand model is accurate compared to survey data.

Figure 9.9 – Rail Demand Model Trip Length HBO 24 hour



9.4.14 Figure 9.10 compares all the rail purposes trip length distribution against survey data and as shown the trip lengths within the demand model are accurate in all three time period models. There are too few very long distance trips over 100 miles in all three time period models but given that the shape of the graphs is a good fit to the surveyed data overall we can be confident that the trip lengths are reflecting reality.

Figure 9.10 – Rail Demand Model Trip Length All Purposes 24 hour



9.4.15 The figures above show that trip length distribution is a food reflection of reality across all purposes when comparing it to survey data. This is Warrington specific data and therefore can be confident that the rail trip lengths are reflecting reality within the study area.

BUS SECTOR TO SECTOR MOVEMENTS

9.4.16 Bus and rail trip movements between main zones, known as sector to sector matrices, are created from the distributed trips for each trip purpose. These represent 24 hour trip totals.

9.4.17 HBW trips are compared at a sector to sector level against the TTW census data matrix. Table 9.7 shows the sector to sector movements for the bus TTW data; these have been adjusted to the demand model totals.

Table 9.7 – Bus Travel to Work Sector to Sector Movements

1533792	1	2	3	4	5	6	7	8	9	10	11	12
1	913746	419	1969	354	418	212	45	50	2	0	10	30
2	1172	153397	9464	26	1032	603	24	5	3	0	5	10
3	3333	3258	253010	1577	2929	149	40	424	0	0	12	21
4	471	37	1349	11285	34	26	1229	220	0	0	0	5
5	568	461	1266	21	86135	1301	61	1604	6	1	91	208
6	421	707	119	64	1329	53139	606	18	14	2	132	376
7	129	32	21	460	58	2502	12142	61	9	7	25	120
8	40	16	222	158	1294	29	95	1817	13	2	14	33
9	4	0	0	0	13	13	7	24	27	6	42	156
10	2	0	0	0	2	5	2	1	2	1	8	25
11	12	0	8	0	154	64	48	10	55	12	381	1035
12	1	0	5	0	63	79	46	12	12	5	174	925

HBW SECTOR – SECTOR MOVEMENTS

9.4.18 Table 9.8 shows the bus demand model results.

Table 9.8 – Demand Model Bus HBW Sector to Sector Movements

1636626	1	2	3	4	5	6	7	8	9	10	11	12
1	1228603	0	0	0	0	0	0	0	0	0	0	0
2	0	178738	0	0	0	0	0	0	0	0	0	0
3	0	0	136156	0	0	0	0	0	0	0	0	0
4	0	0	0	15798	0	0	0	0	0	0	0	0
5	0	0	0	0	36362	3	0	0	0	0	29	0
6	0	0	0	0	0	22770	3	0	0	0	2	11
7	0	0	0	0	0	8	9130	0	0	0	0	0
8	0	0	0	0	0	0	0	5449	19	0	1	0
9	0	0	0	0	0	0	0	6	155	21	69	57
10	0	0	0	0	0	0	4	0	13	14	7	11
11	0	0	0	0	168	19	0	0	47	11	982	618
12	0	0	0	0	1	14	0	0	14	5	99	1210

9.4.19 Table 9.9 shows the GEH value between the HBW and the adjusted TTW sector to sector movements for bus. Generally, movements within, to or from Warrington show a good match and only a few external to external sectors do not match. However, these do not have any impact on the Warrington area and can therefore be discounted. It is fair to say that trips within the model that will impact on the Warrington area validate well against TTW data.

Table 9.9 –Bus HBW GEH Compared to TTW

	1	2	3	4	5	6	7	8	9	10	11	12
1									2	1	5	8
2									2	0	3	5
3									0	0	5	7
4									0	0	0	3
5									3	1	8	20
6									5	2	16	26
7									4	3	7	15
8									2	2	5	8
9	3	0	0	0	5	5	4	5	13	4	4	10
10	2	0	0	0	2	3	1	2	4	5	0	3
11	5	0	4	0	1	7	10	4	1	0	23	15
12	2	0	3	0	11	9	10	5	1	0	6	9

RAIL SECTOR TO SECTOR MOVEMENTS

9.4.20 Table 9.10 shows the sector to sector movements for the rail TTW data, these have been adjusted to the demand model totals.

Table 9.10 – Rail Travel to Work Sector to Sector Movements

835551	1	2	3	4	5	6	7	8	9	10	11	12
1	741005	573	1500	177	406	203	45	80	2	0	2	16
2	1568	11167	4108	24	824	229	21	40	2	0	10	26
3	3395	1332	22691	87	4077	77	16	128	0	0	0	0
4	666	40	79	902	293	156	241	79	0	0	8	20
5	486	253	612	88	9878	444	74	550	0	0	26	79
6	414	487	53	101	2150	12374	667	51	4	1	22	158
7	222	37	29	133	314	3741	2254	42	2	1	18	99
8	164	13	124	84	1765	66	50	405	0	0	3	5
9	15	0	3	0	57	23	0	6	9	1	2	1
10	3	0	0	0	18	3	1	2	2	1	1	2
11	7	3	5	3	184	36	9	7	0	0	14	15
12	17	3	5	3	136	71	4	0	0	0	4	22

HBW SECTOR – SECTOR MOVEMENTS

9.4.21 Table 9.11 shows the rail demand model results.

Table 9.11 –Rail HBW Sector to Sector Movements

839473	1	2	3	4	5	6	7	8	9	10	11	12
1	625456	0	698	743	0	0	29	144	0	0	0	0
2	396	89285	508	342	465	772	60	30	4	1	7	12
3	3011	39	64031	119	1706	807	201	729	3	2	7	8
4	142	127	43	7080	219	70	721	578	11	2	15	21
5	22	65	252	11	18175	664	56	509	31	4	105	182
6	80	160	27	4	1268	8938	594	31	68	10	336	712
7	13	16	46	217	53	1463	2833	22	19	4	36	106
8	129	1	74	241	560	50	43	1847	6	1	11	25
9	2	0	0	0	30	48	11	3	9	1	5	12
10	1	0	0	0	5	14	4	1	2	3	1	2
11	2	0	0	0	83	160	15	3	2	0	12	10
12	3	0	0	0	89	134	17	5	3	0	4	9

9.4.22 Table 9.12 shows the GEH value between the HBW and the adjusted TTW sector to sector movements for rail. Generally, movements within, to or from Warrington show a good match and only a few external to external sectors do not match. However, these do not have any impact on the Warrington area and can therefore be discounted. It is fair to say that trips within the model that will impact on the Warrington area are validated against TTW data.

Table 9.12 –Rail HBW GEH Compared to TTW

	1	2	3	4	5	6	7	8	9	10	11	12
1									2	1	2	6
2									1	1	1	3
3									3	2	4	4
4									5	2	2	0
5									8	3	10	9
6									11	4	23	27
7									5	2	3	1
8									3	1	3	5
9	4	0	2	0	4	4	5	1	0	0	2	4
10	2	0	0	0	4	4	2	1	0	2	1	0
11	2	2	3	2	9	13	2	2	2	1	1	1
12	4	2	3	2	4	6	4	3	3	1	0	3

9.4.23 Sector to sector movements for other journey purposes do not have a data set that they can be compared to such as TTW census data. They have therefore not been included here.

9.5 TIME SLICE

9.5.1 Distributed trips produced by the demand model are 24 hours totals and prior to an assignment need to be converted to an AM, IP or PM peak hour via the application of scaling factors. These are derived from NTS data (for 24 hour to 3 hour conversion) and bus and rail survey data (for 3 hour to 1 hour peak conversion). The combined 24 hour to 1 hour time slice factors are summarised in Table 9.13 for the bus matrices and Table 9.14 for the rail matrices.

Table 9.13 – Bus AM, IP and PM Time Scaling Factors

Trip Purpose	Direction	AM	IP	PM
HBW	From Home	0.197	0.014	0.042
	To Home	0.014	0.020	0.367
HBEB	From Home	0.183	0.037	0.057
	To Home	0.015	0.033	0.275
HBEd	From Home	0.410	0.029	0.010
	To Home	0.082	0.076	0.108
HBO	From Home	0.032	0.069	0.079
	To Home	0.014	0.060	0.091
NHBEB	NHB	0.078	0.080	0.076
NHBO	NHB	0.051	0.081	0.098

Table 9.14 – Rail AM, IP and PM Time Scaling Factors

Trip Purpose	Direction	AM	IP	PM
HBW	From Home	0.256	0.054	0.030
	To Home	0.022	0.051	0.212
HBEB	From Home	0.150	0.113	0.032
	To Home	0.016	0.070	0.135
HBEd	From Home	0.129	0.038	0.004
	To Home	0.031	0.066	0.029
HBO	From Home	0.054	0.158	0.066
	To Home	0.018	0.100	0.055
NHBEB	NHB	0.000	0.000	0.000
NHBO	NHB	0.000	0.000	0.000

9.6 ASSIGNMENT

9.6.1 The Tier 2 trip generation, mode choice and trip distribution stages produce synthetic production and attraction demand matrices representing all person trips by journey purpose undertaken by bus and rail during a single weekday 24 hour period. Time slice factors are used to convert the 24 hour production/ attraction matrices into origin/ destination matrices ready for assignment. At this stage the journey purpose matrices are aggregated into single bus and rail matrices per peak hour.

9.6.2 The public transport demand matrices are never assigned for analysis purposes. The observed matrix when assigned generates the time and distance costs that feed into mode choice and trip distribution meaning the generalised costs of travel are consistent between the demand and observed model.

10 Realism Testing

10.1 REALISM TESTS

REALISM TESTING

10.1.1 WebTAG guidance Tag Unit 3.10.4 section 1.6, states that once a variable demand model has been constructed it is essential to ensure that it behaves "realistically' by changing various components of travel costs and travel times and checking that the overall response of the demand accords with general experience. The three realism tests recommended by WebTAG are:

- Increase car fuel cost by 20%
- Increase car journey times by 10%
- Increase public transport fares by 10%

10.1.2 The first two realism tests were undertaken solely in Tier 1 of the demand model as these tests are based on changes in car costs. The public transport Realism test was undertaken in the Tier 1 and Tier 2 demand models as the mode choice between Car, PT and Slow had to be completed with the increase in public transport fares before the mode split could be calculated between Bus and Rail.

10.1.3 The highway tests were undertaken on the calibrated and validated base year 2008 demand models. Using the trip outputs from the base model and the test model, the following formulae were applied to measure the levels of elasticity:

$$\text{Elasticity} = [\log(T^1) - \log(T^0)] / [\log(C^1) - \log(C^0)]$$

where: superscripts 0 and 1 indicate Base and Test models respectively

T = trip output total (or vehicle kilometres total)

C = cost component

Since:

$$[\log(C^1) - \log(C^0)] = \log\left(\frac{C^1}{C^0}\right)$$

The change in cost component (e.g. Fuel cost) is $\frac{C^1}{C^0}$

Or 1.2 (for an increase of 20%) or 1.1 (for an increase of 10%).

PROCESS

10.1.4 In summary the methodology used for the tests included the following steps:

- Recalculation of the generalised costs for each mode reproduced as a result of the realism adjustments
- Mode Choice recalculated
- Trip distribution recalculated

- Vehicle kilometres travelled in assignment calculated for the base and realism test
- Elasticity formulae applied

AREA

10.1.5 For the fuel cost and journey time realism test the sector movements used to assess the demand model elasticity are shown in Table 10.1, plans of the models sectors are shown in Figure 3.5 to Figure 3.7. As a rule only movements that potentially use the road network around Warrington have been included.

Table 10.1 – Sector Movements Used

	1	2	3	4	5	6	7	8	9	10	11	12
1	Not Used	Not Used	Not Used	Not Used	Used	Used	Used	Used	Used	Used	Used	Used
2	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Used	Used	Used	Used	Used	Used
3	Not Used	Not Used	Not Used	Not Used	Not Used	Used	Used	Used	Used	Used	Used	Used
4	Not Used	Not Used	Not Used	Not Used	Used	Used	Used	Used	Used	Used	Used	Used
5	Used	Not Used	Not Used	Used	Not Used	Used	Used	Used	Used	Used	Used	Used
6	Used	Not Used	Used	Used	Used	Not Used	Used	Used	Used	Used	Used	Used
7	Used	Used	Used	Used	Used	Used	Not Used	Used	Used	Used	Used	Used
8	Used	Used	Used	Used	Used	Used	Used	Not Used	Used	Used	Used	Used
9	Used	Used	Used	Used	Used	Used	Used	Used	Used	Used	Used	Used
10	Used	Used	Used	Used	Used	Used	Used	Used	Used	Used	Used	Used
11	Used	Used	Used	Used	Used	Used	Used	Used	Used	Used	Used	Used
12	Used	Used	Used	Used	Used	Used	Used	Used	Used	Used	Used	Used

MSA (sectors 5–8)
Warrington (sectors 9–12)

Used
Not Used

10.1.6 The table above shows that most sector to sector movements to, from and within the Main Study Area (MSA) and the Warrington sectors are included with the exception of the following:

- Intra-sector movements
- Sector movement 2-5 and 5-2 (Manchester – Scotland)
- Sector movement 2-6 and 6-2 (Liverpool – Scotland)
- Sector Movement 3-5 and 5-3 (Yorkshire – Manchester)

10.1.7 Within the Warrington Multi Modal Transport Model (WMMTM) the detailed public transport network is confined to the Warrington area and the MSA does not have a detailed public transport network fully coded in this area. Therefore for the public transport fare realism test all trips to, from and within Warrington were used.

10.2 20% INCREASE IN FUEL COST

10.2.1 WebTAG 3.10.4 published for consultation in September 2009 guidance states that fuel cost elasticity should lie within the range -0.25 to -0.35.

10.2.2 Table 10.2 to Table 10.4 show the elasticity results for the increase in Fuel Cost for the AM, IP and PM peak hours. These results are based on the mode choice and trip distribution sensitivity parameter values presented chapter 6. Note the closer the elasticity value is to zero the less elastic it is.

Table 10.2 – AM Peak Fuel Cost Elasticities

Trip Purpose	Elasticity
All Purposes	**-0.37**
HBW	-0.45
HBEB	-0.12
HBEd	-0.06
HBO	-0.31
NHBEB	-0.19
NHBO	-0.34

Table 10.3 – Inter Peak Fuel Cost Elasticities

Journey Purpose	Elasticity
ALL	**-0.29**
HBW	-0.44
HBEb	-0.12
HBEd	-0.06
HBO	-0.29
NHBEb	-0.19
NHBO	-0.33

Table 10.4 – PM Peak Fuel Cost Elasticities

Journey Purpose	Elasticity
All	**-0.35**
HBW	-0.43
HBEb	-0.12
HBEd	-0.06
HBO	-0.29
NHBEb	-0.19
NHBO	-0.33

10.2.3 Section 3.10.4 of WebTAG guidance, currently under consultation, states that fuel cost elasticities should be between -0.25 and -0.35. The IP and PM peak hour elasticities are within this range, however the AP peak hour is still outside. These results are at peak hour levels, but often 24 hour results are required and in some cases preferred.

10.2.4 With regard to the journey purposes, HBEB, NHBEB and HBEd have the lowest elasticities. The more discretional journey purposes (HBW, HBO and NHBO) show elasticities between -0.29 and -0.45. The relative range of results between journey purposes is in accordance with WebTAG.

10.2.5 It is expected that employer's business and education trip purposes will be less elastic to an increase in fuel costs compared to other trips purposes because these types of journeys are more likely to depend on car usage for the trip no matter the fuel cost.

24 HOUR CONVERSION

10.2.6 The AM, IP and PM peak hour elasticities have been converted into an average 24 hour elasticity for both catchment areas, Table 10.5 shows that the results are within the WebTAG guidance levels, i.e. between -0.25 and -0.35.

Table 10.5 – 24 hour Average Fuel Cost Elasticities

Journey Purpose	Elasticity
All	**-0.34**
HBW	-0.44
HBEb	-0.12
HBEd	-0.06
HBO	-0.29
NHBEb	-0.19
NHBO	-0.33

10.3 10% INCREASE IN JOURNEY TIME

10.3.1 WebTAG states that journey time elasticities should be checked to ensure that the model does not produce very high output elasticities (say less than -2.0). Table 10.6 to Table 10.8 show the journey time elasticities for AM, IP and PM peak hours.

Table 10.6 – AM Peak Journey Time Elasticities

Journey Purpose	Elasticity
ALL	**-1.64**
HBW	-1.37
HBEb	-3.14
HBEd	-0.34
HBO	-1.03
NHBEb	-3.04
NHBO	-0.78

Table 10.7 – Inter Peak Journey Time Elasticities

Journey Purpose	Elasticity
ALL	**-1.50**
HBW	-1.36
HBEb	-3.11
HBEd	-0.34
HBO	-0.95
NHBEb	-3.01
NHBO	-0.80

Table 10.8 – PM Peak Journey Time Elasticities

Journey Purpose	Elasticity
ALL	**-1.54**
HBW	-1.35
HBEB	-3.11
HBEd	-0.34
HBO	-0.91
NHBEb	-3.01
NHBO	-0.80

10.3.2 The overall elasticity of car use with respect to a change in car journey time ranges from -1.50 to -1.64. This is within WebTAG's acceptable value of -2.0, however the trip purposes HBEB and NHBEB have elasticities less than -2.0. This is because these journey purposes are most sensitive to change because the value of time for employers business trips is greater compared to other purposes. Therefore a 10% increase in journey time significantly increases the cost of their journey compared to other trip purposes.

10.3.3 The least elastic response is that of HBEd trips, which again is expected as school trips are fairly in elastic.

24 HOUR CONVERSION

10.3.4 The AM, IP and PM peak hour elasticities have been converted into average 24 hour elasticities. Table 10.9 shows that as with the peak hour results these are within the WebTAG guidelines overall however the trip purposes HBEB and NHBEB have elasticities less than -2.0 in the MSA results.

Table 10.9 – 24 hour Average Journey Time Elasticities

Journey Purpose	Elasticity
All	**-1.57**
HBW	-1.36
HBEb	-3.12
HBEd	-0.34
HBO	-0.95
NHBEb	-3.02
NHBO	-0.80

10.4 10% INCREASE PUBLIC TRANSPORT FARE

10.4.1 The realism test involving an increase in public transport fares was conducted in both Tier 1 and Tier 2 of the demand model. WebTAG guidance indicates that public transport fare elasticity typically lies in the range of -0.2 to -0.9. Table 10.10 to Table 10.12 show the results of the realism test for all the time period demand models. These show the different time period demand model's elasticities lie between -0.004 to -0.01, outside of the WebTAG criteria.

Table 10.10 – AM Peak Public Transport Fare Elasticities

Journey Purpose	Elasticity
All	**-0.0038**
HBW	-0.005
HBEB	0.001
HBEd	-0.001
HBO	-0.005

Table 10.11 – Inter Peak Public Transport Fare Elasticities

Journey Purpose	Elasticity
All	**-0.005**
HBW	-0.007
HBEB	0.001
HBEd	-0.001
HBO	-0.006

Table 10.12 – PM Peak Public Transport Fare Elasticities

Journey Purpose	Elasticity
All	**-0.004**
HBW	-0.004
HBEB	-0.011
HBEd	-0.001
HBO	-0.004

10.4.2 As a result of the inelasticity of this realism test it was decided to increase bus fares by £1 instead of 10% this was decided because:

- Bus fares in the model are low ranging from 0.44p to £1.47
- There is a high number of concessionary fares,
  - 43% of passengers travel for free
  - 11% passengers pay half fare

10.4.3 It is important to note that the fare range is calculated by distance and the majority of trips in Warrington will be towards the lower end of the fare range. Therefore a 10% increase in fares is insignificant, 4p- 15p, and not enough to effect mode choice. The results of the £1 increase in bus fare realism result are shown in Table 10.10 to Table 10.12. It is important to note that rail fares remained increased at 10% in this realism test.

Table 10.13 – AM Peak Public Transport Fare Elasticities

Journey Purpose	Elasticity
All	**-0.0268**
HBW	-0.028
HBEB	-0.002
HBEd	-0.030
HBO	-0.022

Table 10.14 – Inter Peak Public Transport Fare Elasticities

Journey Purpose	Elasticity
All	**-0.02**
HBW	-0.021
HBEB	-0.001
HBEd	-0.030
HBO	-0.022

Table 10.15 – PM Peak Public Transport Fare Elasticities

Journey Purpose	Elasticity
All	**-0.03**
HBW	-0.029
HBEB	-0.013
HBEd	-0.030
HBO	-0.025

10.4.4 These results show an increase in elasticity compared to the original results however WebTAG criteria is still not met. WebTAG does state that values close to -0.2 are unlikely for the whole public transport market unless this includes a high proportion of concessionary fare trips with a significant number made free of charge. This is something that requires further discussion with the Technical Working Group.

24 HOUR CONVERSION

10.4.5 The AM, IP and PM peak hour elasticities have been converted into an average 24 hour elasticities for both tests, Table 10.16 shows that these are outside the WebTAG guidelines, -0.2 to -0.9.

Table 10.16 – 24 hour Average Public Transport Fare Elasticities

Journey Purpose	Elasticity 10% PT	Elasticity £1/10% PT
All	**-0.004**	**-0.026**
HBW	-0.005	-0.028
HBEb	-0.003	-0.006
HBEd	-0.001	-0.030
HBO	-0.005	-0.023

10.5 SUMMARY

The realism test for journey times and increased fuel costs gave results that met the WebTAG criteria. The Public Transport fare realism tests however the model is not as elastic as the WebTAG criteria advises. This is a result of the very low PT fares in Warrington due to the high proportion of concessions meaning that a 10% increase in PT fares is a marginal increase in the generalised cost.

11 Observed Model Highway Calibration and Validation Results

11.1 INTRODUCTION

11.1.1 The VISUM highway model was prepared in accordance with the procedures set out in DMRB and a number of key calibration and validation checks were made between the modelled outputs and actual observations.

Network Calibration and Validation

- Adjustment and checking of the network to ensure plausible and realistic routing of traffic in the model through monitoring RSI matrix assignments
- Network validation, in terms of range checking and routing
- Checks to ensure that speed/flow calculations on network links and delay calculations at junctions were operating as expected

Matrix Calibration and Validation

- Checking assignment model convergence
- Comparison of sector to sector movements between the prior observed model and the observed model after the matrix estimation process for internal to external and external to internal movements between Warrington and the surrounding areas
- Comparison of trip length distribution between the prior observed model and the observed model after the matrix estimation process
- Comparison of modelled flows against independent observed flows (i.e. those not used in the matrix building process), across screenlines and at other locations
- Comparison of observed and modelled journey time routes

11.1.2 The observed model is built up from the RSI matrices and the infill demand matrices brought in from the demand model. The model calibration and validation exercise went as far as it could with the majority of RSI sites reaching DMRB criteria before matrix estimation was introduced. Further validation procedures were then undertaken to ensure the goodness of fit with observed data and that DMRB validation criteria are met.

MATRIX SECTOR COMPARISON

11.1.3 The demand model is used as an infill for the observed model, so that trip patterns not captured by the RSI data are infilled from the demand model to produce a prior matrix.

11.1.4 The matrices of the demand and the observed model can be compared to ensure that the sector to sector movements do not change greatly. This ensures that the origin-destination trips captured by the RSI data are being accurately replicated by the demand model which shows again that the demand model is accurately producing the correct trips.

11.1.5 Figure 11.1 to Figure 11.3 compare the demand and observed sector to sector comparison, this is only completed for Internal to External and External to

Internal trips. The External to External and Internal to Internal trips in the observed model come from the demand model as an infill and are therefore too similar to make worthwhile comparisons.

Figure 11.1 - AM Demand and Observed Model Sector to Sector Comparison

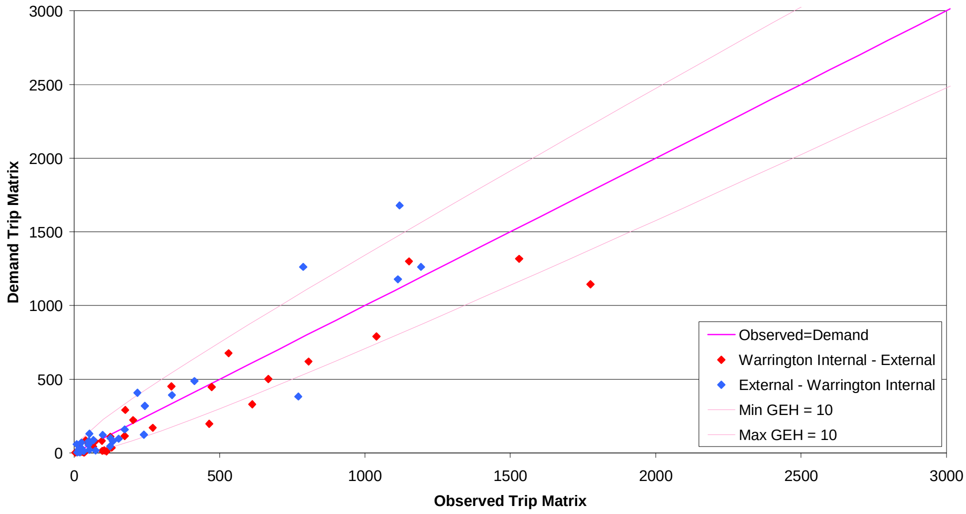


Figure 11.2 - IP Demand and Observed Model Sector to Sector Comparison

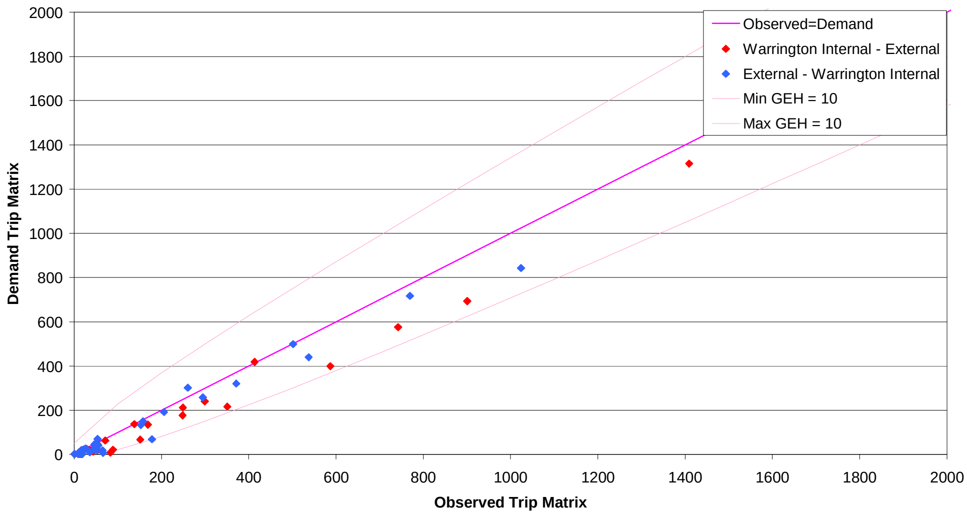
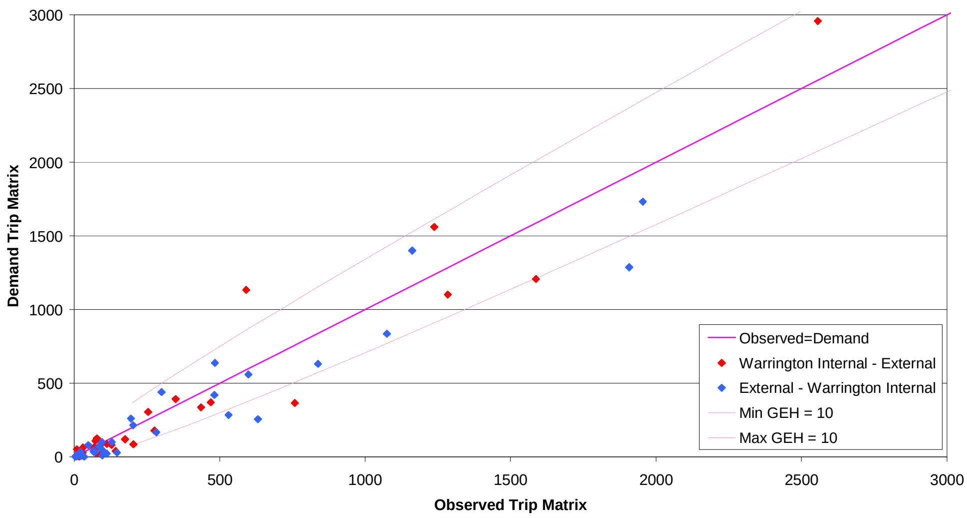


Figure 11.3 - PM Demand and Observed Model Sector to Sector Comparison



11.1.6 The sector to sector comparisons show a good match in most cases between the demand matrix and the prior matrix at a sector level indicating that the demand model is a close reflection of the RSI observed movements.

HIGHWAY MODEL ASSIGNMENT

11.1.7 The Equilibrium Lohse method was chosen as the assignment algorithm for the WMMTM. Equilibrium Lohse follows the same principles as the Wardrop equilibrium assignment algorithms, i.e. each path between OD pairs is the least cost path and that all other paths are of an equal or higher cost. Research conducted by PTV has demonstrated that the Equilibrium Lohse algorithm produces realistic and stable results.

11.1.8 This procedure models the 'learning process' of road users using the network. The 1st iteration step is an 'all or nothing' assignment, which means that all trips are assigned onto the lowest impedance route of the unloaded network. In each subsequent iteration step, the new lowest impedance route for each OD pair is found. Drivers make use of information gained during their previous trips for the new route search and all known 'shortest' routes are searched in an iterative process. For the route search the impedance is deduced from the impedance of the current volume and the estimated impedance from the previous iteration step. Junction delays and blocking back are considered between each assignment iteration.

11.1.9 It was deemed appropriate to use the Equilibrium Lohse assignment procedure for the WMMTM.

11.2 ROUTE CHECKING

11.2.1 The route choices made in the WMMTM were verified by systematically plotting a series of test trees at RSI sites between specified zone pairs. This procedure identified, for a given journey, the preferred route through the network under peak hour conditions. Each tree was assessed carefully to ensure that the chosen path was sensible; any counterintuitive results were investigated further.

The exercise revealed no untoward routings and all routings of a slightly dubious nature were discounted as the consequence of congestion elsewhere in the network.

11.2.2 Distribution plots at a series of locations around the study area are presented in Appendix D.

11.3 CONVERGENCE

11.3.1 The WMMTM achieved a very good measure of convergence within 23 iterations in the AM peak, 9 iterations in the IP and within 29 iterations in the PM peak. The duality gap expresses the convergence quality as the volume-weighted difference between the total impedance calculated along the chosen routes and the hypothetical vehicle impedance if all vehicles used the minimum impedance routes, as a proportion of the minimum vehicle impedance. The duality gap is comparable to the 'delta' described in the DMRB which asserts that iterations should continue until delta < 1%. The duality gap of the AM, IP and PM Peak models were a fraction of a percent as shown in Table 11.1 below.

Table 11.1 – Model Convergence (Duality Gap)

	AM Peak		Inter Peak		PM peak	
	Car	HGV	Car	HGV	Car	HGV
Duality Gap	0.0063%	0.3061%	0.0031%	0.0010%	0.0079%	0.0296%

11.3.2 The percentage of links on which flows change by less than 5% between successive iterations is often known as 'P'. It is recommended in the DMRB that, in addition to satisfying the true convergence measures for the duality gap described above, assignment model iterations should continue until at least four successive values of P in excess of 90% have been obtained. This was achieved by the WMMTM for all cases and provides an indication of the stability of the WMMTM. The value of P for the last 4 iterations of the model assignment is shown in Table 11.2.

Table 11.2 – Model Stability Indication (Percentage of links on which flows change by less than 5% between successive iterations)

	AM Peak			Inter Peak			PM peak	
Iteration	Car	HGV	Iteration	Car	HGV	Iteration	Car	HGV
20	99.20%	97.00%	6	97.80%	96.60%	17	98.00%	93.10%
21	99.80%	99.20%	7	98.20%	96.90%	18	98.40%	93.10%
22	99.80%	98.30%	8	98.80%	97.70%	19	98.50%	93.40%
23	100.00%	99.20%	9	99.00%	98.30%	20	99.20%	96.00%

11.4 SECTOR TO SECTOR MOVEMENTS

11.4.1 The matrices went through a process of matrix estimation in order to obtain a better calibrated matrix. During this process, the traffic volumes passing through the RSI sites in the interview direction were frozen, so were unable to change during the process thus preserving their distribution patterns. However, at the other calibration sites traffic volumes were able to change during this process.

11.4.2 Checks on this process at a sector to sector level were made to ensure changing traffic volumes slightly has not changed the main distribution patterns within the model.

Figure 11.4 – AM Matrix Sector to Sector Comparison

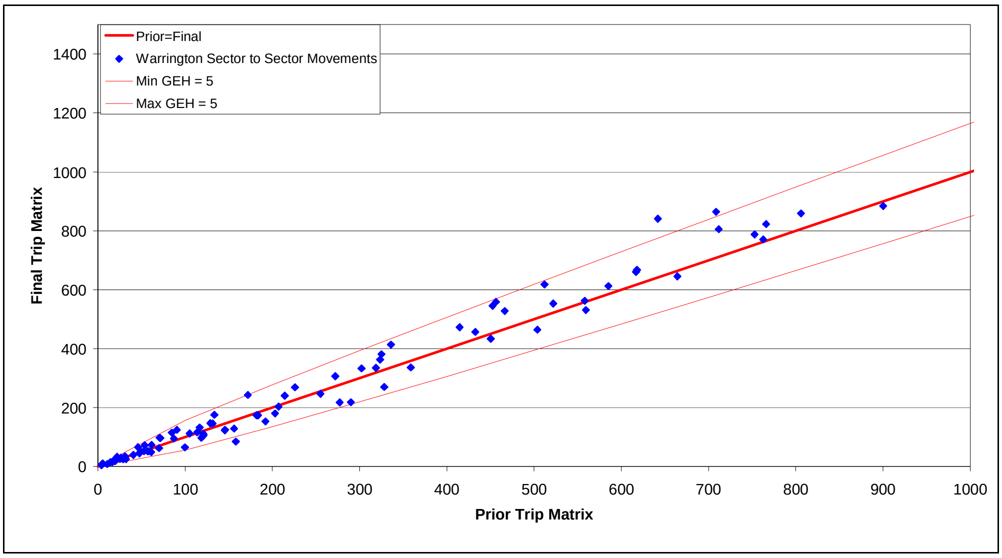


Figure 11.5 – IP Matrix Sector to Sector Comparison

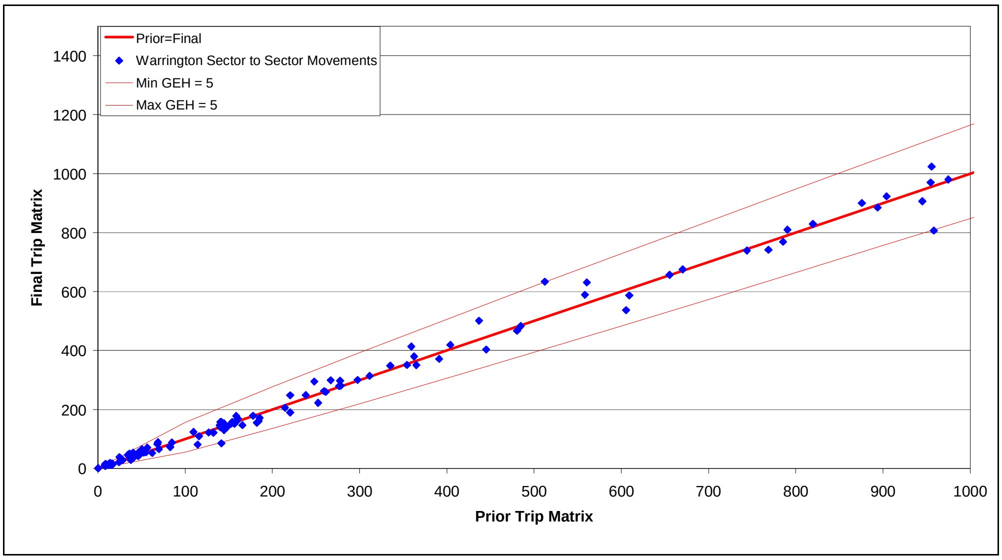
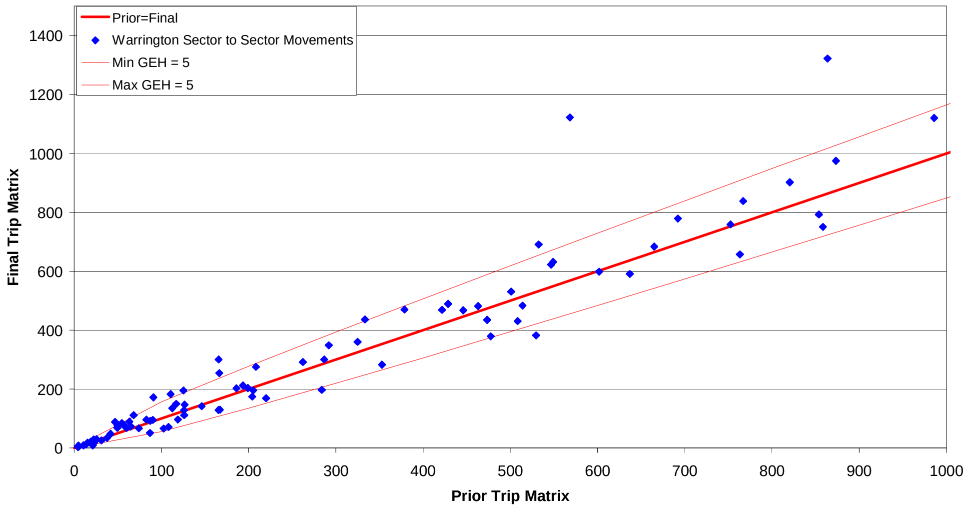


Figure 11.6 – PM Matrix Sector to Sector Comparison



11.4.3 Figure 11.4 to Figure 11.6 show clearly that the matrix estimation process has not significantly changed the sector to sector distribution.

11.4.4 The outliers shown in Figure 11.6 are between sector 9 and 11 and internally within sector 9 (both within Warrington). As these are effectively trips internal to Warrington it is likely that the RSI surveys would have missed them, hence matrix estimation raising the trip levels.

11.5 TRIP LENGTH DISTRIBUTION

11.5.1 Trip length distribution pre and post matrix estimation has been compared, in the observed model in all three time periods, AM, IP and PM peak. Figure 11.7 and Figure 11.8 show the trip length changes for car and HGV in the AM peak. For car Figure 11.7 shows that generally the percentage of cars is similar before and after matrix estimation. There is a greater percentage of trips under 5 miles after matrix estimation and this is to be expected because the internal - internal Warrington trips are not fully observed at RSI sites.

11.5.2 Figure 11.8 shows the HGVs have similar percentages of trip lengths both before and after matrix estimation.

Figure 11.7 – AM Peak Car Trip Length Distribution

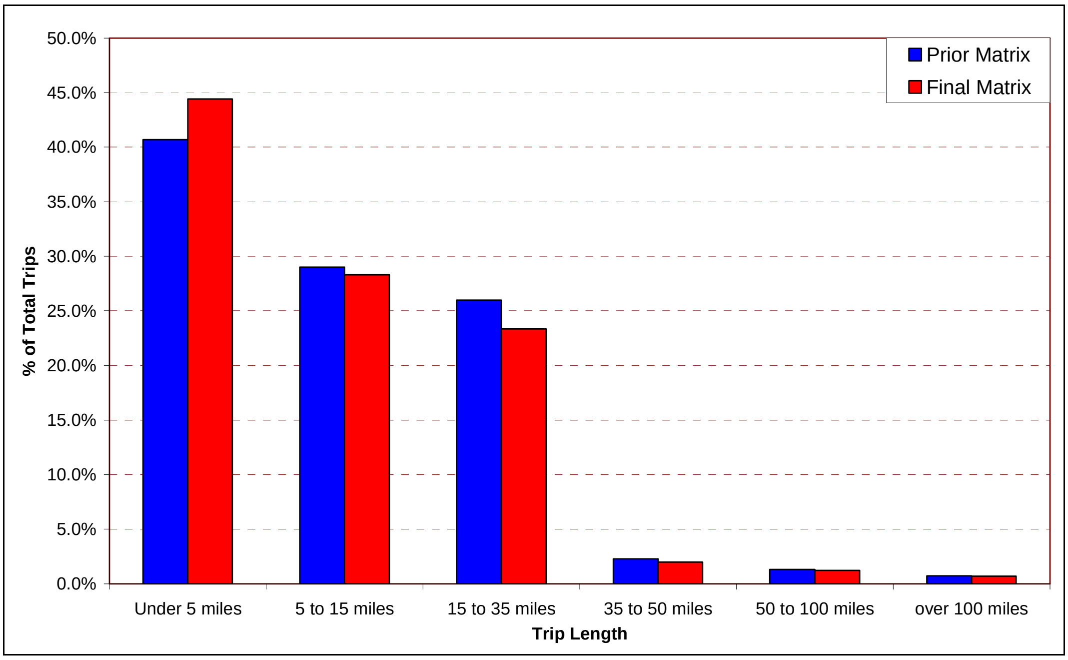
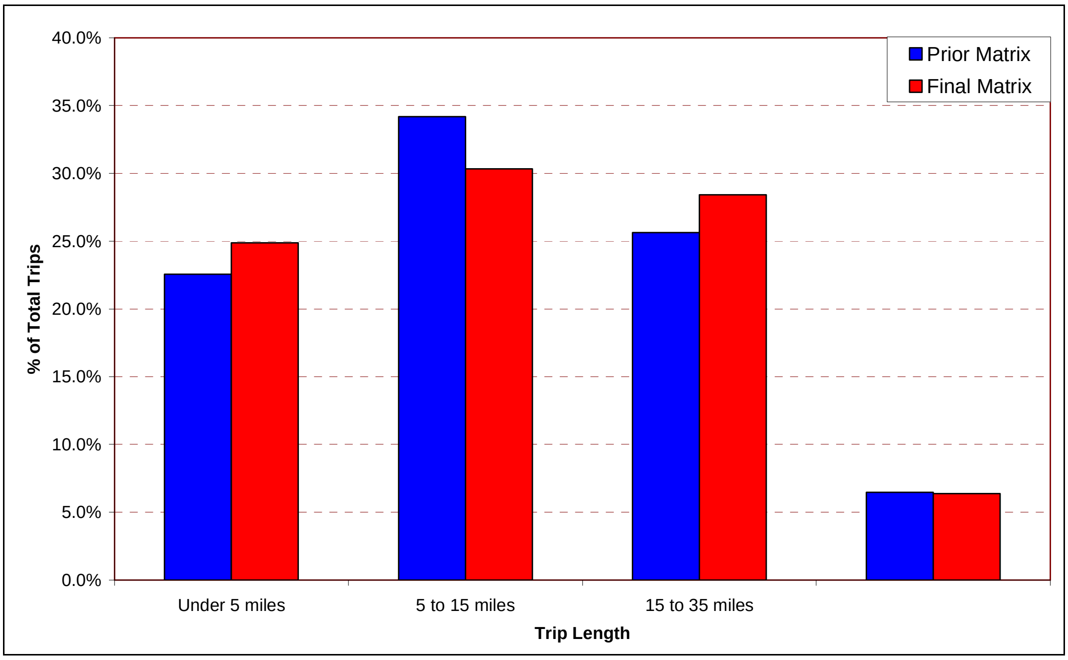


Figure 11.8 – AM Peak HGV Trip Length Distribution



11.5.3 Figure 11.9 and Figure 11.10 show the trip length distribution before and after matrix estimation in the IP observed model. Figure 11.9 shows there is practically no percentage change in the car trip lengths however there are a few differences in percentage term for the HGV trip lengths, see Figure 11.10. These changes are to be expected given the limited information available on internal Warrington HGV trips.

Figure 11.9 – IP Peak Car Trip Length Distribution

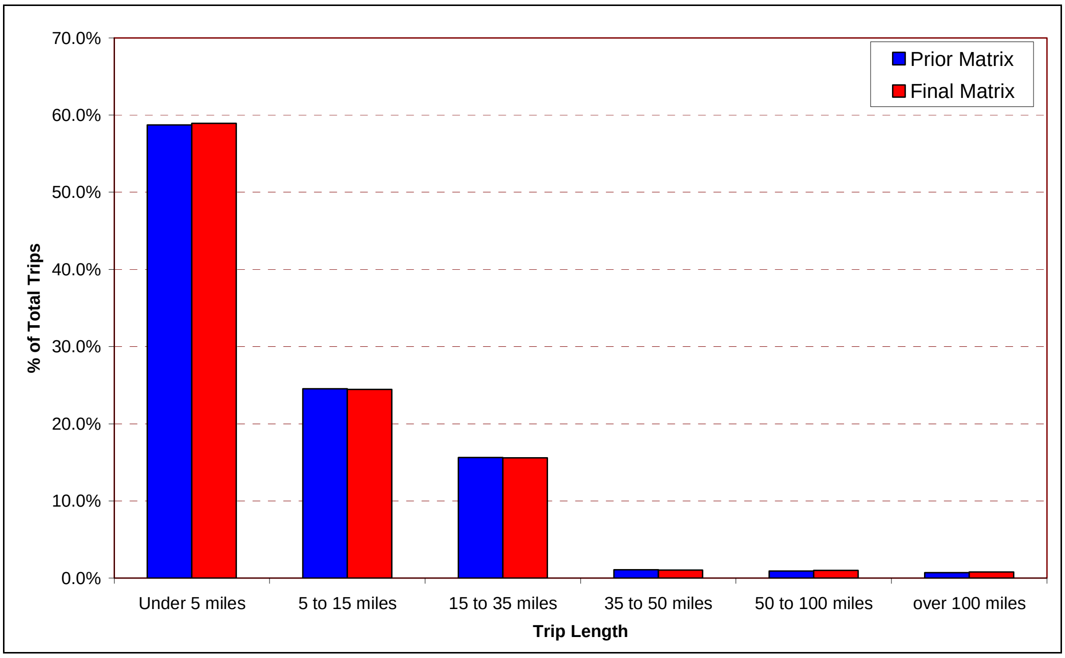
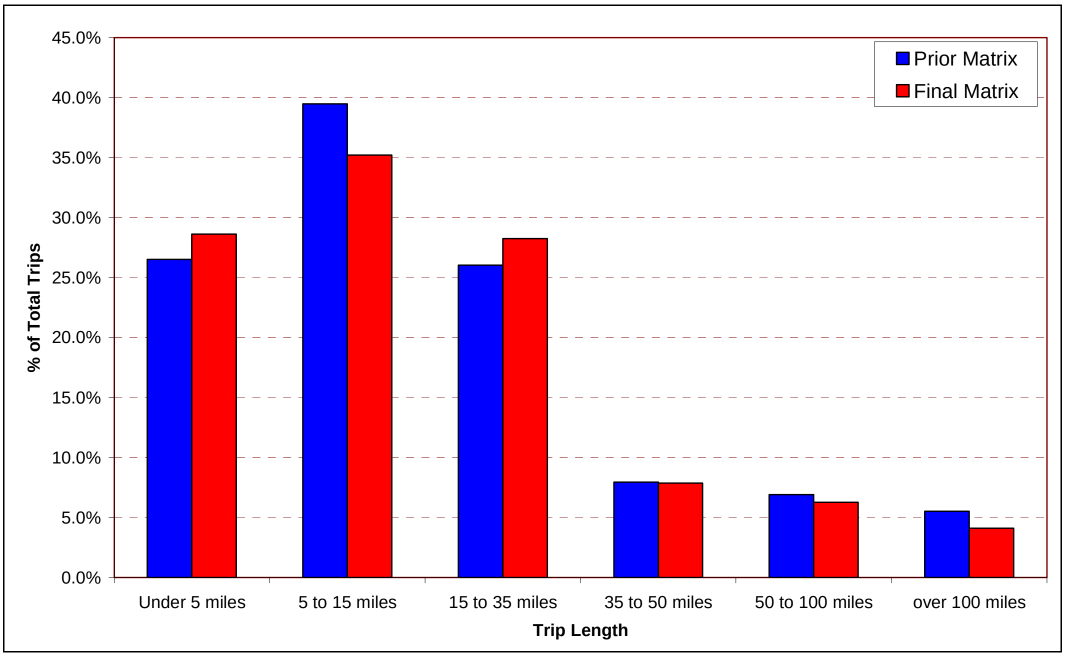


Figure 11.10 – IP Peak HGV Trip Length Distribution



11.5.4 Figure 11.11 and Figure 11.12 show the PM peak trip length distribution and both figures show a percentage increase in trips shorter than 5 miles. This is likely due to lack of short distance internal to internal trips in the RSI matrix with matrix estimation restoring the balance.

Figure 11.11 – PM Peak Car Trip Length Distribution

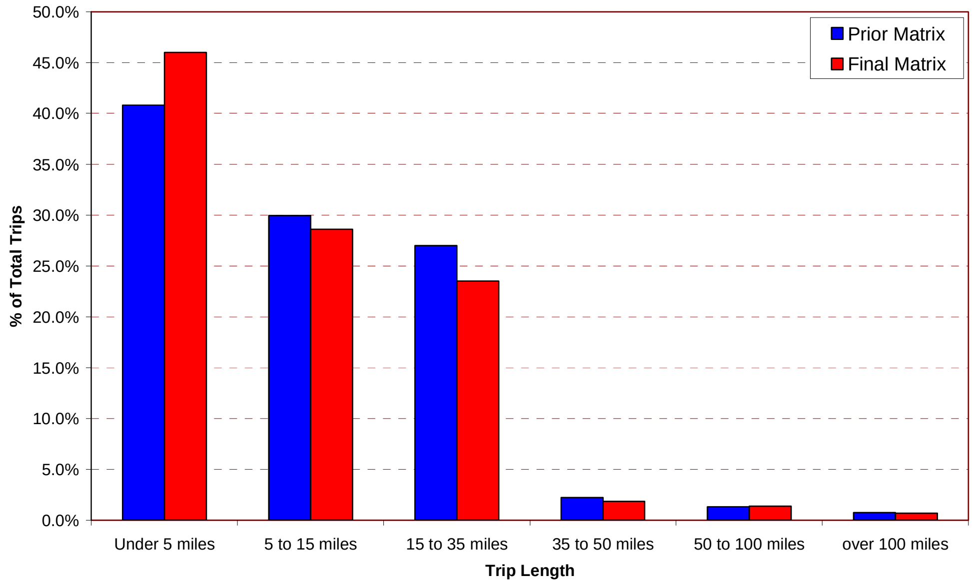
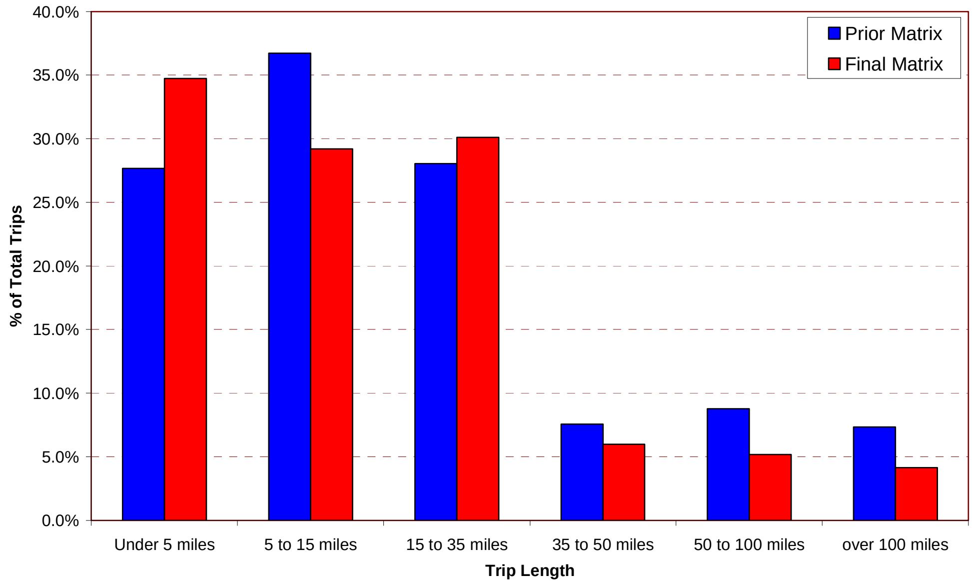


Figure 11.12 – PM Peak HGV Trip Length Distribution



11.5.5 Overall the trips length distribution graphs provide confidence that matrix estimation has not overly changed the percentage of trip lengths within the matrix.

11.6 HIGHWAY TRAFFIC FLOWS

11.6.1 It is an important measure of model performance that the model reproduces the observed volumes of traffic. The DMRB criteria for comparing the performance of the model traffic counts are reproduced in Chapter 7. Modelled flows are expected to be within a certain tolerance of the observed values and this goodness of fit is measured using the GEH statistic. Both the flow comparison and GEH criteria are assessed in this report. DMRB states that both conditions are expected to be satisfied for 85% of the cases. However, in the past the Highways Agency has suggested that meeting at least one of the criteria for 85% of the cases is sufficient. Figure 11.13 shows the location of calibration sites while Table 11.3 to Table 11.5 summarise the calibration results for the AM, IP and PM peaks respectively. Figure 11.14 shows the location of validation sites, while Table 11.6 to Table 11.8 summarise the validation results for the AM, IP and PM peaks respectively. Larger versions of Figure 11.13 and Figure 11.14 can be found in Appendix E. The validation sites represent approximately 20% of all count data available.

Figure 11.13 – Location of Calibration Sites

Table 11.3 – AM Calibration Summary

	Flow Criteria (PCU/hr) <700	700 to 2700	>2700	Total	GEH < 5	GEH < 5 or Flow Criteria Achieved	GEH < 5 and Flow Criteria Achieved
Car / LGV							
✓	94	71	29	194	202	206	195
✗	13	12	1	26	24	20	31
Total	107	83	30	220	226	226	226
% ✓	88%	86%	97%	**88%**	**89%**	**91%**	**86%**
HGV							
✓	47	0	0	47	205	226	205
✗	0	2	0	2	21	0	21
Total	47	2	0	49	226	226	226
% ✓	100%	0%	0%	**96%**	**91%**	**100%**	**91%**
All Vehicles							
✓	75	83	28	186	194	200	187
✗	15	14	5	34	32	26	39
Total	90	97	33	220	226	226	226
% ✓	83%	86%	85%	**85%**	**86%**	**88%**	**83%**

Table 11.4 – IP Calibration Summary

	Flow Criteria (PCU/hr) <700	700 to 2700	>2700	Total	GEH < 5	GEH < 5 or Flow Criteria Achieved	GEH < 5 and Flow Criteria Achieved
Car / LGV							
✓	165	48	6	219	218	221	216
✗	3	4	0	7	8	5	10
Total	168	52	6	226	226	226	226
% ✓	98%	92%	100%	**97%**	**96%**	**98%**	**96%**
HGV							
✓	193	16	0	209	175	209	175
✗	6	11	0	17	51	17	51
Total	199	27	0	226	226	226	226
% ✓	97%	59%	0%	**92%**	**77%**	**92%**	**77%**
All Vehicles							
✓	150	36	21	207	205	212	200
✗	6	7	6	19	21	14	26
Total	156	43	27	226	226	226	226
% ✓	96%	84%	78%	**92%**	**91%**	**94%**	**88%**

Table 11.5 – PM Calibration Summary

	Flow Criteria (PCU/hr) <700	700 to 2700	>2700	Total	GEH < 5	GEH < 5 or Flow Criteria Achieved	GEH < 5 and Flow Criteria Achieved
Car / LGV							
✓	92	77	29	198	203	207	194
✗	16	11	1	28	23	19	32
Total	108	88	30	226	226	226	226
% ✓	85%	88%	97%	**88%**	**90%**	**92%**	**86%**
HGV							
✓	198	15	0	213	194	215	192
✗	4	9	0	13	32	11	34
Total	202	24	0	226	226	226	226
% ✓	98%	63%	0%	**94%**	**86%**	**95%**	**85%**
All Vehicles							
✓	88	83	28	199	195	203	191
✗	12	13	2	27	31	23	35
Total	100	96	30	226	226	226	226
% ✓	88%	86%	93%	**88%**	**86%**	**90%**	**85%**

Figure 11.14 – Location of Validation Sites

11.6.2 Note that no motorway sites are included in the validation exercise. This is because the motorway flows are taken predominantly from the demand model and by their nature are not accurate enough to remain as validation sites. Other than those trips passing through RSI sites there is no detailed OD data pertaining to motorway trips, therefore entering these counts into the matrix estimation process is unavoidable.

Table 11.6 – AM Validation Summary

	Flow Criteria (PCU/hr) <700	700 to 2700	>2700	Total	GEH < 5	GEH < 5 or Flow Criteria Achieved	GEH < 5 and Flow Criteria Achieved
Car / LGV							
✓	36	10	0	46	48	48	46
×	12	0	0	12	10	10	12
Total	48	10	0	58	58	58	58
% ✓	75%	100%	0%	**79%**	**83%**	**83%**	**79%**
HGV							
✓	58	0	0	58	53	58	53
×	0	0	0	0	5	0	5
Total	58	0	0	58	58	58	58
% ✓	100%	0%	0%	**100%**	**91%**	**100%**	**91%**
All Vehicles							
✓	30	14	0	44	50	50	44
×	9	5	0	14	8	8	14
Total	39	19	0	58	58	58	58
% ✓	77%	74%	0%	**76%**	**86%**	**86%**	**76%**

Table 11.7 – IP Validation Summary

	Flow Criteria (PCU/hr) <700	700 to 2700	>2700	Total	GEH < 5	GEH < 5 or Flow Criteria Achieved	GEH < 5 and Flow Criteria Achieved
Car / LGV							
✓	46	0	0	46	44	48	42
×	10	2	0	12	14	10	16
Total	56	2	0	58	58	58	58
% ✓	82%	0%	0%	**79%**	**76%**	**83%**	**72%**
HGV							
✓	58	0	0	58	52	58	52
×	0	0	0	0	6	0	6
Total	58	0	0	58	58	58	58
% ✓	100%	0%	0%	**100%**	**90%**	**100%**	**90%**
All Vehicles							
✓	41	8	0	49	46	51	44
×	8	1	0	9	12	7	14
Total	49	9	0	58	58	58	58
% ✓	84%	89%	0%	**84%**	**79%**	**88%**	**76%**

Table 11.8 – PM Validation Summary

	Flow Criteria (PCU/hr) <700	700 to 2700	>2700	Total	GEH < 5	GEH < 5 or Flow Criteria Achieved	GEH < 5 and Flow Criteria Achieved
Car / LGV							
✓	36	8	0	44	44	45	43
×	8	6	0	14	14	13	15
Total	44	14	0	58	58	58	58
% ✓	82%	57%	0%	**76%**	**76%**	**78%**	**74%**
HGV							
✓	58	0	0	58	51	58	51
×	0	0	0	0	7	0	7
Total	58	0	0	58	58	58	58
% ✓	100%	0%	0%	**100%**	**88%**	**100%**	**88%**
All Vehicles							
✓	35	12	0	47	49	49	47
×	6	5	0	11	9	9	11
Total	41	17	0	58	58	58	58
% ✓	85%	71%	0%	**81%**	**84%**	**84%**	**81%**

11.6.3 A summary of the full counts for each peak period model can be found below in Table 11.9 to Table 11.11.

Table 11.9 – AM All Count Summary

	Flow Criteria (PCU/hr)						
	<700	700 to 2700	>2700	Total	GEH < 5	GEH < 5 or Flow Criteria Achieved	GEH < 5 and Flow Criteria Achieved
Car / LGV							
✓	148	104	29	281	250	254	241
✗	27	14	1	42	34	30	43
Total	175	118	30	323	284	284	284
% ✓	85%	88%	97%	**87%**	**88%**	**89%**	**85%**
HGV							
✓	292	22	0	314	258	278	258
✗	1	8	0	9	26	6	26
Total	293	30	0	323	284	284	284
% ✓	100%	73%	0%	**97%**	**91%**	**98%**	**91%**
All Vehicles							
✓	118	124	28	270	244	250	231
✗	25	23	5	53	40	34	53
Total	143	147	33	323	284	284	284
% ✓	83%	84%	85%	**84%**	**86%**	**88%**	**81%**

Table 11.10 – IP All Count Summary

	Flow Criteria (PCU/hr)						
	<700	700 to 2700	>2700	Total	GEH < 5	GEH < 5 or Flow Criteria Achieved	GEH < 5 and Flow Criteria Achieved
Car / LGV							
✓	211	48	6	265	262	269	258
✗	13	6	0	19	22	15	26
Total	224	54	6	284	284	284	284
% ✓	94%	89%	100%	**93%**	**92%**	**95%**	**91%**
HGV							
✓	251	16	0	267	227	267	227
✗	6	11	0	17	57	17	57
Total	257	27	0	284	284	284	284
% ✓	98%	59%	0%	**94%**	**80%**	**94%**	**80%**
All Vehicles							
✓	191	44	21	256	251	263	244
✗	14	8	6	28	33	21	40
Total	205	52	27	284	284	284	284
% ✓	93%	85%	78%	**90%**	**88%**	**93%**	**86%**

Table 11.11 – PM All Count Summary

	Flow Criteria (PCU/hr)						
	<700	700 to 2700	>2700	Total	GEH < 5	GEH < 5 or Flow Criteria Achieved	GEH < 5 and Flow Criteria Achieved
Car / LGV							
✓	128	85	29	242	247	252	237
✗	24	17	1	42	37	32	47
Total	152	102	30	284	284	284	284
% ✓	84%	83%	97%	**85%**	**87%**	**89%**	**83%**
HGV							
✓	256	15	0	271	245	273	243
✗	4	9	0	13	39	11	41
Total	260	24	0	284	284	284	284
% ✓	98%	63%	0%	**95%**	**86%**	**96%**	**86%**
All Vehicles							
✓	123	95	28	246	244	252	238
✗	18	18	2	38	40	32	46
Total	141	113	30	284	284	284	284
% ✓	87%	84%	93%	**87%**	**86%**	**89%**	**84%**

11.6.4 Figure 11.15 to Figure 11.17 show the counts in the AM, IP and PM time periods which have a total GEH of greater than 5. Those links that are orange have a GEH of under 10 and those with a GEH over 10 are shown in red.

Figure 11.15 – AM Peak Observed Model Counts GEH > 5

Figure 11.16 – IP Peak Observed Model Counts GEH > 5

Figure 11.17 – PM Peak Observed Model Counts GEH > 5

11.6.5 The diagrams show that that there are no concentrated areas within the model that are particularly weak with those links reporting a GEH of over 5 tending to be scattered across the study area.

11.6.6 Full data tables of the calibration and validation results can be found in Appendix F.

11.7 SCREENLINE AND CORDON RESULTS

11.7.1 Table 11.12 to Table 11.14 show the AM, IP and PM Screenline and Cordon results. Both the AM and IP results show a good fit between the modelled and observed flow for all screenlines and cordons apart from one, the North/South screenline in a westbound direction. The PM results are weaker with 4 screenlines not falling under a GEH of 4.

Table 11.12 – AM Screenline & Cordon Results

Screenlines/ Cordons	Calibration/ Validation	Direction	Count	Model	Diff	%	GEH	GEH <4	GEH <4 and % <5%
AM Peak									
North/South Screenline	Calibration	Westbound	4280	4800	520	12%	7.7	×	×
North/South Screenline	Calibration	Eastbound	4700	4590	-110	-2%	1.6	✓	✓
Outer Cordon	Calibration	Inbound	12480	12790	310	2%	2.8	✓	✓
Outer Cordon	Calibration	Outbound	12950	13400	450	3%	3.9	✓	✓
Inner Cordon	Calibration	Inbound	10590	10440	-150	-1%	1.5	✓	✓
Inner Cordon	Calibration	Outbound	6950	6900	-50	-1%	0.6	✓	✓
Validation Cordon	Validation	Inbound	8560	8780	220	3%	2.4	✓	✓
Validation Cordon	Validation	Outbound	7360	7410	50	1%	0.6	✓	✓
East/West Screenline	Validation	Northbound	2830	3080	250	9%	4.6	×	×
East/West Screenline	Validation	Southbound	2500	2390	-110	-4%	2.2	✓	✓

Table 11.13 – IP Screenline & Cordon Results

Screenlines/ Cordons	Calibration/ Validation	Direction	Count	Model	Diff	%	GEH	GEH <4	GEH <4 and % <5%
Inter Peak									
North/South Screenline	Calibration	Westbound	2920	3340	420	14%	7.5	×	×
North/South Screenline	Calibration	Eastbound	3160	3360	200	6%	3.5	✓	×
Outer Cordon	Calibration	Inbound	7490	7520	30	0%	0.3	✓	✓
Outer Cordon	Calibration	Outbound	7370	7410	40	1%	0.5	✓	✓
Inner Cordon	Calibration	Inbound	6750	6520	-230	-3%	2.8	✓	✓
Inner Cordon	Calibration	Outbound	6390	6230	-160	-3%	2.0	✓	✓
Validation Cordon	Validation	Inbound	5950	6160	210	4%	2.7	✓	✓
Validation Cordon	Validation	Outbound	6080	6050	-30	0%	0.4	✓	✓
East/West Screenline	Validation	Northbound	1740	1900	160	9%	3.8	✓	×
East/West Screenline	Validation	Southbound	2010	2010	0	0%	0.0	✓	✓

Table 11.14 – PM Screenline & Cordon Results

Screenlines/ Cordons	Calibration/ Validation	Direction	Count	Model	Diff	%	GEH	GEH <4	GEH <4 or % <10%
PM Peak									
North/South Screenline	Calibration	Westbound	4780	4630	-150	-3%	2.2	✓	✓
North/South Screenline	Calibration	Eastbound	5040	5190	150	3%	2.1	✓	✓
Outer Cordon	Calibration	Inbound	12200	13240	1040	9%	9.2	×	×
Outer Cordon	Calibration	Outbound	12400	12840	440	4%	3.9	✓	✓
Inner Cordon	Calibration	Inbound	8550	8170	-380	-4%	4.2	×	✓
Inner Cordon	Calibration	Outbound	9610	9190	-420	-4%	4.3	×	✓
Validation Cordon	Validation	Inbound	7680	8170	490	6%	5.5	×	×
Validation Cordon	Validation	Outbound	8080	8470	390	5%	4.3	✓	✓
East/West Screenline	Validation	Northbound	1990	2040	50	3%	1.1	✓	✓
East/West Screenline	Validation	Southbound	3030	2910	-120	-4%	2.2	✓	✓

11.8 MOTORWAY TRAFFIC FLOWS

11.8.1 The motorway network surrounds Warrington and therefore has an important role within the area's transport network. This section of the LMVR focuses on the calibration of the motorway traffic flows. Table 11.15 to Table 11.17 show the overall traffic flows from the count sites on the 3 motorways around Warrington. The tables show that together most of the motorway flows across the time periods have a GEH below 5. It can be considered that the GEH statistic is not appropriate for flows of high volumes therefore if the difference between the observed and modelled flow is less than 10% it is considered a good fit. With this taken into consideration the total modelled flows on all three motorways in all time periods is under 10% compared to the counts.

Table 11.15 – AM Motorway Results

Motorways		Count	Model	Diff	%	GEH	GEH <5	GEH <5 or % <10%
AM Peak								
Motorway	M6	61580	63030	1450	2%	5.8	✗	✓
Motorway	M56	30590	31270	680	2%	3.9	✓	✓
Motorway	M62	54450	54490	40	0%	0.2	✓	✓

Table 11.16 – IP Motorway Results

Motorways		Count	Model	Diff	%	GEH	GEH <5	GEH <5 or % <10%
Inter Peak								
Motorway	M6	48160	46000	-2160	-4%	10.0	✗	✓
Motorway	M56	14010	13470	-540	-4%	4.6	✓	✓
Motorway	M62	40890	38920	-1970	-5%	9.9	✗	✓

Table 11.17 – PM Motorway Results

Motorways		Count	Model	Diff	%	GEH	GEH <5	GEH <5 or % <10%
AM Peak								
Motorway	M6	61900	62810	910	1%	3.6	✓	✓
Motorway	M56	22840	22090	-750	-3%	5.0	✗	✓
Motorway	M62	54220	54550	330	1%	1.4	✓	✓

11.8.2 Figure 11.18 to Figure 11.20 compare the observed model turning movements with the ANPR data collected. These figures are very similar to the turning movements presented in chapter 8 of this report, this is to be expected as the majority of the motorways flows come from the demand model as they are not captured in the RSI surveys.

Figure 11.18 – AM Peak Observed Model Turning Flows

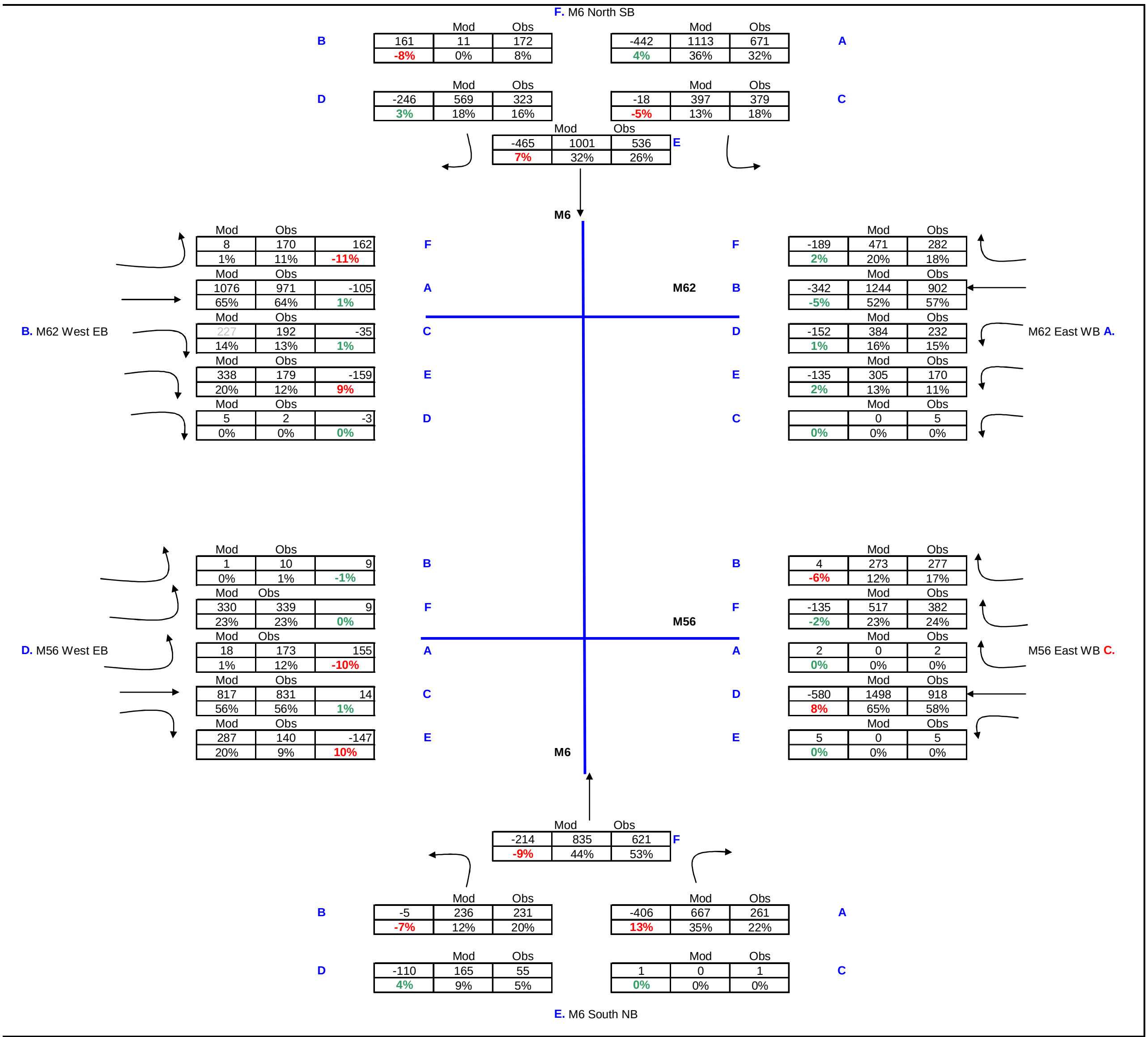


Figure 11.19 – IP Peak Observed Model Turning Flows

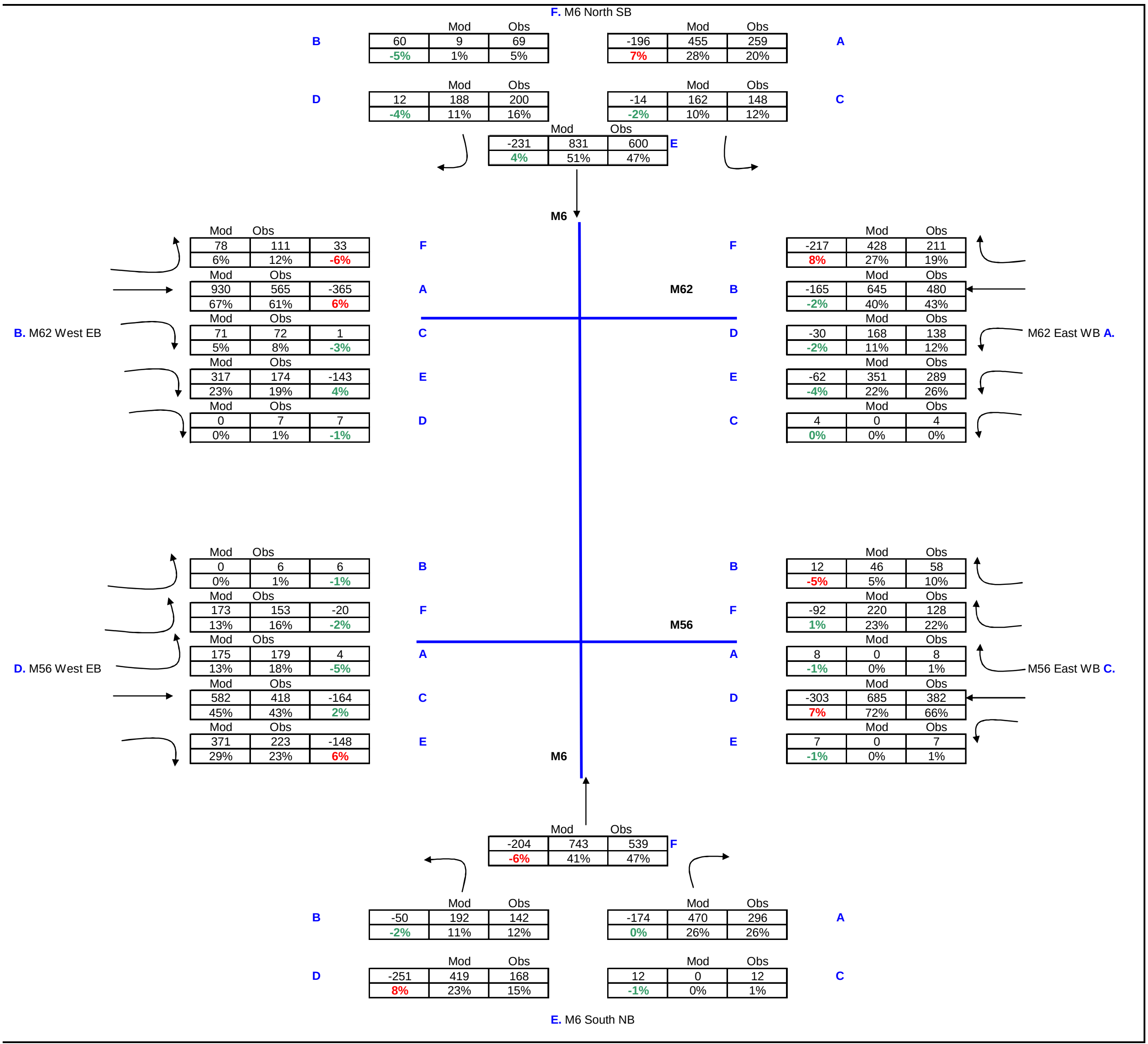
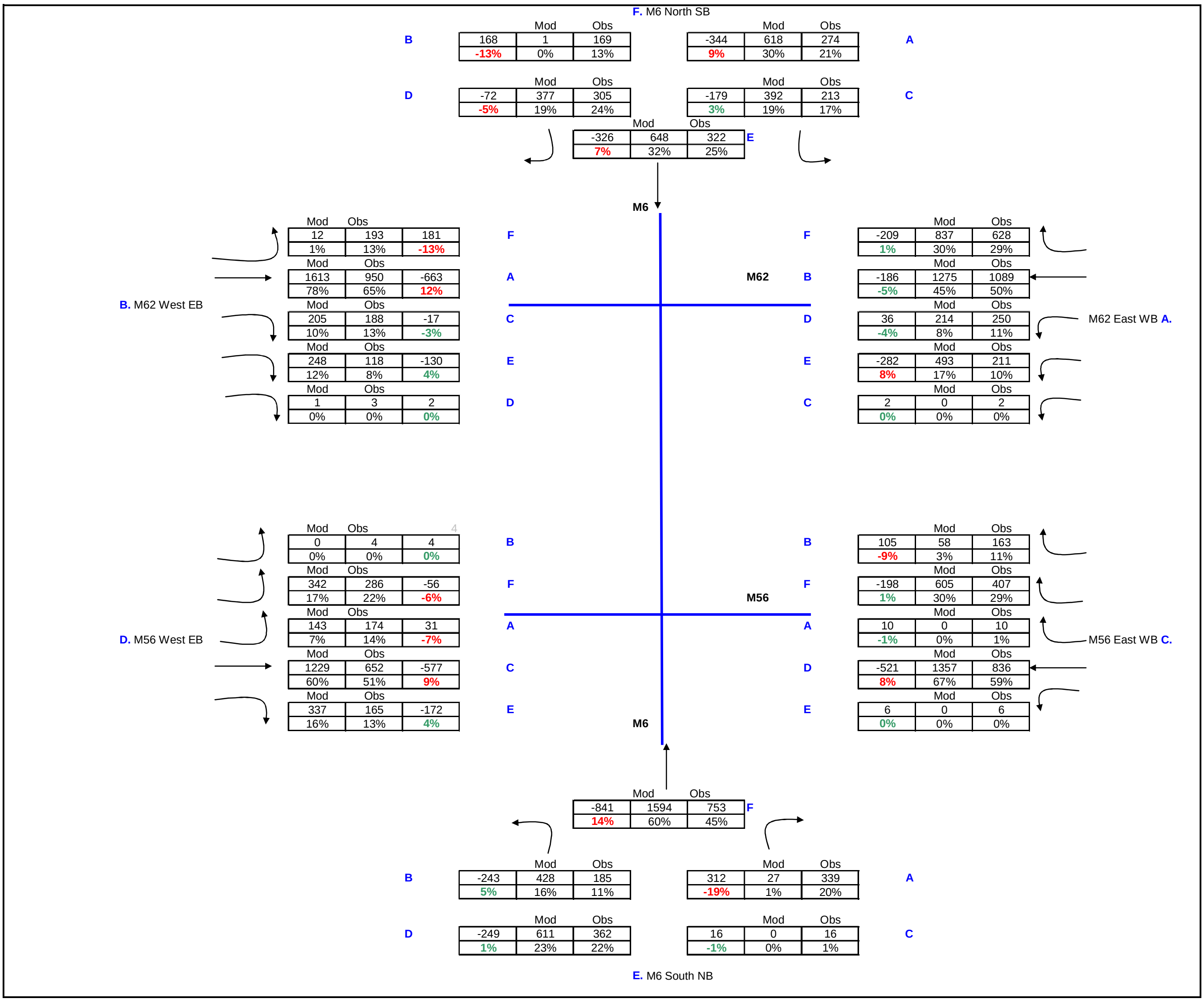


Figure 11.20 – PM Peak Observed Model Turning Flows



11.8.3 Figure 11.21 to Figure 11.23 show the total GEH for the motorway counts. Those links which have a GEH below 5 are represented in green, those with a GEH between 5-10 are orange and those over GEH of 10 are red.

Figure 11.21 – AM Peak Observed Model Motorway GEH

Figure 11.22 – IP Peak Observed Model Motorway GEH

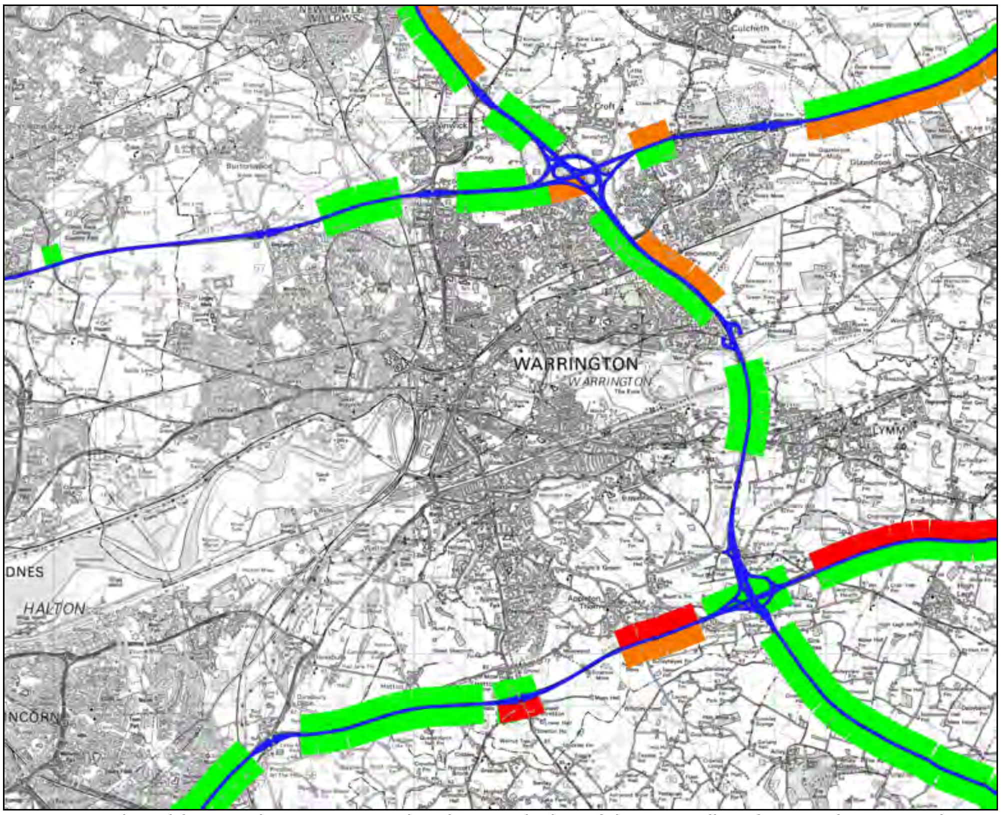
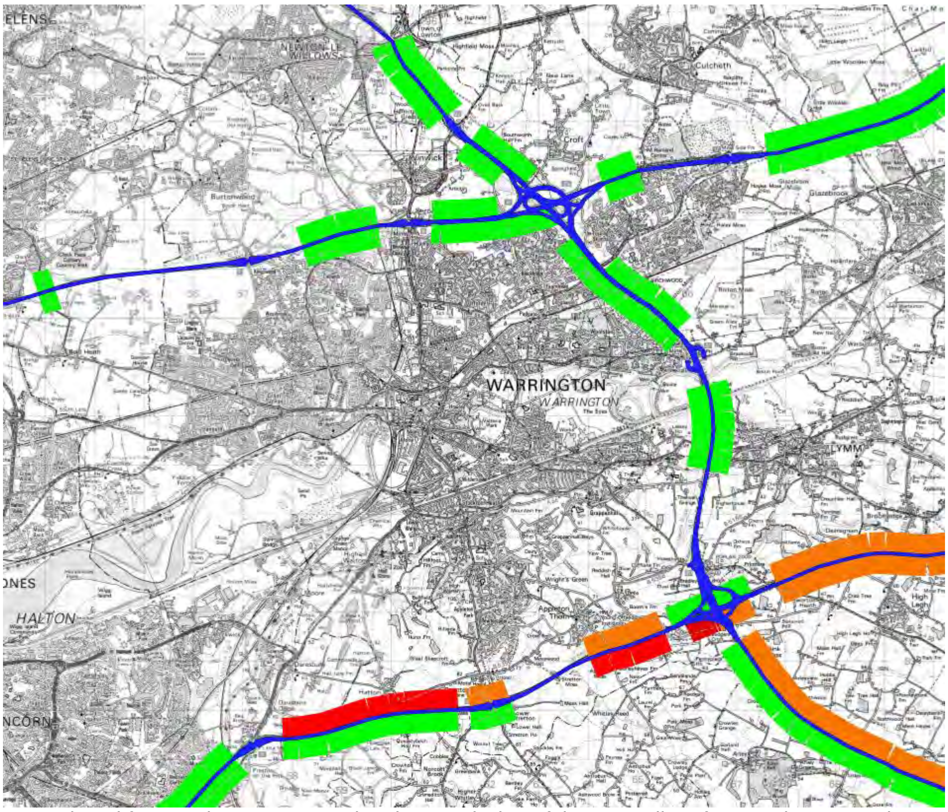


Figure 11.23 – PM Peak Observed Model Motorway GEH



11.8.4 The figures showing the motorway GEH values show that the majority of motorway flows have a GEH below 5 and where the GEH is over 5 these are generally located on M56. Analysis of the M56 data in particular has shown large inconsistencies between neighbouring sites that makes the calibration process difficult to converge on the correct flows. In this respect further work in this area was not deemed beneficial to the model.

11.9 JOURNEY ROUTES TIMES

11.9.1 Modelled journey times can also be examined by comparing modelled journey times against the observed journey times. In total there are 26 routes through the town centre as well as on the four strategic routes on the motorways surrounding the town. The journey time routes are mostly taken from WBC's regular monitoring programme for the LTP backed up with a few from ANPR cameras.

11.9.2 Achieving DMRB levels of validation on these journey time routes ensures that on the motorway the speed-flow curves are controlling speeds accurately, so that with the correct volume of traffic, we obtain the right level of delays along these roads. Within Warrington town centre, the correct modelled journey times ensures that the signal timings and delays at give-way junctions such as roundabouts are reflected by the correct volume of traffic to produce the right level of delays.

11.9.3 Table 11.18 to Table 11.20 show the town centre route journey times in the AM, IP and PM observed model respectively. Full graphical results of these journey times can be found in Appendix G. The graphical results also include the maximum and minimum journey times observed which provide an indication of the extreme ranges in journey times that can occur along some routes. These extremes, in places, can help justify those journey time routes that fall just outside of the DMRB criteria.

Table 11.18 – Observed Model Town Centre Journey Times AM Model

Route	Total Journey Time		Range		Modelled / Observed %age	Within 15%?
	Modelled	Average Observed				
Route 1	10:42	11:43	09:58	13:28	-9%	✓
Route 2	11:16	10:22	08:49	11:55	9%	✓
Route 3	08:58	13:26	11:25	15:27	-33%	×
Route 4	12:06	13:43	11:40	15:46	-12%	✓
Route 5	11:12	14:33	12:22	16:44	-23%	×
Route 6	13:43	13:17	11:17	15:17	3%	✓
Route 7	05:05	06:55	05:53	07:57	-27%	×
Route 8	04:46	05:12	04:25	05:59	-8%	✓
Route 9	13:10	13:28	11:27	15:29	-2%	✓
Route 10	12:39	12:06	10:17	13:55	5%	✓
Route 11	10:15	12:01	10:13	13:49	-15%	✓
Route 12	10:39	10:59	09:20	12:38	-3%	✓
Route 13	11:38	11:13	09:32	12:54	4%	✓
Route 14	13:03	11:31	09:47	13:15	13%	✓
Route 15	08:35	08:33	07:16	09:50	0%	✓
Route 16	09:35	08:45	07:26	10:04	10%	✓
Route 17	15:21	17:20	14:44	19:56	-11%	✓
Route 18	18:47	20:32	17:27	23:37	-9%	✓
Route 19	16:06	15:13	12:56	17:30	6%	✓
Route 20	14:42	15:37	13:16	17:58	-6%	✓
Route 21	08:32	10:07	08:36	11:38	-16%	×
Route 22	08:52	08:35	07:18	09:52	3%	✓
Route 23	07:10	10:48	09:11	12:25	-34%	×
Route 24	08:17	07:08	06:04	08:12	16%	×
Route 25	09:43	11:33	09:49	13:17	-16%	×
Route 26	06:50	06:44	05:43	07:45	1%	✓
Percentage of Routes Within 15% of Mean Observed Journey Times:						**73%**

Table 11.19 - Observed Model Town Centre Journey Times IP Model

Route	Total Journey Time		Range		Modelled / Observed %age	Within 15%?
	Modelled	Average Observed				
Route 1	09:53	10:32	08:57	12:07	-6%	✓
Route 2	10:59	10:04	08:33	11:35	9%	✓
Route 3	08:42	13:40	11:37	15:43	-36%	✗
Route 4	11:42	12:44	10:49	14:39	-8%	✓
Route 5	10:27	13:10	11:11	15:08	-21%	✗
Route 6	12:20	12:08	10:19	13:57	2%	✓
Route 7	04:48	04:20	03:41	04:59	11%	✓
Route 8	04:36	05:04	04:18	05:50	-9%	✓
Route 9	11:06	10:56	09:18	12:34	2%	✓
Route 10	11:20	09:43	08:16	11:10	17%	✗
Route 11	09:40	09:29	08:04	10:54	2%	✓
Route 12	09:37	09:22	07:58	10:46	3%	✓
Route 13	10:29	10:05	08:34	11:36	4%	✓
Route 14	12:02	10:14	08:42	11:46	18%	✗
Route 15	07:34	07:33	06:25	08:41	0%	✓
Route 16	08:53	07:23	06:17	08:29	20%	✗
Route 17	13:32	15:33	13:13	17:53	-13%	✓
Route 18	15:56	16:16	13:50	18:42	-2%	✓
Route 19	15:25	15:55	13:32	18:18	-3%	✓
Route 20	14:22	15:36	13:16	17:56	-8%	✓
Route 21	07:46	08:25	07:09	09:41	-8%	✓
Route 22	07:56	07:14	06:09	08:19	10%	✓
Route 23	06:04	06:28	05:30	07:26	-6%	✓
Route 24	06:04	06:40	05:40	07:40	-9%	✓
Route 25	07:59	06:53	05:51	07:55	16%	✗
Route 26	05:57	06:05	05:10	07:00	-2%	✓
					-1%	✓
Percentage of Routes Within 15% of Mean Observed Journey Times:						77%

Table 11.20 – Observed Model Town Centre Journey Times PM Model

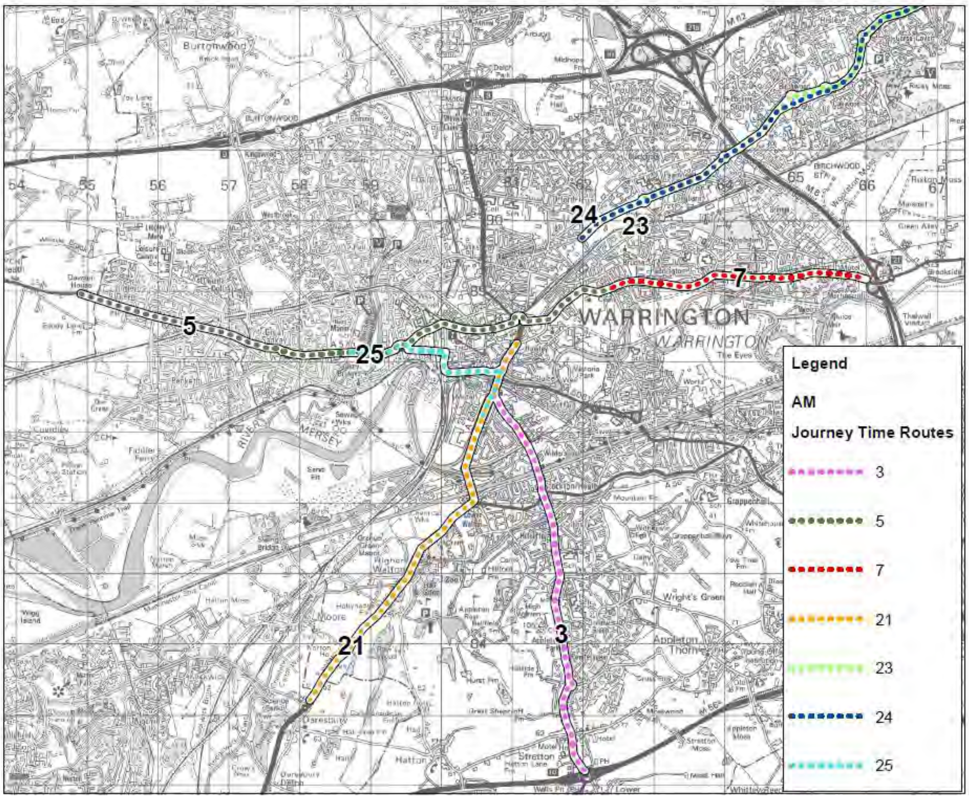
Route	Total Journey Time		Range		Modelled / Observed %age	Within 15%?
	Modelled	Average Observed				
Route 1	09:55	10:55	09:17	12:33	-9%	✓
Route 2	12:25	12:32	10:39	14:25	-1%	✓
Route 3	12:06	14:06	11:59	16:13	-14%	✓
Route 4	13:58	13:56	11:51	16:01	0%	✓
Route 5	11:32	14:49	12:36	17:02	-22%	×
Route 6	14:27	14:21	12:12	16:30	1%	✓
Route 7	04:59	04:28	03:48	05:08	12%	✓
Route 8	05:07	04:56	04:12	05:40	4%	✓
Route 9	13:01	18:44	15:55	21:33	-31%	×
Route 10	15:43	14:29	12:19	16:39	9%	✓
Route 11	10:03	09:55	08:26	11:24	1%	✓
Route 12	10:51	11:52	10:05	13:39	-9%	✓
Route 13	11:20	11:32	09:48	13:16	-2%	✓
Route 14	15:02	11:18	09:36	13:00	33%	×
Route 15	08:40	08:16	07:02	09:30	5%	✓
Route 16	09:52	08:12	06:58	09:26	20%	×
Route 17	15:10	17:18	14:42	19:54	-12%	✓
Route 18	18:26	19:16	16:23	22:09	-4%	✓
Route 19	16:40	17:28	14:51	20:05	-5%	✓
Route 20	15:57	17:24	14:47	20:01	-8%	✓
Route 21	11:05	09:58	08:28	11:28	11%	✓
Route 22	09:32	09:19	07:55	10:43	2%	✓
Route 23	07:47	08:05	06:52	09:18	-4%	✓
Route 24	06:53	08:08	06:55	09:21	-15%	✓
Route 25	13:06	11:44	09:58	13:30	12%	✓
Route 26	09:06	10:39	09:03	12:15	-15%	✓
Percentage of Routes Within 15% of Mean Observed Journey Times:						85%

11.9.4 Those journey time routes that fall outside of 15% of the mean observed journey time in the AM peak are:

- Route 3, 5, 7, 21, 23, 24 and 25

11.9.5 It should be noted that 3 of these routes are within 16% of the observed mean journey time. The location of these routes is shown in Figure 11..

Figure 11.24 – AM Peak Journey Time Outside of DMRB Criteria

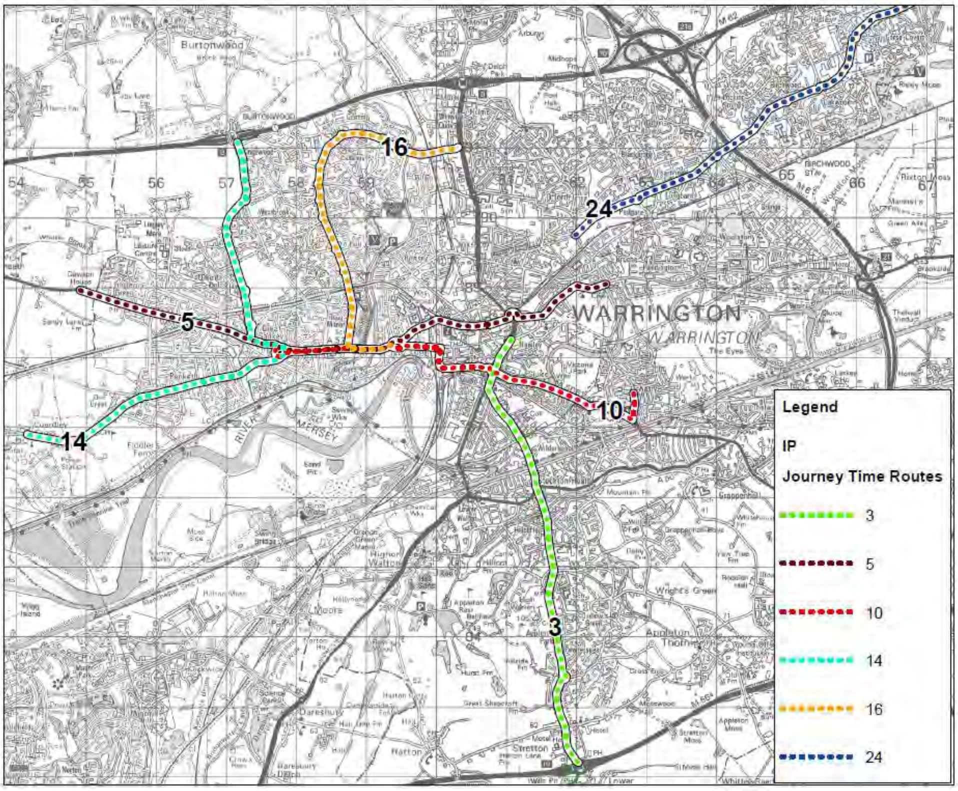


11.9.6 Those journey time routes that fall outside of 15% of the mean observed journey time in the Inter Peak are:

- Route 3, 5, 10, 14, 16 and 24

11.9.7 The location of these routes is shown in Figure 11.25

Figure 11.25 – Inter Peak Journey Time Outside of DMRB criteria

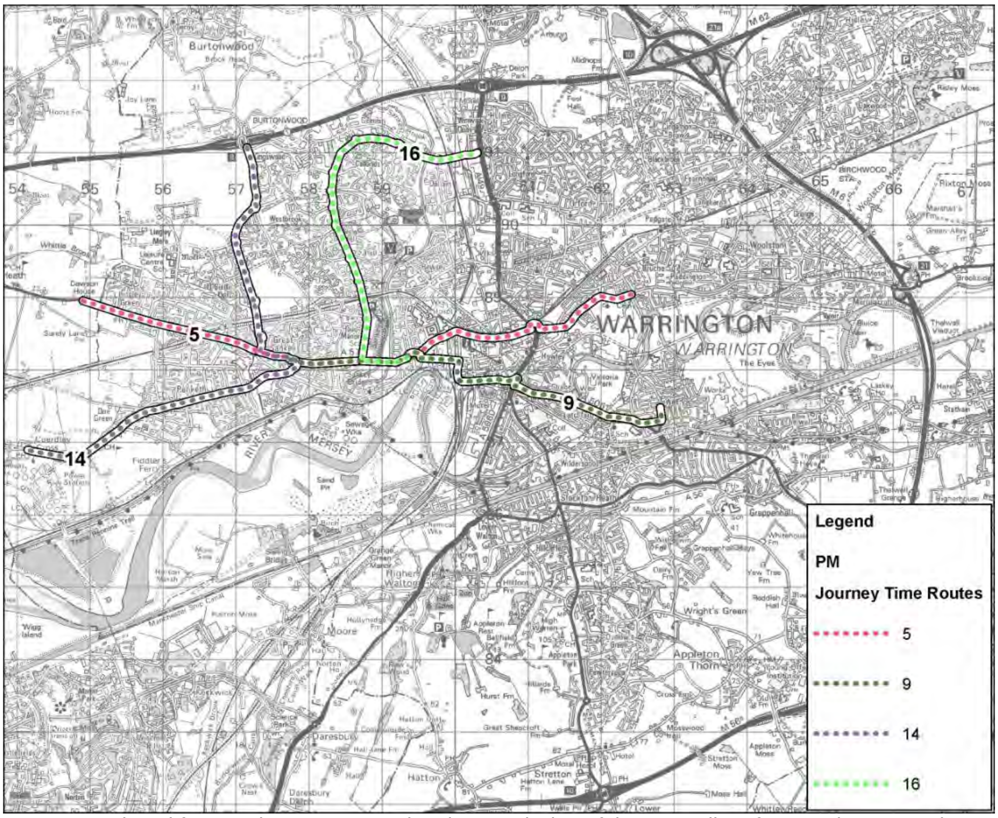


11.9.8 Those journey time routes that fall outside of 15% of the mean observed journey time in the PM peak are:

- Route 5, 9, 14 and 16

11.9.9 The location of these routes is shown in Figure 11.26.

Figure 11.26 – PM Peak Journey Time Outside of DMRB criteria



11.9.10 Table 11.21 to Table 11.23 show the strategic route journey times in the AM, IP and PM observed model respectively.

Table 11.21 – Observed Model Strategic Journey Times AM Model

Route		Total Journey Time		Range		Modelled / Observed %age	Within 15%?
		Modelled	Average Observed				
M62	C	14:04	15:43	13:21	18:04	-10%	✓
	AC	12:53	12:40	10:46	14:34	2%	✓
M6	NB	06:32	06:04	05:09	06:59	8%	✓
	SB	07:45	06:48	05:47	07:50	14%	✓
M56	EB	09:53	08:38	07:20	09:55	15%	✓
	WB	08:35	08:48	07:28	10:07	-2%	✓
Runcorn	NB	16:58	19:09	16:17	22:02	-11%	✓
	SB	12:10	11:45	09:59	13:30	4%	✓

Table 11.22 - Observed Model Strategic Journey Times IP Model

Route		Total Journey Time		Range		Modelled / Observed %age	Within 15%?
		Modelled	Average Observed				
Blue Route	C	12:54	11:41	09:56	13:27	10%	✓
	AC	11:39	11:33	09:49	13:17	1%	✓
Red Route	NB	05:37	05:31	04:41	06:20	2%	✓
	SB	06:45	06:02	05:08	06:56	12%	✓
Green Route	EB	08:15	08:22	07:06	09:37	-1%	✓
	WB	08:03	08:26	07:10	09:42	-5%	✓
Yellow Route	NB	16:31	14:52	12:38	17:06	11%	✓
	SB	11:39	09:54	08:25	11:23	18%	×

Table 11.23 - Observed Model Strategic Journey Times PM Model

Route		Total Journey Time		Range		Modelled / Observed %age	Within 15%?
		Modelled	Average Observed				
Blue Route	C	13:47	14:19	12:11	16:28	-4%	✓
	AC	13:21	12:47	10:52	14:43	4%	✓
Red Route	NB	06:33	06:41	05:41	07:41	-2%	✓
	SB	07:34	05:55	05:02	06:48	28%	×
Green Route	EB	09:11	08:44	07:26	10:03	5%	✓
	WB	08:39	09:13	07:50	10:36	-6%	✓
Yellow Route	NB	16:58	15:56	13:33	18:20	6%	✓
	SB	12:55	13:57	11:52	16:03	-7%	✓

11.9.11 In total the results for each peak period can be seen below in Table 11.24.

Table 11.24 – Observed Model Journey Times

	City Centre Journey Times (26)	Strategic Journey Times (8)	Total	
AM	19	8	27	79%
IP	20	7	27	79%
PM	22	7	29	85%

11.9.12 Full graphical results of these journey times can be found in Appendix H.

12 Public Transport Model Calibration and Validation Results

12.1 INTRODUCTION

12.1.1 The main local bus services and all rail services travelling through Warrington as well as strategic rail journeys were included within the WMMTM. The bus demand matrices were developed by expanding the on board interviews by the number of boarders observed on each route and by the number of services in the peak hour. The rail demand matrices were developed by expanding the station interviews by the number of passengers observed at each station. No infill from the demand model was used for public transport. This agreed approach was adopted for all bus routes and rail stations in all time periods and is detailed in Chapter 5. This section presents the assignment process of the bus and rail demand, and the validation and calibration results.

12.1.2 It is important to note that no matrix estimation has been used on the public transport matrices.

12.2 BUS MODEL ASSIGNMENT

12.2.1 The bus demand matrices in VISUM were assigned to the PT network using a perceived journey time cost function between a given OD pair. The bus demand was assigned to the least cost route rather than loaded onto a fixed route, which realistically described the decision behaviour of passengers who usually have some prior knowledge of the public transport options available to them.

12.2.2 The perceived journey time cost included:

- Walk time to and from bus stops
- Wait time
- In Vehicle Time (IVT)
- Stop / dwell time
- Interchange time

12.2.3 Any change in fares between the base year and the forecast years will be calculated within the demand model not input manually into the observed model. Fares were therefore not required within the observed model as the observed passenger numbers in the base year will be aligned to the base year demand model allowing future changes to be taken into account.

12.2.4 Bus users accessed / egressed the public transport network from origin / destination zones by walking to / from bus stops. The average waiting time for buses was calculated from the bus service headway inputted into the model. The bus run times were taken from the post highway assignment link speeds and turning delays from the Highway Model. All bus services were assumed to stop at each served bus stop along the route for 20 seconds. When interchanging between bus services, passengers were modelled to walk between bus stops and a fixed time penalty of 10 minutes was added to the perceived journey time cost for each interchange.

12.2.5 Walk time, wait time, IVT, stop / dwell time and interchange time calculations where appropriate were integrated in the VISUM software and did not need to be calculated independently of the model.

12.3 WEBTAG CRITERIA

12.3.1 WebTAG Unit 3.11.2 provides guidance on the Validation of Public Transport Passenger Assignment Models. It states that the Validation of a public transport passenger assignment model should involve three kinds of check:

- Validation of the trip matrix
- Network and service validation
- Assignment validation

12.4 VALIDATION OF TRIP MATRIX

12.4.1 WebTAG states that matrix level validation should involve comparisons of assigned and counted passengers across complete screenlines and cordons. This is presented later in this section of the report.

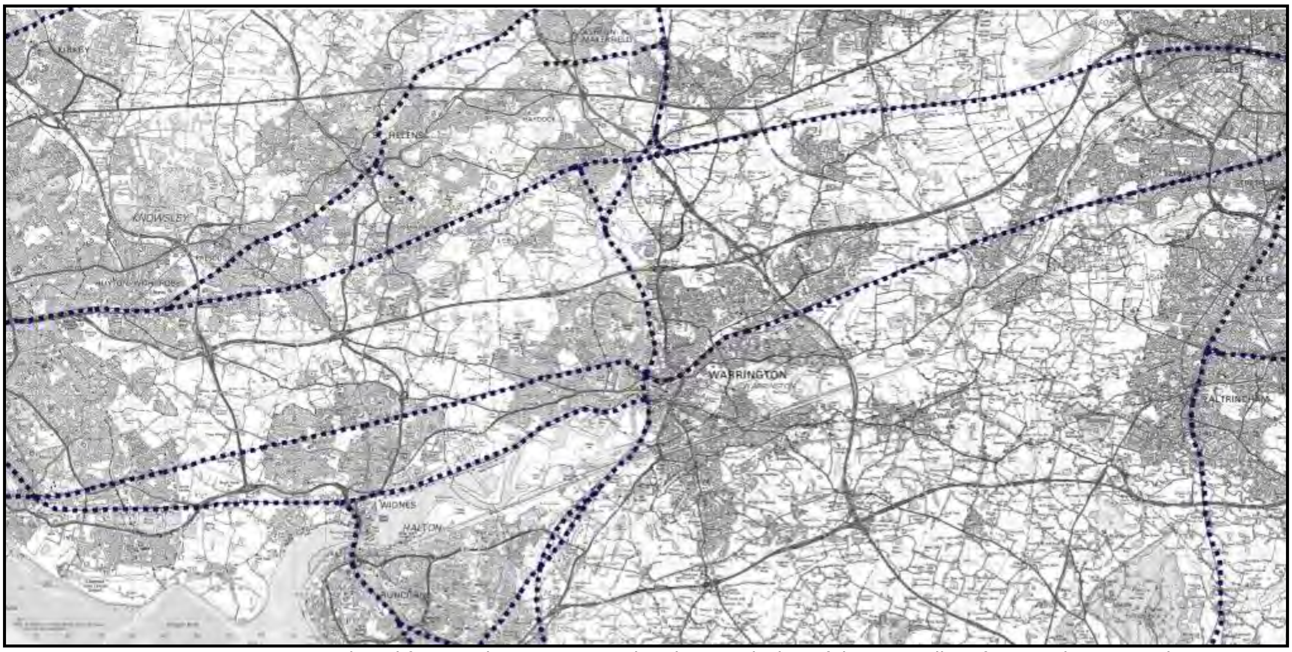
12.5 NETWORK AND SERVICE VALIDATION

12.5.1 WebTAG states that the validation of the network should involve checks on the accuracy of the coded geometry. This can be achieved by overlaying the coded network on a map base.

12.5.2 The WMMTM was built within VISUM which sits on a GIS platform and GIS was used to create railway lines and roads that carry the public transport services (NAVTEQ). On top of this actual public transport routes and interchanges were coded into the network along with timetable information.

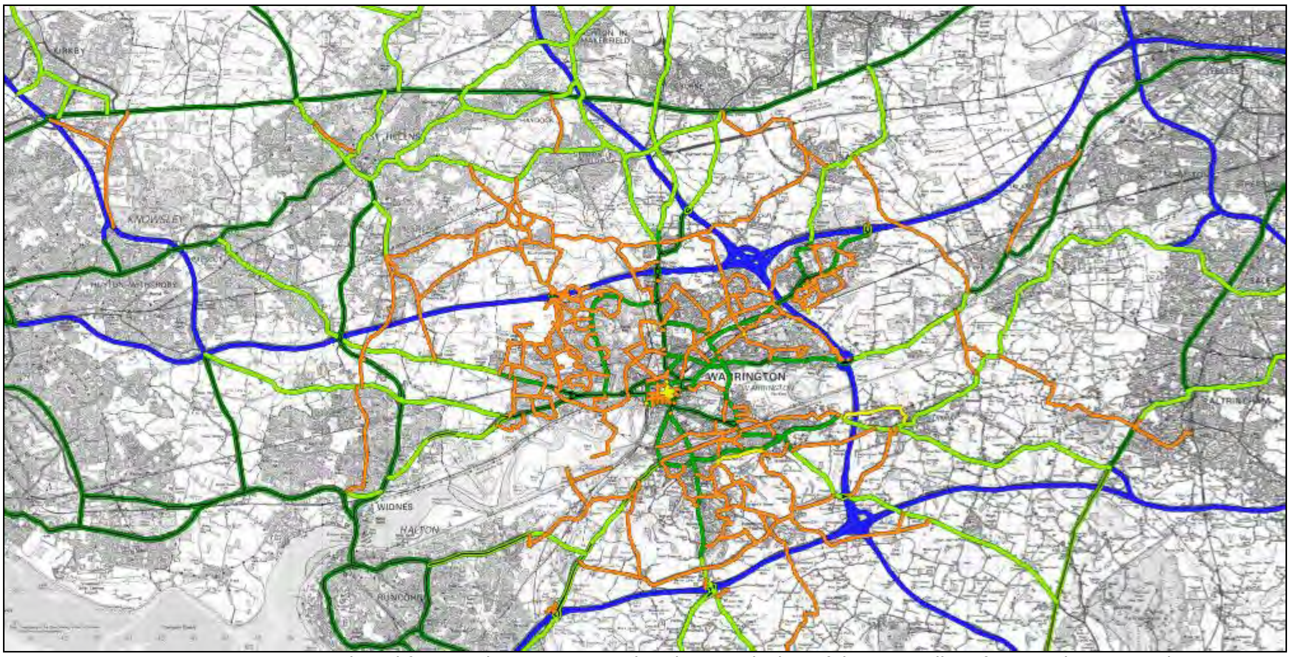
12.5.3 Figure 12.1 shows a screenshot of the Rail network within the WMMTM underplayed with an OS background. It shows that the rail network is accurately coded in terms of the geometry; in addition to this the rail services coded into the model are shown in Appendix I.

Figure 12.1 – Rail Links in WMMTM



12.5.4 Figure 12.2 shows the highway links along which the bus services were coded. All bus routes included in the model are shown in Appendix J.

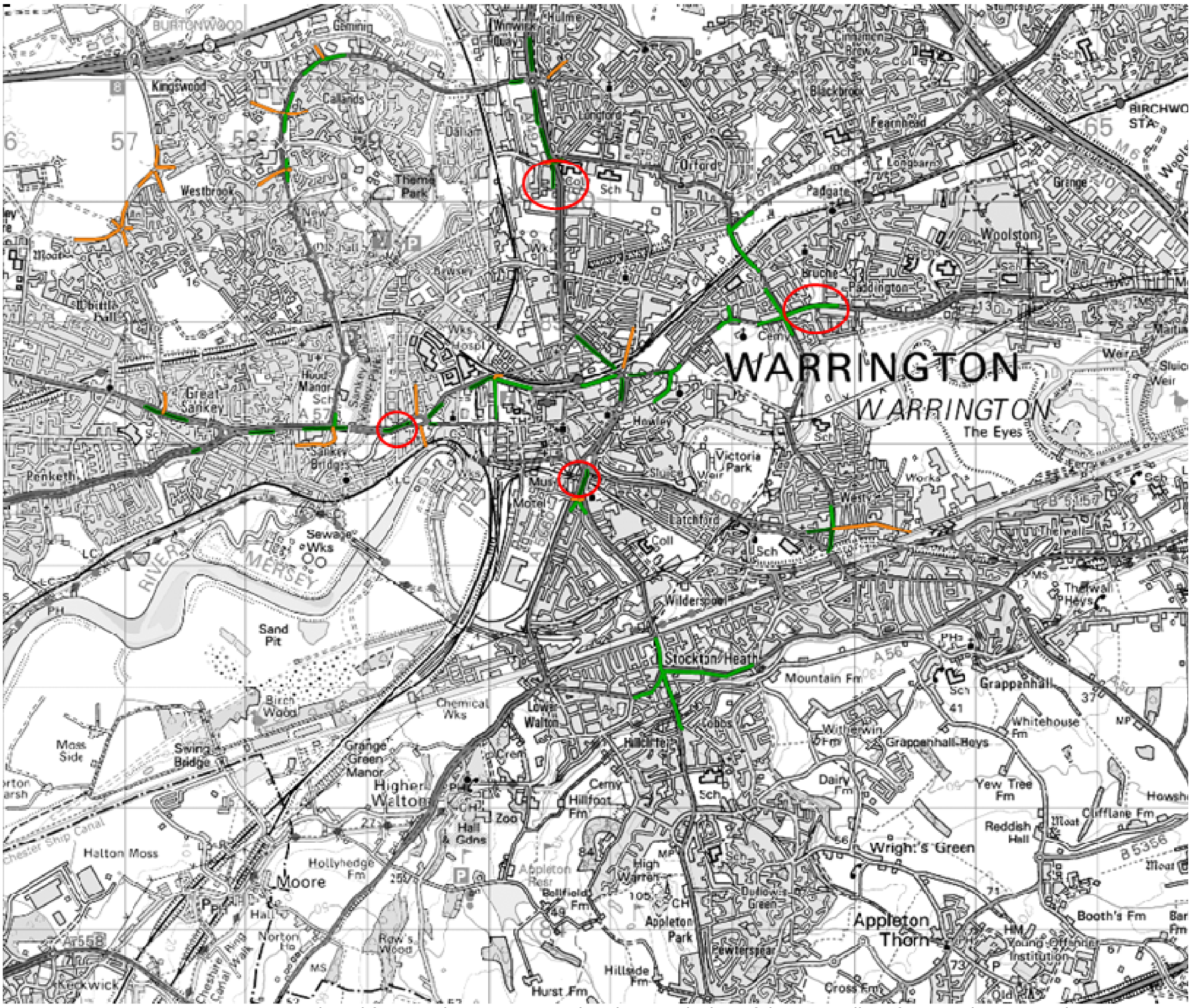
Figure 12.2 –WMMTM Highway Links



12.5.5 WebTAG states that the validation of services should involve comparing the modelled flows of public transport vehicles with roadside counts. No criteria is set by WebTAG as to the level of accuracy between the observed and modelled counts, therefore just the actual difference is calculated and presented.

12.5.6 The number of PSVs along the locations chosen for comparison was taken from MCC data and compared against the number of buses travelling along the routes in the AM, IP and PM peak hour models. These comparisons were made at four locations on key radial routes around the town centre show in Figure 12.3.

Figure 12.3 – PSV Comparison Locations



12.5.7 Table 12.1 shows the comparisons for each peak hour at the four locations above.

Table 12.1 – Summary of Observed PSVs and Modelled Bus Services

Peak Period	Location	MCC Site	Direction	Count Ref	PSV Count	Bus Services Included in Model	Actual Difference
AM Peak	Sankey Way	2	Inbound	143	26	16	-10
			Outbound	148	19	18	-1
	Wilderspool Causeway	11	Inbound	213	25	3	-22
			Outbound	218	24	6	-18
	Winwick Road	7	Inbound	187	22	9	-13
			Outbound	183	13	10	-3
	Manchester Road	4	Inbound	160	15	7	-8
			Outbound	164	9	5	-4
Inter-Peak	Sankey Way	2	Inbound	143	15	17	2
			Outbound	148	19	17	-2
	Wilderspool Causeway	11	Inbound	216	18	5	-13
			Outbound	211	11	4	-7
	Winwick Road	7	Inbound	187	8	8	0
			Outbound	183	6	8	2
	Manchester Road	4	Inbound	160	6	5	-1
			Outbound	164	5	5	0
PM Peak	Sankey Way	2	Inbound	143	19	15	-4
			Outbound	148	20	16	-4
	Wilderspool Causeway	11	Inbound	216	20	4	-16
			Outbound	211	22	4	-18
	Winwick Road	7	Inbound	187	7	7	0
			Outbound	183	8	7	-1
	Manchester Road	4	Inbound	160	4	5	1
			Outbound	164	7	4	-3

12.5.8 At the majority of locations the model has a lower number of buses than those counted at the MCCs. In particular there is a significant difference between the bus services and PSV counts on Wilderspool Causeway. This is because the bus depot is close to this road and buses at the start and end of their shifts would have been captured in the count. Another reason for the difference can be explained as coaches and other bus vehicles captured in the MCCs that are in addition to the timetabled bus services and that these would have been recorded as PSVs in the MCC surveys.

12.6 ASSIGNMENT VALIDATION

12.6.1 WebTAG states that the validation of the assignment should involve comparing modelled and observed:

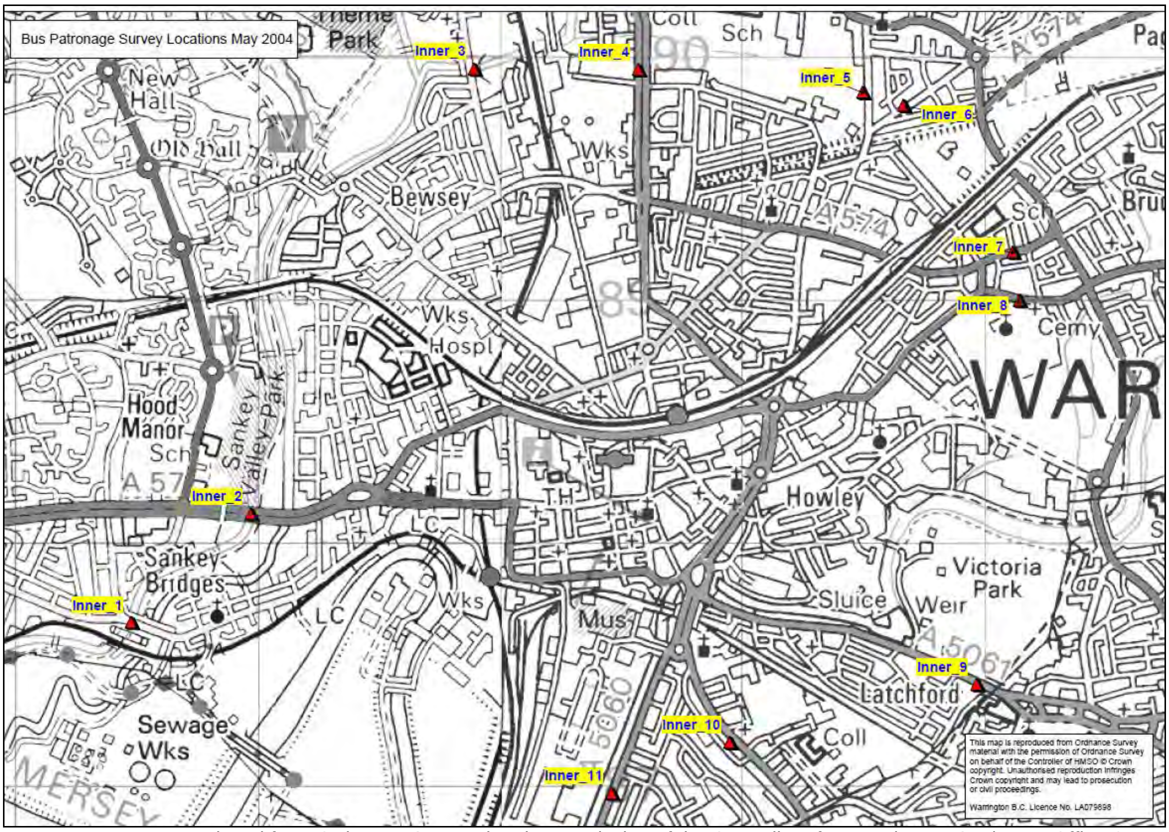
- Passenger flows across screenlines and cordons, usually by public transport mode and sometimes at the level of individual bus or train services.
- Passenger boarding and alighting numbers in urban centres

12.6.2 Across modelled screenlines modelled flows should, in total, be within 15% of the observed values. On individual links in the network, modelled flows should be within 25% of the counts excepts where observed flows are particularly low (i.e. less than 150 passengers).

AM Peak Bus Screenline Results

12.6.3 WBC provided passenger screenline data but this is only available for the AM peak and was collected in June 2006. WBC advised that there was a 14.2% increase in annual bus patronage between April 2006/March 2007 figures and April 2008/March 2009 figures. Given that the bus screenline data was collected prior to the new bus interchange opening (August 2006) it is likely that the actual increase between June 2006 and October 2009 is in excess of 14.2%. The screenline locations are illustrated below.

Figure 12.4 – Location of Bus Patronage Surveys June 2006



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12.6.4 Table 12.2 shows that the total modelled flows are 16% higher than the observed value thereby just falling short of the WebTAG criteria of 15%. Given the relatively large increase observed in the two years shown above there is an argument that patronage levels continued to grow in the period March 2009 to October 2009 when the WMMTM surveys were undertaken.

12.6.5 WebTAG states that on individual links modelled flow should be within 25%, except where observed flows are particularly low. None of observed link flows have passenger totals greater than 50 so the WebTAG criterion does not apply at a link level. Figure 12.4 shows the locations of the Bus cordon survey completed in June 2006.

Table 12.2 – AM Peak Passenger Screenline Results

Location	Cordon Point	Observed +14.2%	Modelled	Difference		
Liverpool Road	**Inner 1**	116	142	26		
Sankey Way	**Inner 2**	137	188	51		
Longshaw Street	**Inner 3**	33	50	17		
Winwick Road	**Inner 4**	114	79	-35		
Smith Drive	**Inner 6**	87	107	20		
Padgate Lane	**Inner 7**	96	70	-26		
Manchester Road	**Inner 8**	59	131	72		
Knutsford Road	**Inner 9**	99	108	9		
Wilderspool Causeway	**Inner 10**	43	35	-8	**% Difference**	**Criteria Met**
	Total	786	910	124	16%	✗

12.6.6 The table above shows that there are some differences between the proxy observed data and the modelled demand, in particular at cordon point 2 and 8. These differences can be explained by the increase in bus patronage as a result of the new bus station that has taken place since the surveys. This has increased patronage along these corridors greater than the overall annual growth of 14.2% between April 2006/March2007 to April 2008/March 2009.

Bus Boarding and Alighting Surveys

12.6.7 WebTAG states that modelled and observed boarding and alighting (B&A) data in urban centres should be compared and that modelled B&A flows should be within 25% of the observed B&A counts. This criterion has been applied to the bus B&A results previously presented.

12.6.8 It is important to note that the observations in all three time periods are below 150, with the exception of the boarding and alighting total for the whole station. Therefore the % difference is not applicable to the individual bus stands and only to the total and each time period meets the B&A criteria. This is summarised in **Error! Reference source not found.**.

12.6.9 The boarding and alighting data at the bus station has not been used in the matrix building process and therefore it is a truly independent validation comparison. The table below summarises the results of all the boarding and alighting data using the % difference criteria. Only the PM peak alighting data falls outside of the WebTAG criteria where the percentage difference is25.1%. All other counts meet the requirements.

Table 12.3 – Bus Boarding and Alighting Validation Results

Peak Hour	Boarding					Alighting				
	Observed	Modelled	Difference	%	% Difference Criteria	Observed	Modelled	Difference	%	% Difference Criteria
AM Peak	460	432	-28	6%	✓	739	708	-31	4%	✓
Inter Peak	671	514	-157	-23%	✓	562	441	-121	-22%	✓
PM Peak	617	535	-82	-13%	✓	195	244	49	25%	×

RAIL BOARDING AND ALIGHTING

12.6.10 The rail data is also compared against the same WebTAG criteria used for buses. It is important to note that at some stations the observed counts are below 150 passengers so the WebTAG criterion in these instances does not apply. The comparisons are presented in Table 12.4.

12.6.11 The boarding and alighting data at the railway stations was not used in the matrix building process and therefore is independent validation data. The table below summarises the results of all the boarding and alighting data using the % difference criteria. Only the AM peak boarding data at Warrington Central station falls outside of the WebTAG criteria of below 25% (the model is 27% higher). All other counts, including the total rail boarding and alighting data in all 3 time periods meet the criteria.

Table 12.4 – Rail Boarding and Alighting Validation Results

Peak Hour	Station	Boarding					Alighting				
		Observed	Modelled	Difference	%	% Difference Criteria	Observed	Modelled	Difference	%	% Difference Criteria
AM Peak	Sankey for Penketh Station	25	20	-5	-20%	N/A	7	3	-4	-57%	N/A
	Warrington Central Station	193	245	52	27%	×	146	136	-10	-7%	N/A
	Warrington Bank Quay Station	135	82	-53	-39%	N/A	181	147	-34	-19%	✓
	Padgate Station	58	35	-23	-40%	N/A	5	1	-4	-80%	N/A
	Birchwood Station	143	139	-4	-3%	N/A	185	183	-2	-1%	✓
	Total	**554**	**521**	**-33**	**-6%**	✓	**524**	**470**	**-54**	**-10%**	✓
Inter Peak	Sankey for Penketh Station	11	2	-9	-82%	N/A	0	3	3	0%	N/A
	Warrington Central Station	75	96	21	28%	N/A	93	84	-9	-10%	N/A
	Warrington Bank Quay Station	102	62	-40	-39%	N/A	85	59	-26	-31%	N/A
	Padgate Station	7	1	-6	-86%	N/A	3	1	-2	-67%	N/A
	Birchwood Station	30	222	-8	-27%	N/A	30	22	-8	-27%	N/A
	Total	**225**	**383**	**-42**	**18%**	✓	**211**	**169**	**-42**	**-20%**	✓
PM Peak	Sankey for Penketh Station	9	9	0	0%	N/A	53	65	12	23%	N/A
	Warrington Central Station	143	144	1	1%	N/A	191	195	4	2%	✓
	Warrington Bank Quay Station	153	121	-32	-21%	✓	107	99	-8	-7%	N/A
	Padgate Station	6	4	-2	-33%	N/A	77	14	-63	-82%	N/A
	Birchwood Station	151	151	0	0%	✓	148	141	-7	-5%	N/A
	Total	**462**	**429**	**-33**	**-7%**	✓	**576**	**514**	**-62**	**-11%**	✓

Bus Annual Flows

12.6.12 WebTAG states that wherever possible a check should be made between annual patronage derived from the model and annual patronage derived by the operator from revenue records. Precise comparisons may be difficult due to the expansion calculations that measure annual patronage levels from single peak hour models, but they provide a general sanity check on the general scale of patronage.

12.6.13 WBC provided WSP with the annual bus patronage figures for 2008/9 (April to March); this was 10.9 million passengers starting a bus journey within the Warrington Borough.

12.6.14 The annual figure is derived from the base year AM, IP and PM peak weekday bus as follows:

- Using B&A data as observed at the bus station the AM, Inter peak and PM peak hour matrix totals were converted into a peak period totals; 7am-10am 10am – 4pm & 4pm-7pm by using pro-rata expansion factors
- NTS statistics was used to convert the 12 hour totals into a daily figure
- The daily total was uplifted to account for bus services not surveyed using the proportion of non surveyed buses against surveyed buses
- The daily total was factored by 300 to represent an annual total.

12.6.15 Table 12.5 shows both the annual bus patronage calculated using the modelled peak hour matrices and the boarding and alighting data collected at the main bus station. The table shows that both the modelled and observed patronage are close to each other. However there is a difference of around 2 million between these figures and the actual annual bus patronage. Given the fact that the data for the modelled and observed annual patronage was collected on one day and used as a basis to derive the annual patronage there are likely to be discrepancies between the numbers.

Table 12.5 – Modelled and Observed Annual Bus Patronage

	Modelled	Observed
Annual Bus Patronage Derived from Public Transport Model	8,092,394	8,840,323
2008/2009 Bus Patronage WBC	10,890,000	10,890,000
Actual Difference	-2,797,606	-2,049,677

13 Conclusions

13.1 MODEL DEVELOPMENT

13.1.1 A multi-modal model has been developed using VISUM as a foundation for forecasting the effects and impacts of the proposed developments in and around Warrington. The use of PTV-VISUM transport modelling software, with its GIS capabilities, enables the accurate representation of the road network/junctions and efficient data handling. The modelled modes included in the multi-modal model are car/LGV, HGV, bus, rail and slow. The models have been developed in accordance with DMRB and WebTAG standards, representing weekday AM, IP and PM peak hours in a typical neutral month in 2008.

13.1.2 Data collected and collated for the highway model development includes comprehensive RSI surveys to cover trip distribution patterns for all highway modes, 2001 census data for journey to work trip distribution patterns for all modes, automatic and manual traffic counts including full junction turning counts and journey time surveys. Bus and rail passenger survey data was collected in 2008 for 24 bus routes and five railway stations in both directions. This data has been used to develop the Observed model in accordance with DMRB standards.

13.1.3 The Demand model has been developed following WebTAG's suggested four stage process of Trip Generation, Mode Choice, Trip Distribution and Assignment. The process calculates the number of person trips at a 24 hour level originating in each zone from census NTS data for several journey purposes. The probability of the person trips travelling by one of the available modes is calculated by comparing relative costs of travel of each mode. Once mode share is established the person trips by mode are subsequently distributed to zones based upon the relative attractiveness of each destination zone. The resultant journey purpose by mode matrices are converted to vehicle peak hour matrices ready for assignment.

13.1.4 The demand model uses travel costs taken from the observed model, which is deemed more accurate in assignment than the demand model. These costs are used to generate the demand model matrices, elements of which are passed into the observed model. In turn new costs are calculated and so on until model validation is achieved.

13.2 MODEL VALIDATION / CALIBRATION

13.2.1 The robustness of the observed highway model as a forecasting tool was measured by comparing link flows and journey times against observations. The comparisons were benchmarked against DMRB calibration and validation standards.

13.2.2 The public transport model was calibrated/ validated against observed bus patronage levels and observed railway station patronage levels for 24 bus routes and five railway stations within Warrington. Although there is no strict guidance available for validating public transport models, the model meets the DMRB criteria set for highway models in terms of patronage levels measured in GEH.

13.2.3 The demand model was validated against census data for HBW trips and against NTS and observations for other purposes and modes where data was available. Whilst no validation criteria exists for demand models the measurements presented in this report demonstrate a demand model that accurately reflects the transport demand characteristics of Warrington.

13.2.4 To support the validation a series of WebTAG guidance realism tests have been prepared to ensure the elasticity of the demand model is within acceptable limits. This has been proven to be the case for increased car journey times and fuel costs, but the model has a lower PT Far increase elasticity than WebTAG guidelines suggest. In addition WebTAG guidance on demand/ supply convergence has been met.

13.2.5 A series of Proving Tests specific to Warrington have been prepared to help gauge intuitive responses. This exercise has been completed and is reported on separately in the Model Testing Report.

13.3 MODEL APPROVAL & FIT FOR PURPOSE

13.3.1 The purpose of this report is to present the technical details of the model to the Steering Group, through the Technical Working Group with a view to reaching and agreeing sign off of the models as fit for purpose.