Whiteley Traffic Model

Local Model Validation Report

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Hampshire County Council Scheme: RJ568274.01

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P1	02.07.09	NAD	TOH	AKP	Full Draft of LMVR to HCC
P2	07.09.09	NAD	TOH	AH	Amendment to figures 6.1 and 6.2 and issue as final.

List of Contents

Page

Chapters and Appendices

1 INTRODUCTION

1.1 Background

Mott Gifford has been appointed to prepare a traffic model of Whiteley and its surrounding environs to forecast future traffic patterns on the local highway network within the context of proposed development and altered access arrangements.

The initial step in the preparation of the future year traffic model has been to prepare a validated base model. This base model should be able to simulate existing patterns of traffic movement within the study area that have been observed through traffic surveys. Once it can be demonstrated that the model can simulate existing network operation to within an acceptable degree of confidence, additional future year models can be built using this base.

This Local Model Validation Report (LMVR) has been prepared to describe the development of the base model, and to demonstrate the level of validation it achieves against a number of model acceptability criteria. This LMVR has been prepared in accordance with best practice guidance, as reflected by DfT Transport Assessment Guidance (WEBTAG) and Design Manual for Roads and Bridges (DMRB).

1.2 Format of Report

Following this introductory chapter, this LMVR is structured as follows:

- Overview of the Whiteley Traffic Model (chapter 2)
- Data used for model preparation (chapter 3)
- Development of demand matrix (chapter 4)
- Development of modelled network (chapter 5)
- Model validation criteria (chapter 6)
- Model convergence (chapter 7)
- Summary of model calibration (chapter 8)
- Model validation results (chapter 9)
- Conclusions and recommendations (chapter 10)

2 OVERVIEW OF THE WHITELEY TRAFFIC MODEL

2.1 Requirements for the Model

The final study brief for the Whiteley Traffic Model highlights the following modelling requirements:

- To forecast the effect of proposed schemes which alter available access routes into Whiteley.
- To forecast how traffic from additional developments in Whiteley will be distributed across the network within the context of proposed access schemes.
- To provide forecasts for an AM Peak weekday only.
- To explicitly model various trip purposes and vehicle classes using a multiple user class approach.

2.2 Model Type

The Whiteley Traffic Model is a fixed demand model which has been prepared using SATURN. SATURN is a widely used traffic assignment tool. It is able to assign a given fixed distribution of traffic demand onto a network and forecast resulting traffic flows and delays.

The SATURN modelling package is an appropriate tool for modelling the future traffic patterns within the Whiteley study area because it is able to clearly show how traffic will respond to increased levels of congestion in future years, and will show how traffic will respond to proposed changes in access to Whiteley. These responses will be limited to traffic re-assignment, as behavioural changes such as demand redistribution, mode choice or trip re-timing have not been modelled.

SATURN is a widely used traffic modelling software package which is familiar to the client and its agents, and as such it may be adapted and used for other assessments or incorporated into other models in the future.

2.3 Model Study Area

The geographical scope of the modelled area is illustrated in figure 2.1.

It has been agreed with Hampshire County Council that this study area is extensive enough to allow appropriate conclusions to be drawn from model forecasts relating to re-assignment effects.

The study area covers the whole of the Whiteley settlement, plus the surrounding areas of Swanwick, Locks Heath, Park Gate and Segensworth. The model extends to the River Hamble in the west, to the edge of Titchfield in the east and to Curbridge in the north. To the south, the Locks Heath area is included in the modelled area, however the highway network in this region has not been explicitly modelled.

2.4 Modelling Approach

The approach to the development and validation of the Whiteley traffic model can be broadly summarised into the following steps:

1. Collection of Roadside Interview (RSI) data and traffic count data
2. Formatting of traffic count data
3. Development of zone structure
4. Gathering network data (e.g. signal timing data)
5. Coding of highway network into SATURN model
6. Formatting of RSI data
7. Matrix building
8. Model calibration
9. Model validation

Each of these steps is presented in further detail in subsequent chapters of this LMVR.

3 MODEL INPUT DATA

3.1 Traffic Count Data

Some of the traffic count data used in the development of the model was collected specifically for the study, and the remainder was sourced from Hampshire County Council's traffic count database. In addition the Highways Agency Traffic Flow Data System (TRADS) database was used to obtain a directional flow on the M27 at Junction 9.

Surveys undertaken specifically for this study were as follows:

- Video surveys of M27 Junction 9 and Segensworth Roundabout (classified)
- 11 manual classified turning counts throughout the study area

Figure 3.1 highlights the locations of all traffic count data used for this study.

A subset of this data has been used for validation purposes, with the rest of the data used to aid in model preparation and calibration.

3.2 Derivation of Model Time Period

The traffic model has been configured to model an AM peak period for a duration of 1 hour. Traffic count data has been used to select an appropriate AM peak time period to model.

Traffic count data collected by Automatic Traffic Counter (ATC) on Whiteley Way into and out of Whiteley for the period 8 August 2008 to 15 September 2008, has been used to represent the operation of the local network. Profiles of traffic flow on Whiteley Way are presented in figures 3.2 and 3.3 overleaf, and show the AM operational peak to be between 08:00 to 09:00 on each week day.

Following discussions with Hampshire County Council it was agreed that the model should represent an AM peak period of 08:00 to 09:00.

3.3 PCU Factors

Traffic data input into SATURN is converted into Passenger Car Units (PCU) using the PCU factors shown in table 3.1 below, which have been derived from TRL Research Report 67.

Table 3.1: PCU Factors

Vehicle Type	PCU Factor
Car	1
Motorcycle	0.4
Light Goods Vehicle	1.5
Heavy Good Vehicle	2.3
Bus	2.0
Other	1

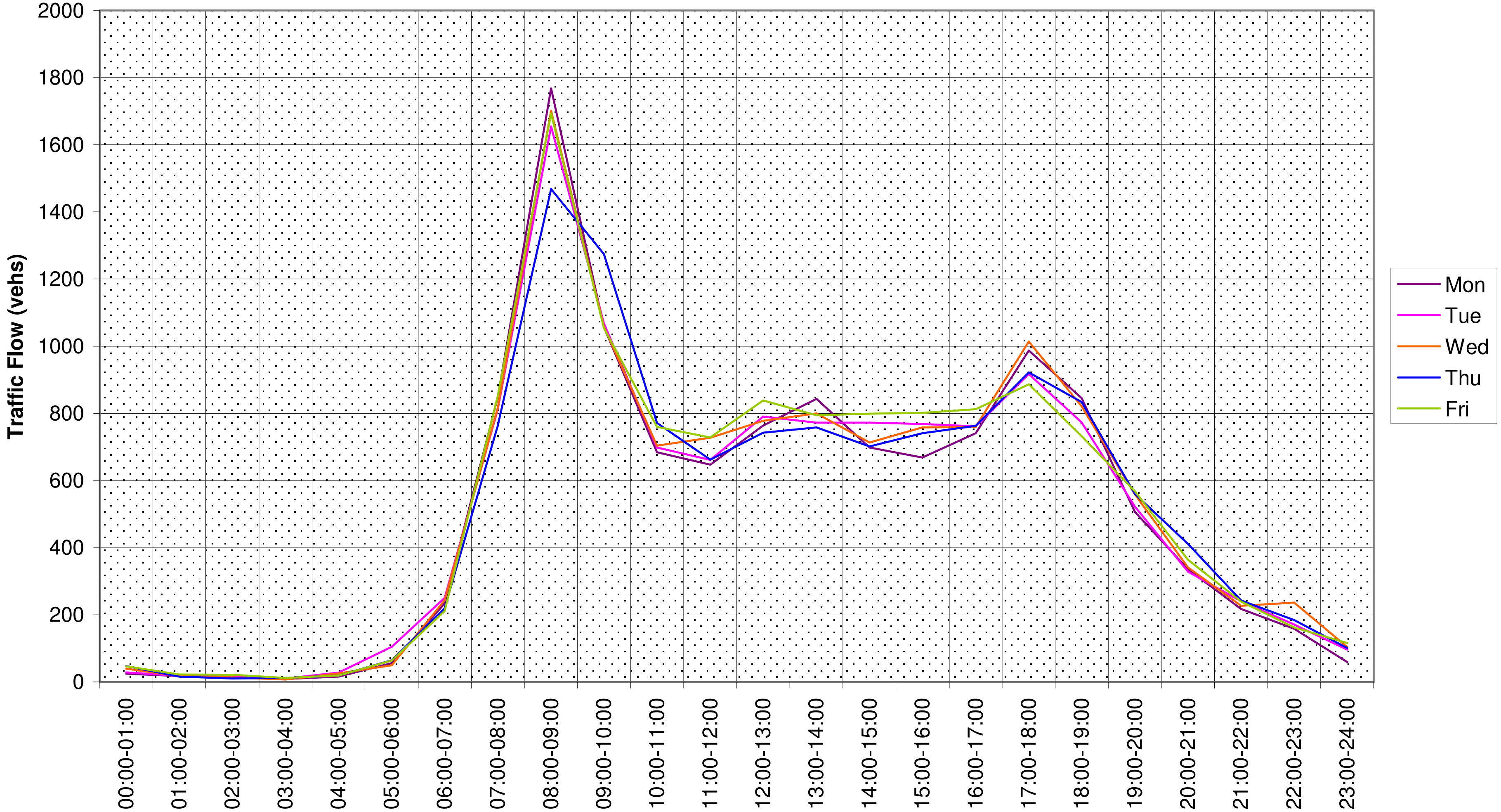


Figure 3.2: Weekday traffic flow profile on Whiteley Way northbound

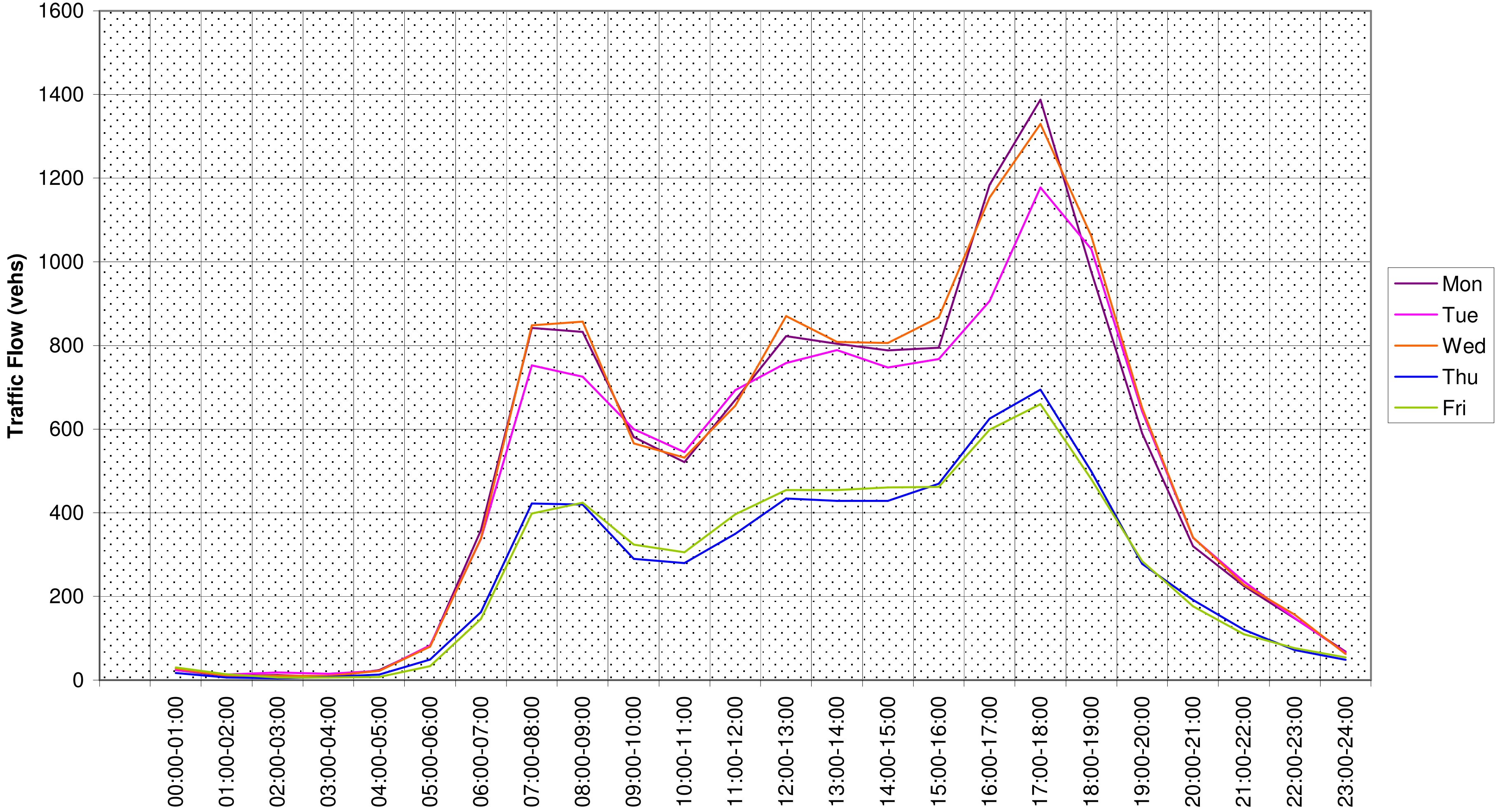


Figure 3.3: Weekday traffic flow profile on Whiteley Way southbound

3.4 Journey Time Data

Journey time observations along 2 routes were undertaken by Mott Gifford for use during model validation. Routes were observed during the AM peak on Thursday 7 May 2009.

The routes observed are circulating routes through the modelled area via Whiteley Way, Leafy Lane, Cartwright Drive and the A27. The routes capture the key north/south movement through the model, including movement into and out of Whiteley. Figure 3.4 illustrates the routes observed plus the timings points used along the route.

This data has been incorporated into the SATURN model for comparison with the journey times of modelled traffic

3.5 Roadside Interview (RSI) Surveys

Data from 7 RSI sites were used to prepare the demand matrices for the base model. Preparation of the demand matrices is detailed in chapter 4 of this LMVR.

Figure 3.5 illustrates the location of the RSI sites and the direction of survey at each site. Sites 1 and 2 provide samples of demand data into and out of Whiteley, whilst sites 3, 4, 6 and 7 provide samples of demand into and out of the internal modelled area. Site 5 provides a sample of demand data at the centre of the internal model area.

RSIs were carried out over a 12 hour survey period (07:00 to 19:00), however only samples observed during the modelled time period of 08.00 to 09.00 were used for matrix building.

Traffic counts were undertaken at the RSI site locations in order to expand the RSI sample to total flow past the site in the modelled time period.

Tables 3.2 and 3.3 below shows the sample rates obtained at each site for light and heavy vehicle classifications within the modelled time period. It can be seen that across the 7 sites, good sample rates have been achieved, averaging 17.6%. This sample rate has been considered adequate for preparation of the light vehicle matrix components. However due to poor sample rates for heavy vehicles, averaging only 1.5% across the 7 sites, RSI data was not considered adequate for preparation of the heavy vehicle matrix components. Heavy vehicle matrices have therefore been synthesised as detailed in section 4.7 of this report.

Table 3.2: Sample rates at RSI sites (light vehicles, 08:00-09:00)

RSI site	Sample Size	Observed Flow (vehs)	Sample Rate (%)
1	127	764	16.6
2	86	365	23.6
3	128	511	25.0
4	68	978	7.0
5	230	1770	13.0
6	75	1145	6.6
7	73	231	31.6

Table 3.3: Sample rates at RSI sites (heavy vehicles, 08:00-09:00)

RSI site	Sample Size	Observed Flow (vehs)	Sample Rate (%)
1	0	59	0
2	0	9	0
3	2	55	3.6
4	2	35	5.7
5	2	151	1.3
6	0	39	0
7	0	3	0

3.6 2001 Census Journey to Work Data

Journey to work data from the 2001 Census has been used to develop a commuter trip matrix which has been used in selected parts of the matrix build for trips which were not observed.

The National Statistics Journey to work dataset is provided as a list of movements between NeSS Hierarchy Output Areas. An interface programme was developed in order to extract data relating to the zone structure of the model.

In order to ensure compatibility with the modelled time period, the output census journey to work matrix was factored down from all journey to work movements to a single hour of journey to work movements. Some assumptions were made to facilitate this as follows:

- All journeys to work from census data are made between 07:00 and 10:00
- Traffic flow data at M27 Junction 9 represents a suitable source of data for factoring the quantity of journey to work movements to a single hour.

Examination of traffic flow data at M27 Junction 9 indicated that a suitable reduction factor of 0.42 could be applied uniformly to the census journey to work database in order to make it compatible with the modelled time period of 08.00 to 09.00.

A further adjustment was made to the journey to work matrix by removing movements from the external to external portion of the matrix which would not be made through the internal modelled area.

Further details regarding how 2001 Census journey to work data has been incorporated into the model build are provided in chapter 4.

3.7 Whiteley Business Park Staff Travel Survey

A postcode plot showing where Whiteley Business Park staff live was provided by Hampshire County Council (figure 3.6). A matrix of commuting to the business park was approximated by overlaying the model zone structure onto this plot.

This matrix was used to provide a better representation of commuter trips to the Business Park within the final trip matrix, as detailed in section 4.4.1.

3.8 School Travel Plan Data

A postcode plot showing where pupils at Whiteley Primary School travel from was sourced from the school travel plan by Hampshire County Council. This data was used in the matrix build to adjust the trips to and from the school.

The postcode plot cannot be reproduced in this LMVR due to reasons relating to data protection.

3.9 Traffic Signal Data

Representation of signalised junctions within the model is based on signal controller specifications provided by Hampshire County Council.

There are 5 traffic signal junctions within the model, requiring both fixed time and real time signal data.

Real time data from SCOOT was obtained for M27 Junction 9 and Segensworth Roundabout. This data represents the signal timings observed by the SCOOT controller between 08:00 and 09:00. This data has been input into the model with appropriate offsets to ensure correct modelling of the relationship between the two junctions.

Signals operating independently have been coded to their maximum green settings, unless adjusted based on observations made on site.

3.10 Bus Route Data

Bus timetables from local bus operator First Group were used to prepare bus routes and frequencies for input into the model.

4 DEMAND MATRICES

4.1 Zone Structure

A zone structure of 71 zones has been prepared at 3 levels as shown by figure 4.1:

1. Internal model area
2. External local model area
3. External national model area

4.1.1 Internal Model Area

The internal model area contains the modelled highway network and the highest level of zone disaggregation.

The extent of the internal model area was shown in figure 2.1 and covers the whole of the Whiteley settlement, plus the surrounding areas of Swanwick, Locks Heath, Park Gate and Segensworth.

Within the internal model area, a majority of the highway network is modelled, including key through-routes M27, A27 and A3051, important local access routes like Whiteley Way, and local ‘rat-run’ or ‘shortcut’ routes via Leafy Lane and Mill Lane.

The internal model area is split into 52 zones as shown by figure 4.2. The internal zone structure is bespoke to this model and has been created based on land use evident from aerial photography and on-site study.

The internal model area was initially sectorised based on predominant land uses (e.g. Whiteley Business Park, Segensworth East industrial area etc.). The sectors were disaggregated into zones to facilitate appropriate traffic loading within each sector.

4.1.2 External Local Model Area

The external local model area surrounds the internal model area as shown by figure 4.3 and is comprised of 15 zones. Each external local zone is an aggregation of NeSS Hierachy boundaries, and is typically as large, or larger that the whole of the internal model area. External local zones are listed for reference in table 4.1 below.

Table 4.1: External Local Zones

Zone Number	Zone Name
1	Botley
2	Bursledon/Hamble
3	East Hampshire
4	Eastleigh
5	Fareham
6	Gosport
7	Havant
8	Hedge End
9	New Forest
10	Portsmouth
11	Southampton
12	Stubbington
13	Test Valley
14	Winchester City
15	Winchester District (excl. City)

4.1.3 External National Model Area

The external national model area surrounds the external local model area and is split into 4 zones (North, South, East and West) which covers the remaining land area in England and Wales.

4.2 Zone Connectivity

4.2.1 Internal Zones

Internal zones are connected to the network via at least one zone connector. Loading points reflect actual junctions or accesses where appropriate. Alternatively zones are loaded at the start and end of modelled links where there are a number of zone access points. Zone connectors are coded with a default length of 100m, except in cases where a zone has multiple connectors and there is a need to reflect a longer travel from a zone centroid on a particular connector.

4.2.2 External Zones

External zones are connected to the network at exit points on the M27, A27 and A3051. Some external zones are connected by multiple connectors where there are several potential entry/exit routes from a zone into the model. It was considered important that the model is able to simulate parallel routeing between the M27 and A27.

External zone connectors are coded with a default length of 100m. However where external zones are connected by multiple connectors, appropriate restrictive weighting has been given in order to simulate actual travel time to the zone centroid.

4.3 Matrix Segmentation

The traffic model explicitly models 3 types of trip purpose and 2 vehicle classes. A multiple user class approach was requested by Hampshire County Council to aid further work relating to developments in north Whiteley. Trip purposes to be explicitly modelled are as follows:

(a) Commute

(b) Non Commute (excluding Employers Business)

(c) Employers Business

Vehicle types are classed as either light vehicles or heavy vehicles as follows:

- Light vehicles – cars, motorcycles, vans and small rigid trucks.
- Heavy vehicles – large rigid trucks, articulated vehicles

Buses are included within the model as fixed flows under a third vehicle class. In total, 4 user classes are represented within the model:

1. Light vehicle commute
2. Light vehicle non-commute
3. Light vehicle employers business
4. Heavy vehicle employers business

The numerical references given above for the 4 user classes are utilised throughout the LMVR. The model requires a stacked trip matrix containing 4 sub-matrices for each user class. User class matrices have been developed independently of each other.

4.4 Matrix Composition

The user class matrices that form the model trip matrix have been built using the following references:

- RSI data
- Census 2001 journey to work data
- Whiteley Primary School travel survey data
- Whiteley Business Park travel survey data

These data sources can be attributed to specific movements within the model. To explain this in more detail it is necessary to consider the trip matrix split into 6 key movements:

1. Into and out of Whiteley
2. External model area to internal model area and vice versa (excl. Whiteley)
3. External model area to external model area via motorway
4. External model area to external model area not via motorway

5. Internal model area to internal model area outside Whiteley

6. Internal model area to internal model area within Whiteley

Observed demand data from each RSI site has been merged together for each of these movements. Further detail regarding the RSI merging process is provided in section 4.5.2 below.

Table 4.2 below summarises which of these movements can be obtained from each data source, and for which user classes these movements may relate to.

Table 4.2: Data sources used in user class matrices

Data Source	User Class	Movement					
		1	2	3	4	5	6
RSI	1, 2, 3	Y	Y	N	Y	Y	N
Census	1	Y	Y	Y	Y	Y	Y
School Travel Plan	2	Y	N	N	N	N	Y
Business Park Travel Survey	1	Y	N	N	N	N	Y

4.4.1 User Class 1 (light vehicle commute)

The matrix for user class 1 is predominantly RSI data which has been merged according to section 4.5.2 below.

Census journey to work data has been added to the matrix only for movements within the Whiteley sector (i.e. movement 6). As is shown by table 4.2 above, this movement was not observed by RSIs. Further details regarding the preparation of Census journey to work data into a compatible matrix format are provided in section 4.6.

The Business Park travel survey data has been used to adjust the matrix to ensure that it reflects a robust pattern of commuting to the Business Park. It was considered necessary to apply this adjustment following a comparison of RSI data from sites 1 and 2 which showed a poor correlation between the pattern of RSI observed commute trips to the Business Park and the pattern of commute trips from the Business Park travel survey.

4.4.2 User Class 2 (light vehicle non-commute)

The matrix for user class 2 is predominantly RSI data which has been merged according to section 4.5.2 below.

Travel survey data from the Whiteley Primary School travel plan has been added to the matrix. It was necessary to add this data to the matrix because the RSI surveys did not observe movements within the Whiteley sector, as indicated by table 4.2 above.

It has been assumed that the trips to Whiteley Primary School obtained from School Travel Plan data are for the purpose of dropping off pupils at the school. Due to lack of data, regarding onward trip chains, it has therefore been assumed that this trip will be a return trip back to place of origin.

4.4.3 User Class 3 (light vehicle employers business)

The matrix for user class 3 was entirely generated from RSI data and merged according to section 4.5.2 below. As such, movements 3 and 6 for user class 3 are not represented within the model.

4.4.4 User Class 4 (heavy vehicle employers business)

Due to poor sample rates for heavy vehicles at the RSI sites, the matrix for user class 4 has been synthesised. Synthesis of user class 4 trips is detailed in section 4.7 below.

4.5 Matrix Building

4.5.1 Preparation of RSI Data

Before RSI data was merged together to form the RSI component of user class matrices, it was prepared as follows:

1. RSI samples for peak periods of interest were extracted from the 12 hour samples.
2. RSI postcode data was converted into grid references.
3. RSI grid reference data was mapped to the zone structure using GIS.
4. Origin and destination locations and trip purposes from PM peak samples were transposed in order to provide demand data for the opposite direction of travel to survey direction.
5. RSI data for both directions was expanded to count data using the expansion factors shown in tables 4.3 and 4.4 below.
6. Expanded RSI data was converted into 71 zone PCU matrix format by an interface programme, producing PCU sub-matrices per direction for each user class at each RSI site.

Table 4.3: RSI expansion factors (survey direction)

RSI site	Expansion Factor
1	6.02
2	4.24
3	3.99
4	14.39
5	7.70
6	15.26
7	3.17

Table 4.4: RSI expansion factors (non-survey direction)

RSI site	Expansion Factor
1	31.86
2	6.96
3	8.93
4	14.22
5	15.97
6	38.30
7	5.47

4.5.2 RSI Merging

RSI data from each of the 7 sites has been carefully merged together, ensuring that the matrix totals have been controlled throughout the merging process to avoid an inflated matrix total due to double counting. Table 4.5 below summarises which of the key movements can be obtained from each RSI site.

Table 4.5: Key movements available from RSI sites

RSI Site	MOVEMENT					
	1	2	3	4	5	6
1	Y	N	N	N	N	N
2	Y	N	N	N	N	N
3	Y	Y	N	Y	N	N
4	Y	Y	N	Y	N	N
5	Y	Y	N	Y	N	N
6	Y	Y	N	Y	N	N
7	Y	Y	N	Y	N	N

(i) Movement 1 – Into and out of Whiteley

RSI sites 1 and 2 were added together to obtain traffic travelling into and out of Whiteley.

(ii) Movement 2 – External model area to/from internal model area (excluding Whiteley)

RSI sites 3, 4, 6 and 7 were added together to obtain traffic moving from the external model area to the internal model area (excluding the Whiteley sector) and vice versa.

RSI site 5 also provided traffic for movement 2 where the OD pairs could not have been observed by perimeter RSI sites 3, 4, 6 and 7 i.e. trips to and from zones which are connected to the motorway only.

(iii) Movement 3 – External model area to internal model area via motorway

This movement cannot be obtained from RSI data.

(iv) Movement 4 – External model area to internal model area not via motorway

RSI sites 3, 4, 6 and 7 were added together to obtain traffic moving through the internal model area not via the motorway.

(v) Movement 5 – Internal model area to internal model area outside Whiteley

This movement cannot be obtained from RSI data.

(vi) Movement 6 – Internal model area to internal model area within Whiteley

This movement cannot be obtained from RSI data.

Following the matrix merging process, movements 3, 5 and 6 are not represented within the matrix as the layout of RSI sites was not able to provide demand data for them. These movements were obtained from Census journey to work data, as detailed in section 4.6.

4.6 Incorporation of Census Journey to Work Data

Commuting contained within the Whiteley sector was obtained from the Census journey to work matrix. Since this movement does not pass through any of the RSI sites it is appropriate to directly add these trips to the user class 1 matrix.

Similarly, commuting within the internal model area (excluding the Whiteley sector) was obtained from the Census journey to work matrix and added directly to the user class 1 matrix, again as this movement did not pass through any of the RSI sites.

Commuter through-movements on the M27 were also obtained directly from the Census journey to work matrix for those external zones with direct connection to the M27. This movement was synthesised for user classes 2 and 3, using the pattern of journey to work trips as a proxy for trip distribution. Relative demand between each user class was obtained using the breakdown of samples obtained for each user class at RSI site 5. The overall demand for this movement across user classes 1-3 was adjusted in accordance with observed throughput flow at M27 Junction 9.

A limitation of the Census journey to work data as a source of information for unobserved trips is that it has not been possible to estimate a proportion of demand that can be attributed to the external national zone structure, i.e. trips to and from the north, south, east and west of the country. However, since through-movements have been adjusted in accordance with observed flows, it is considered that traffic travelling nationally is in fact represented in the model.

4.7 Synthesis of User Class 4 Matrix

Samples of RSI records for heavy vehicles were not considered to be representative of heavy vehicle travel distribution due to low sample rates achieved. As such, the user class matrix for heavy vehicles has been synthesised.

Due to limitation of available data it was necessary to make an assumption that there are no heavy vehicle trips which have origin and destination within the internal model area. In addition it has not been possible to synthesise heavy vehicle trips to and from external national zones.

Internal zones were selected to produce and attract heavy vehicle trips if they represented industrial or retail land uses. Zones representing Whiteley Business Park were included in this selection. All external local zones were considered able to produce and attract heavy vehicle trips.

The level of demand for heavy vehicle trips to and from the selection of internal zones was established using observed heavy vehicle flow on adjacent links.

The distribution of this demand for heavy vehicle trips into and out of the internal model area was established using the relative demand to and from each external local zone found in Census journey to work data.

In addition to heavy vehicle movement into and out of the internal model area it was also necessary to estimate demand and distribution for heavy vehicle through-movement. Distribution of this through-movement is taken directly from Census journey to work data and therefore mirrors the distribution of through movements found in the other user classes which were similarly derived. Demand for heavy vehicle through-movement was adjusted according to an average flow of heavy vehicles observed on the A27 and M27 corridors within the internal model area.

5 MODELLED NETWORK

5.1 Highway Network Coding

5.1.1 Approach to Network Coding

The modelled network has been coded as an all-simulation type network. Network coding has been undertaken in a structured way, using a standard approach to code each type of junction and a standard set of saturation flows for the coding of modelled turns. Junctions were initially coded using coding sheets, allowing observations from site visits or aerial photography to be noted. Coding sheets were converted to SATURN coding using an interface programme.

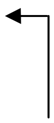
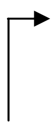
Initially the network to be modelled was sketched onto a map base. Nodes were placed at each junction to be simulated within the model, and additional dummy nodes were placed in some locations to aid network shaping or zone connectivity. Nodes were numbered with 4 digit codes which relate to the position of the node within the network.

The modelled network was drawn onto a CAD map base, from which link distances were measured. This CAD layer was also used in the calculation of saturation flows at some junctions, as described in section 5.1.2.

5.1.2 Saturation Flow Assumptions

Saturation flow assumptions used to prepare the priority and signal type junctions in the modelled network are illustrated by table 5.6 below. Where turns are opposed, appropriate markers G (give way) and X (opposed right turn) are added.

Table 5.6: Saturation flow assumptions for network coding

Type of Turn	Description	Saturation Flow (per lane)
	Straight ahead	Nearside = 1,965 Offside = 2,105
	Left turn	Into minor arm = 1,765 Out of minor arm = 748
	Right turn	Into minor arm = 748 Out of minor arm = 626

The coding of saturation flow for turns at M27 Junction 9 and Segensworth roundabout were calculated from first principles. The formulae (TRL Research Report 67) used to calculate these saturation flows is as follows:

(1) $S = (S_o - 140dn) / (1 + 1.5/r)$

(2) $S_o = 2080 - 42dgG + 100(w - 3.25)$

where S = saturation flow, S_o = saturation flow for straight on line, dn = nearside lane dummy variable, r = radius of curvature of vehicle paths, dg = gradient dummy variable, G = gradient, w = lane width.

Radius of curvature of vehicle paths was measured using CAD.

Gradient was not taken into consideration in calculating saturation flows due to data limitations.

Saturation flows for roundabout entries were derived from look up tables from TRRL LR 942, which are based on approach width, entry width and effective flare length for 1 to 4 lanes.

5.1.3 Coding of Stacking Capacity

In some cases it was desirable to input a specific stacking capacity for a link. This was used where a link expands at a flared entry into a junction into multiple lanes, but where queuing on that link is predominantly in one lane only. In some cases right turns are coded as two lanes to prevent blocking of straight ahead traffic, and in these instances, a specific stacking capacity was also input. Stacking capacity was calculated using the following formula:

$S = n (L/5.75)$

where S = stacking capacity, n = number of lanes, L = link length, and parameter 5.75 represents the length in metres of an average passenger car unit plus headway in a queue.

5.1.4 Network Restrictions

The following network restrictions have been coded into the modelled network:

- One way from Longacres to Southampton Road
- One way on Barnes Wallis Road adjacent to Segensworth roundabout
- One way on Segensworth Road adjacent to Segensworth roundabout
- Left turn only for traffic exiting Locks Road at junction with A27
- Left turn only for traffic entering Middle Road
- Restriction to all traffic (excluding buses) on link between Yew Tree Drive and A3051 Botley Road
- Heavy vehicle restriction from Longacres to Southampton Road
- Heavy vehicle restriction in both directions along Leafy Lane

5.1.5 Fixed Flows

Bus routes have been coded into the model as fixed flows operating at a frequency obtained from timetable information.

Buses have been added to the model so that an appropriate bus flow is included in the simulation of junctions. In addition, the model would be able to demonstrate the impact to existing bus journey times in a modelled scenario if required by the client or its agents in the future.

5.2 Simulation Network Link Speeds

Free flow link speeds have been coded equivalent to speed limits for a majority of the modelled network. In some cases lower speeds were input, particularly in traffic calmed areas where the average speed of uncongested traffic movement was observed to be lower that the speed limit.

Speed flow curves have not been coded for any links in the modelled network, so in the event that a link experiences no capacity restraint due to the simulation of the downstream junction, vehicle speed is modelled as the speed limit of that link.

5.3 Gap Acceptance Parameters

Gap Acceptance Parameters (GAP) has been set to global default values shown in table 5.7 below.

Table 5.7: GAP parameters adopted as network default

Parameter	Global Value	Movement
GAP	3	Give way at priority junction Opposed movement at signals
GAPR	2.5	Roundabout entry
GAPM	2	Merging traffic

During model calibration, some junctions were assigned a bespoke GAP value in order to more realistically model observed driver behaviour.

5.4 Coding of Motorway Merges

The calculation of delay at congested motorway merges can be unrealistically modelled by SATURN since delay is applied to the merging traffic stream only and not mainline traffic. Appendix M of the SATURN manual discusses various techniques for modelling motorway merges so that delays are experienced on both the merge and the main carriageway.

The two motorway merges in the Whiteley modelled network will be coded using the standard M marker and with parameter APRESV set to 1.0 (i.e. turned on). This parameter gives merging traffic an equal weighting with mainline traffic and thus preference to merging traffic. The study outlined in Appendix M of the SATURN manual shows that this method improves the performance of the M marker.

5.5 Behavioural Routeing Parameters

National values of Time (VoT) for a variety of vehicle types and trip purposes have been sourced from WebTAG Unit 3.5.6 and converted into pence-per-minute (PPM) values. Table 5.1 below shows the VoTs that have been adopted.

Table 5.1: VoT from WebTAG (AM Weekday 07.00-10.00)

Vehicle Type /Journey Purpose	Values of Time	
	£ per hr	PPM
Car commute	5.84	9.73
Car Employers Business	30.74	51.23
Car other	7.58	12.63
LGV Employers Business	12.22	20.37
HGV Employers Business	10.18	16.97

Vehicle Operating Costs (VOCs) have been calculated using formulae from WebTAG Unit 3.5.6. VOCs have been split into fuel and non-fuel costs, and are calculated as pence-per-km (PPK) values.

Fuel costs were calculated using the following formula:

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

where L = fuel consumption (PPK), v = average vehicle speed (KpH), and a, b and c are parameters set out in WebTAG and reproduced in table 5.2 below.

Table 5.2: WebTAG Parameters for calculation of fuel VOCs by vehicle type

Vehicle Type	Parameters			
	a	b	c	d
Car	3.253842	-0.07402	0.000839	-0.00000269
LGV	3.786669	-0.05781	0.000315	0.00000117
HGV	17.56914	-0.51735	0.007453	-0.000032935
PSV	12.43951	-0.3722	0.005377	-0.00002384

Average speed was taken as the average per-kilometre free flow speed (based on speed limit, as per section 5.2) within the modelled network. Table 5.3 below shows the calculated fuel costs for each vehicle type, based on the parameters given in table 5.2, and formulae from WebTAG Unit 3.5.6.

Table 5.3: Calculated fuel consumption, L (PPK) by vehicle type

Vehicle Type	Fuel Consumption, L (PPK)
Car	1.25
LGV	1.71
HGV	6.23
PSV	4.30

Non-fuel costs were calculated using the following formula:

$C = a + b / v$

where C = cost (PPK), v = average vehicle speed (KpH), and parameters a and b are set out in WebTAG and reproduced in table 5.4 below.

Table 5.4: WebTAG Parameters for calculation of non-fuel VOCs by vehicle type

Vehicle Type	a	b
Non-Employers Business Car	3.7020	0.0000
Employers Business Car	4.0690	111.3910
Employers Business LGV	5.9100	38.6030
HGV	8.1015	316.4185
PSV	24.959	569.0940

Average speed was taken as the average per-kilometre free flow speed within the modelled network. Table 5.5 shows the calculated non-fuel costs for each vehicle type, based on the parameters given in table 5.4 and formulae from WebTAG Unit 3.5.6.

Table 5.5: Calculated non-fuel VOC (PPK) by vehicle type

Vehicle Type/Journey Purpose	Non-fuel Cost (PPK)
Non-Employers Business Car	3.70
Employers Business Car	5.95
Employers Business LGV	6.56
HGV	13.44
PSV	34.56

From tables 5.1 and 5.5 above, the behavioural routeing parameters used in the model are summarised in table 5.6 below.

Table 5.6: Behavioural routeing parameters for each user class

User Class	VoT (PPM)	VOC (PPK)
1	9.73	4.96
2	12.63	4.96
3	35.80	7.74
4	16.97	19.67

6 MODEL ACCEPTABILITY CRTIERIA

6.1 Validation and Model Acceptability

The preceding chapters of this LMVR have described the process whereby the modelled network and trip matrices have been developed. Following preparation of the model, it is necessary to validate the model by verifying that the model is able to reproduce observed traffic movement to a level appropriate for its use.

The purpose of this chapter is to outline the criteria against which the model has been validated.

6.2 Validation Indicators

In order to define appropriate validation indicators it is useful to once again summarise the purpose of the Whiteley traffic model:

- To forecast the effect of proposed schemes which alter available access routes into Whiteley;
- To forecast how traffic from additional developments in Whiteley will be distributed across the network within the context of proposed access schemes.

Based on these overarching aims, the model must be able to robustly simulate movement into and out of Whiteley, and must have adequate levels of demand and delay in order to produce realistic routeing between Whiteley and non-Whiteley zones once access arrangements are altered.

In order to evaluate model acceptability according to these requirements, the model has been validated on movements into and out of Whiteley and throughout the internal model area, via a number of screenlines, cordons and key junctions. In addition the modelled journey time along 2 key routes through the internal model area has been compared to observed journey times.

6.2.1 Screenlines

Screenlines have been established for 5 key movements on the modelled network. Figure 6.1 illustrates the position of the screenlines. The purpose of these screenlines is discussed below.

(i) Screenline 1 – Access to/from Whiteley

This screenline relates to the movement in and out of Whiteley via Whiteley Way and Leafy Lane. This screenline is useful for demonstrating both how well the model is able to simulate overall demand to travel into and out of Whiteley, and also how well the model is able to balance the level of traffic between each of the accesses into Whiteley. This is considered a key screenline for model validation as the model will ultimately be used to forecast the impact of adding and removing access points to the Whiteley sector.

(ii) Screenline 2 – East Access

This screenline relates to the movement in and out of the internal modelled area at its eastern edge via the M27 and A27 links. The level of validation achieved on this screenline demonstrates how well the model is able to simulate the parallel routeing between M27 and A27 links, in addition to the overall demand to enter and exit the internal model area to and from external zones connected to the east edge of the modelled area.

(iii) Screenline 3 – West Access

This screenline relates to the movement into and out of the internal model area at its western edge via the M27, A27 and Swanwick Lane. Its purpose is identical to that of screenline 2, but for the western edge of the internal modelled area.

(iv) Screenline 4 – North Access

Screenline 4 has only a single intersecting link, however it is considered important in order to evaluate the level of demand in the model for travel to and from zones 1 (Botley), 4 (Eastleigh), 8 (Hedge End) and 15 (Winchester District) via the A3051.

(v) Screenline 5 – Whiteley Residential Area

Screenline 5 is important in order to evaluate how well the model is distributing trips to and from each part of the Whiteley residential area via Whiteley Way (east Whiteley) and Yew Tree Drive (west Whiteley).

6.2.2 Cordons

Cordons have been established surrounding the Whiteley Residential area and Whiteley Business Park. The purpose of these cordons is to evaluate the level of traffic entering these areas, and to assess the balance of traffic at each of the entry/exit points into each cordon. Figure 6.2 illustrates the position of the cordons.

6.2.3 Key Junctions

Junctions located on the central north-south corridor through the internal model area are considered to be the most significant in distributing traffic within the modelled network. As such, validation of both the level of traffic passing through these junctions and the turning proportions is considered important in assessing model acceptability.

The following junctions are included:

- M27 Junction 9
- Segensworth Roundabout
- Parkway South Roundabout

6.3 Validation Criteria

6.3.1 GEH Statistic

Traffic flow validation makes use of the GEH statistic. Table 4.2 of the DMRB Volume 12A defines this indicator as follows:

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

where M = modelled flow, C = observed flow

GEH scores are always positive and range upwards from 0, which represents a perfect fit. Scores in the range 0-5 are considered to be very good. The GEH statistic is more demanding for larger flows than smaller ones.

The effects of relatively small day-to-day variations in counts can have a significant effect on the level of GEH statistic achieved.

6.3.2 Targets for Model Acceptability

The following validation targets have been established in order to benchmark model acceptability:

1. Total flows across all screenlines should have GEH < 5 for all intersecting links
2. Total flows across all cordons should have GEH < 5 for all intersecting links
3. Total flow into key junctions should have a value for GEH < 5
4. Each turning movement at key junctions should have a value for GEH < 5
5. Journey times along observed routes should have an error within +/- 15% of observed times (commensurate with DMRB guidelines)

7 MODEL CONVERGENCE

The assignment of a SATURN traffic model aims to satisfy Wardrop's Principle of Traffic Equilibrium which states that traffic arranges itself on congested networks such that the cost of travel on all routes used between each origin-destination pair is equal to the minimum cost of travel, and all unused routes have equal or greater cost. Consequently, the SATURN assignment tries to satisfy this principle by minimising an objective function over a number of iterations in order to find an equilibrium solution. In a simulated SATURN assignment, groups of assignment iterations are followed by network simulation iterations, termed an 'Assignment/Simulation loop'.

SATURN runs assignment/simulation loops until a satisfactory equilibrium solution is achieved or a user specified maximum number of loops is reached. The Whiteley model has been configured to run the default maximum of 30 assignment/simulation loops but reaches a satisfactory equilibrium solution within 12 loops. A satisfactory equilibrium solution is reached where at least 95% of link flows differ by less than 5% over 4 successive loops.

In general, such an iterative method for reaching equilibrium will not converge absolutely, but it is necessary to demonstrate that the model has achieved convergence to an acceptable level such that it is able to produce stable, consistent and robust model results. Table 7.1 below presents model convergence statistics for the final 4 loops of the base model assignment.

Table 7.1: Assignment convergence statistics

Loop	Assignment	% Flows	% Delays	% V.I.
n-3	0.170/11	97.1	97.4	0.00730
n-2	0.163/8	99.6	98.5	0.00250
n-1	0.149/15	95.6	97.8	0.00035
n	0.168/4	99.9	99.5	0.00200

Assignment; Delta function (%) / number of assignment iterations

% Flows; % Link flows differing by < 5% between successive iterations

% Delays; % Turn delays differing by < 5% between successive iterations

% V.I.; Variational Inequality

The convergence statistics achieved by the base model indicate an excellent level of convergence towards Wardrop's Principle. It is therefore considered that the model will produce stable and consistent model results.

8 MODEL CALIBRATION

8.1 Approach to Model Calibration

The modelled network has been calibrated in a number of ways in order to improve model performance against the target validation criteria outlined in section 6.3.2.

Model calibration was undertaken as a series of sensitivity tests which examined the effect of various adjustments to the modelled network and trip matrix on assigned traffic flows and routeing.

This chapter summarises the most common network and matrix calibration techniques that have been used.

8.2 Network Calibration

The primary purpose of calibrating the modelled network is to adjust the relative capacity and connectivity of the modelled links and junctions in order to more realistically represent the actual operation of the network within the modelled time period.

In addition, it was necessary to adjust the coding of some centroid connectors to affect loading of traffic at certain locations. Commonly zones were converted from loading at the start and end of links to a single loading point in order to assist traffic routeing and reduce the problem of deficient mid-link flows.

Two additional sections of network were added to the model during calibration in order to model suspected ‘rat-run’ routes along Mill Lane through to Cartwright Drive and along Common Lane to Stubbington via Titchfield. These updates were undertaken following discussion with Hampshire County Council officers regarding assumed movements at St Margaret’s Roundabout.

Network weights for external zones with multiple connection points were also subject to calibration in order to achieve satisfactory routeing into the network from these zones.

8.3 Matrix Calibration

Where deficiencies in modelled flow were found to be a result of inappropriate levels of demand, adjustments were made to the trip matrix. Matrix adjustments included redistribution of trips within the matrix, removal of unnecessary trips or addition of new trips.

To aid model calibration, trips making a through movement between external zones via the M27 were fixed to the motorway route by allocation to a number of new zones with motorway-limited connection. The advantage of isolating this traffic stream was to remove the effect of network weighting on motorway through traffic. As a fixed demand assignment model, this adjustment will not have an adverse impact on model forecasts.

It was considered that manual matrix calibration was more appropriate than automated matrix estimation methods due to the complex routeing issues generated by the presence of external local zones with multiple zone connectors.

9 MODEL VALIDATION

9.1 Validation Overview

Based on the model acceptability criteria presented in chapter 6, and the calibration of the model summarised in chapter 8, this chapter considers how the resultant model validates, firstly at its screenlines, then cordons, before focussing on key junctions, and journey times.

9.2 Screenlines

9.2.1 Validation into and out of Whiteley

Table 9.1 below shows the validation achieved for movements into and out of Whiteley across screenline 1 in further detail. It can be seen that the model shows a good match between observed and modelled flows into and out of Whiteley, and that the balance of traffic on Whiteley Way and Leafy Lane is also good, with GEH statistics for the screenline by direction and its component parts all below 5, meeting the defined validation criteria.

Table 9.1: Validation achieved into and out of Whiteley

Link	Northbound			Southbound		
	Observed Flow (pcu)	Modelled Flow (pcu)	GEH	Observed Flow (pcu)	Modelled Flow (pcu)	GEH
Whiteley Way	2010	1970	0.9	872	792	2.8
Leafy Lane	383	340	2.3	182	215	2.3
Screenline Total	2393	2310	1.7	1054	1007	1.4

9.2.2 Validation into and out of Internal Model Area

Table 9.2 overleaf summarises the level of validation achieved on screenlines 2, 3 and 4 governing access into the internal model area from the external zones. This table demonstrates that the model is allocating satisfactory levels of demand to each access point into the internal model area, and that the balance of traffic on each of the intersecting links is good, with GEH statistics for the screenline by direction and its component parts all below 5, meeting the defined validation criteria.

Table 9.2: Validation at entry and exit of internal model area

Link	Direction 1				Direction 2			
	Direction	Observed Flow (pcu)	Modelled Flow (pcu)	GEH	Direction	Observed Flow (pcu)	Modelled Flow (pcu)	GEH
Screenline 2 – East Access								
M27	WB	5270	5300	0.4	EB	4752	4735	0.2
A27		1807	1778	0.7		1199	1198	0.0
Screenline Total		7077	7079	0.0		5951	5933	0.2
Screenline 3 – West Access								
Swanwick Lane	WB	234	190	3.0	EB	306	271	2.1
M27		6358	6684	4.0		5853	5543	4.1
A27		740	698	1.6		1013	1046	1.0
Screenline Total		7333	7572	2.8		7173	6861	3.7
Screenline 4 – North Access								
A3051	NB	487	542	2.5	SB	535	549	0.6
Screenline Total		487	542	2.5		535	549	0.6

9.2.3 Validation within Whiteley

Table 9.3 below shows the validation achieved across screenline 5, which demonstrates the model's ability to obtain a good balance of flow between the 2 residential areas within the Whiteley sector. It can be seen that the model achieves a good validation of total movement across the screenline in each direction, and also a good balance of flow between each of the intersecting links, with GEH statistics for the screenline by direction and its component parts all below 5, meeting the defined validation criteria.

Table 9.3: Validation between Whiteley residential areas

Link	Westbound			Eastbound		
	Observed Flow (pcu)	Modelled Flow (pcu)	GEH	Observed Flow (pcu)	Modelled Flow (pcu)	GEH
Yew Tree Drive	254	207	3.1	597	617	0.8
Whiteley Way	157	185	2.2	250	194	3.7
Screenline Total	411	392	0.9	847	811	1.2

9.2.4 Summary of Screenline Validation

Table 9.4 below shows a summary of GEH statistic achieved in each direction across each of the 5 screenlines.

Table 9.4: Summary of GEH values achieved across screenlines

Screenline		Direction	GEH
1	Whiteley Access	NB	1.7
		SB	1.4
2	East Access	WB	0.0
		EB	0.2
3	West Access	WB	3.7
		EB	2.8
4	North Access	NB	2.5
		SB	0.6
5	Whiteley Internal	WB	0.9
		EB	1.2

It can be seen from summary table 9.4, and also from other tables presented in this section, that all screenline links achieve a GEH value less than 5. This demonstrates that the model has adequate levels of demand across key movements within the modelled area, and that the model is able to robustly simulate movement in and out of Whiteley. These were cited as key requirements for model acceptability in section 6.3.2.

9.3 Cordons

9.3.1 Whiteley Business Park

Table 9.5 below shows a breakdown of the level of validation achieved for the Whiteley Business Park cordon. It can be seen that the model has an adequate level of demand into the cordon and a good balance of traffic on each entry link. The overall level of demand out of the cordon validates well, however it can be seen that Parkway North has a GEH value in excess of 5 due to a shortfall of 43 pcu trips exiting the cordon on Parkway North. It is considered that this is a minor issue which does not significantly affect the robustness of the model.

Table 9.5: Validation at Whiteley Business Park cordon

Link	Inbound			Outbound		
	Observed Flow (pcu)	Modelled Flow (pcu)	GEH	Observed Flow (pcu)	Modelled Flow (pcu)	GEH
Leafy Lane	383	340	2.3	182	215	2.3
Parkway North	702	776	2.7	56	13	7.3
Parkway South	1067	1171	3.1	244	245	0.1
Cordon Total	2152	2287	2.9	482	473	0.4

9.3.2 Whiteley Residential Area

Table 9.6 below shows a the level of validation achieved for the Whiteley Residential cordon. It can be seen that traffic demand into and out of the cordon both have GEH values less than 5. It is considered that this cordon achieves a satisfactory level of validation in each direction.

Table 9.6: Validation at Whiteley Residential cordon

Link	Inbound			Outbound		
	Observed Flow (pcu)	Modelled Flow (pcu)	GEH	Observed Flow (pcu)	Modelled Flow (pcu)	GEH
Rookery Avenue	423	337	4.4	608	662	2.2
Whiteley Way	268	235	2.0	431	459	1.4
Cordon Total	691	572	4.7	1039	1121	2.5

9.4 Key Junctions

9.4.1 Total Movements

Table 9.7 below presents total through movement at each of the key junctions selected for validation in section 6.2.3. It is shown that total movements through each of the junctions achieve a GEH value of less than 5 and it is therefore considered that the total movements through each of the junctions validates to an acceptable level. This demonstrates that the model has the right level of demand into and out of the junctions which are most significant in distributing traffic within the modelled network.

Table 9.7: Validation of total through movement at key junctions

Junction	Observed Flow (pcu)	Modelled Flow (pcu)	GEH
M27 Junction 9	6309	6356	0.6
Segensworth Roundabout	5939	5595	4.5
Parkway South Roundabout	3197	3261	1.1

9.4.2 Turning Movements

(i) M27 Junction 9

Figure 9.1 below illustrates observed and modelled turning movements at M27 Junction 9. It can be seen that the total flow observed into each arm of the junction is closely matched by the modelled flows. Table 9.8 indicates that the modelled flow into each arm of the junction achieves a GEH value less than 5.

Table 9.9 below shows the GEH values achieved on each turning movement. It can be seen that all turning movements have a GEH value of 5 or less. It is of particular note that the turning proportions leaving Whiteley achieve a very good level of validation.

It is considered that the modelled turning proportions at M27 Junction 9 validate to an acceptable level.

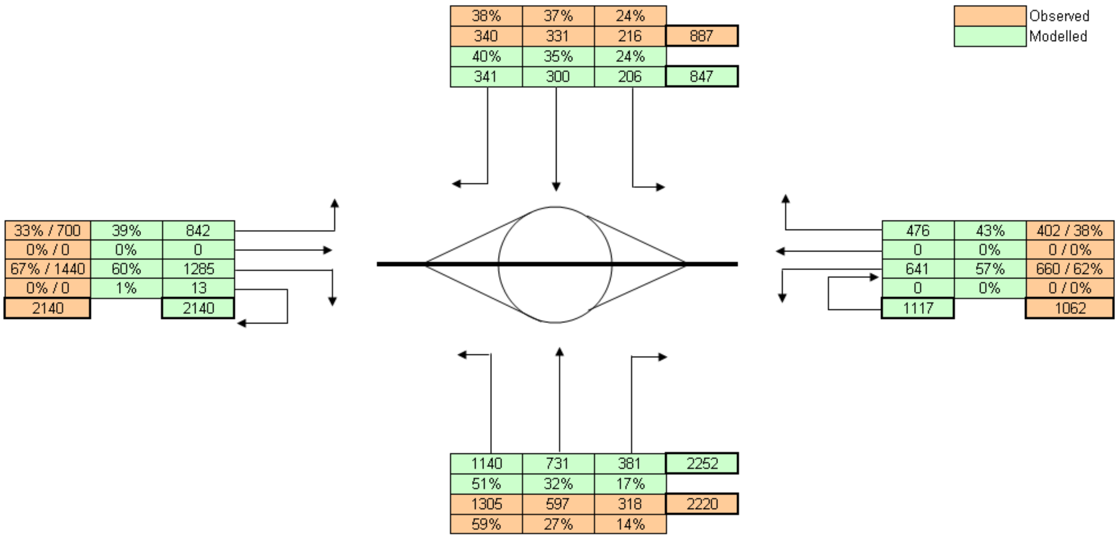


Figure 9.1: Turning movements at M27 Junction 9

Table 9.8: Validation of inbound flow on each arm of M27 Junction 9

Arm	Observed Flow (pcu)	Modelled Flow (pcu)	GEH
M27 eastbound offslip	2140	2140	0.0
Whiteley Way southbound	887	847	1.4
M27 westbound offslip	1062	1117	1.7
Southampton Road northbound	2220	2252	0.7

Table 9.9: Validation of turning movements at M27 Junction 9

Turn Direction	Observed Flow pcu (Turn Proportion)	Modelled Flow pcu (Turn Proportion)	GEH
M27 Eastbound Offslip			
Left	700 (33%)	842 (40%)	5.1
Right	1440 (67%)	1285 (60%)	4.2
Whiteley Way Southbound			
Left	216 (24%)	206 (24%)	0.7
Straight	331 (37%)	300 (35%)	1.7
Right	340 (38%)	341 (40%)	0.1
M27 Westbound Offslip			
Left	660 (62%)	641 (57%)	0.7
Right	402 (38%)	476 (43%)	3.5
Southampton Road Northbound			
Left	1305 (59%)	1140 (51%)	4.7
Straight	597 (27%)	731 (32%)	5.2
Right	318 (14%)	381 (17%)	3.4

(ii) Segensworth Roundabout

Figure 9.2 below compares observed and modelled turning movements at Segensworth Roundabout. Table 9.10 below shows GEH values achieved for total inbound flow on each arm of the junction. All modelled inbound flows achieve a GEH value less than 5 which demonstrates that the model is delivering a robust level of traffic to each arm of the junction.

Table 9.11 shows the GEH values achieved between the 3 major turning movement at the junction i.e. Southampton Road southbound, A27 northbound and A27 eastbound. Whilst turning movements from A27 eastbound and A27 northbound are generally good, it can be seen that the model only achieves an intermediate level of validation for the straight ahead movement southbound through the junction. Demand for this turning movement is short by approximately 325 pcu. This shortfall may be accounted for by consideration of turns to the minor arms at the junction, which as shown by figure 9.2 are oversubscribed by 250 pcu. In addition to this, the total movement into the junction from this arm (as shown by table 9.10) indicates that overall demand is short by approximately 150 pcu. The straight ahead movement southbound through Segensworth is mostly comprised of traffic exiting the model towards zones 5 (Fareham), 6 (Gosport) and 12 (Stubbington). As such it is unlikely that a shortfall in this movement will have a significant adverse effect on forecasts produced by the model relating to access to Whiteley.

It is considered that the modelled turning proportions at Segensworth Roundabout validate to an acceptable level for the purposes of the model.

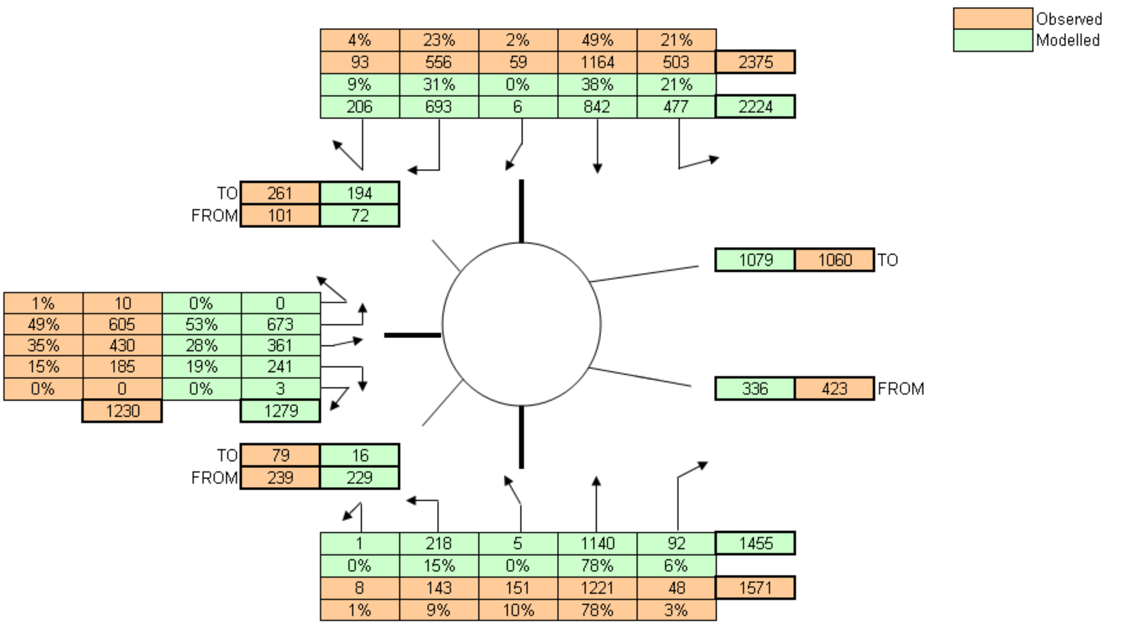


Figure 9.2: Turning movements at Segensworth Roundabout

Table 9.10: Validation of inbound flow on each arm of Segensworth Roundabout

Arm	Observed Flow (pcu)	Modelled Flow (pcu)	GEH
Southampton Road southbound	2375	2224	3.1
Segensworth Road westbound	423	336	4.5
A27 northbound	1571	1455	3.0
Southampton Road northbound	239	229	0.7
A27 eastbound	1230	1279	1.4
Little Park Farm Road southbound	101	72	3.1

Table 9.11: Validation of major turning movements at Segensworth Roundabout

Turn Direction	Observed Flow (pcu)	Modelled Flow (pcu)	GEH
Southampton Road southbound			
Straight	1164	842	10.2
Right	556	693	5.5
A27 northbound			
Left	143	218	5.6
Straight	1221	1140	2.4
A27 eastbound			
Left	605	673	2.7
Right	185	241	3.8

(iii) Parkway South

Figure 9.3 below compares observed and modelled turning movements at Parkway South Roundabout. Table 9.12 below shows that all modelled inbound flows achieve a GEH value less than 5 which demonstrates that the model has an adequate level of demand at this junction.

Table 9.13 compares the observed and modelled turning movements at the Parkway South roundabout. GEH values achieved for each of the turning movements are generally below 5, however the left turn from Whiteley Way southbound only achieves a GEH value of 12 owing to a deficit of 79 pcu. Analysis of the model has shown that traffic entering the business park from the north Whiteley residential area is assigned to enter the Business Park cordon at the Parkway North junction upstream. Therefore it is considered that whilst this turning movement does not achieve an acceptable level of validation, it is does not present any significant adverse effect on the model as a whole.

It is concluded that the modelled turning movements at Parkway South Roundabout achieve an acceptable level of validation.

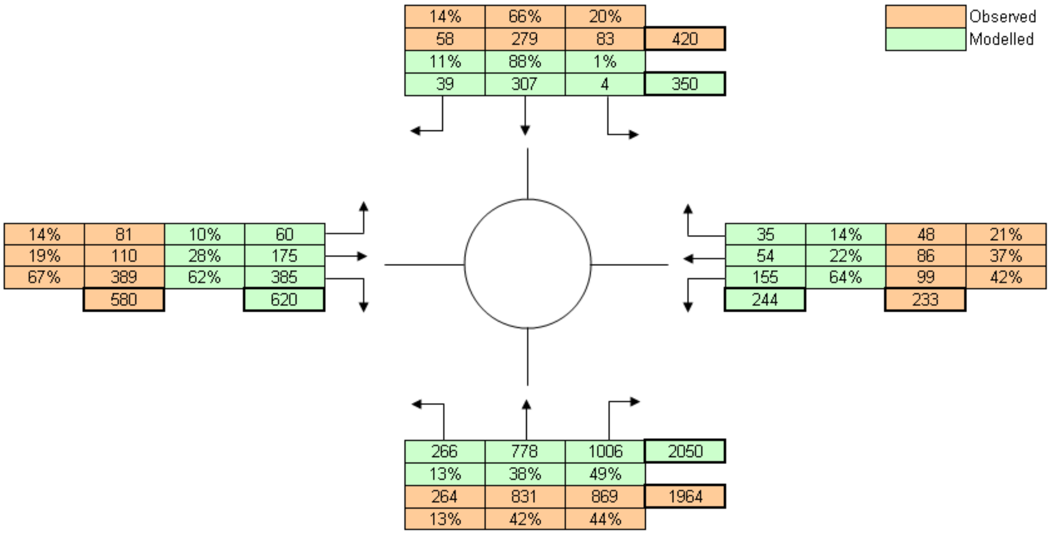


Figure 9.3: Turning movements at Parkway South Roundabout

Table 9.12: Validation of inbound flow on each arm of Parkway South Roundabout

Arm	Observed Flow (pcu)	Modelled Flow (pcu)	GEH
Whiteley Way northbound	1964	2049	1.9
Rookery Avenue eastbound	580	619	1.6
Whiteley Way southbound	420	350	3.6
Parkway South westbound	233	243	0.6

Table 9.13: Validation of turning movements at Parkway South Roundabout

Turn Direction	Observed Flow pcu (Turn Proportion)	Modelled Flow pcu (Turn Proportion)	GEH
Whiteley Way northbound			
Left	264 (13%)	266 (13%)	0.1
Straight	831 (42%)	778 (38%)	1.9
Right	869 (44%)	1006 (49%)	4.5
Rookery Avenue eastbound			
Left	81 (14%)	60 (10%)	2.5
Straight	110 (19%)	175 (28%)	5.4
Right	389 (67%)	385 (62%)	0.2
Whiteley Way Southbound			
Left	83	4	12.0
Straight	279	307	1.6
Right	58	39	2.7
Parkway South westbound			
Left	99	155	5.0
Straight	86	54	3.8
Right	48	35	2.0

9.5 Journey Times

9.5.1 Whole Route Times

Figure 3.4 illustrates the journey time routes that have been surveyed for the purposes of model validation. Table 9.14 below compares total observed and modelled journey times for each journey time route surveyed. It can be seen that the error on each route is within the target 15% error as stated in section 6.3.2.

Table 9.14: Validation of journey times (whole route)

	Journey Time (s)	
	Route 1	Route 2
Observed	750	721
Model	639	789
Error	-111 (-14.8%)	+68 (+9.5%)

9.5.2 Route Commentaries

Figures 9.4 and 9.5 overleaf show time versus distance plots comparing modelled and observed journey times.

(i) Route 1

Route 1 achieves particularly good validation from 0 to 4km, equivalent to the portion of route from Whiteley Way through the Business Park, eastbound along Leafy Lane and southbound along Whiteley Lane and Cartwright Drive to St Margaret's Roundabout. The modelled journey time of the following section of route passing northbound along the A27 from St Margaret's Roundabout to Segensworth Roundabout (from 4 to 5km) has a greater average speed than was observed. The modelled journey time for the remainder of the route northbound through Segensworth Roundabout and M27 Junction 9 compares well to the observed times.

(ii) Route 2

Route 2 closely matches observed journey times for a majority of the route. Good validation is achieved as the route moves southbound through M27 Junction 9 and Segensworth Roundabout, and subsequently northbound along Cartiwright Drive, Whiteley Lane and Leafy Lane. The modelled times indicate surplus delay in the model at the junction between Leafy Lane and Parkway South (5.3km) and also at the entry into Parkway South Roundabout from Whiteley Way North.

9.5.3 Evaluation of Journey Time Validation

It has been demonstrated as far as possible that the model is able to reproduce realistic journey times and delays on the key routes into and out of Whiteley, and north/south through the internal model area.

The model meets the 15% error target stated in section 6.3.2 for each of the routes surveyed, and also exhibits time versus distance profiles with a good level of fit to observed profiles. As such it is considered that the modelled journey times validate to an acceptable level, albeit based on limited observed data.

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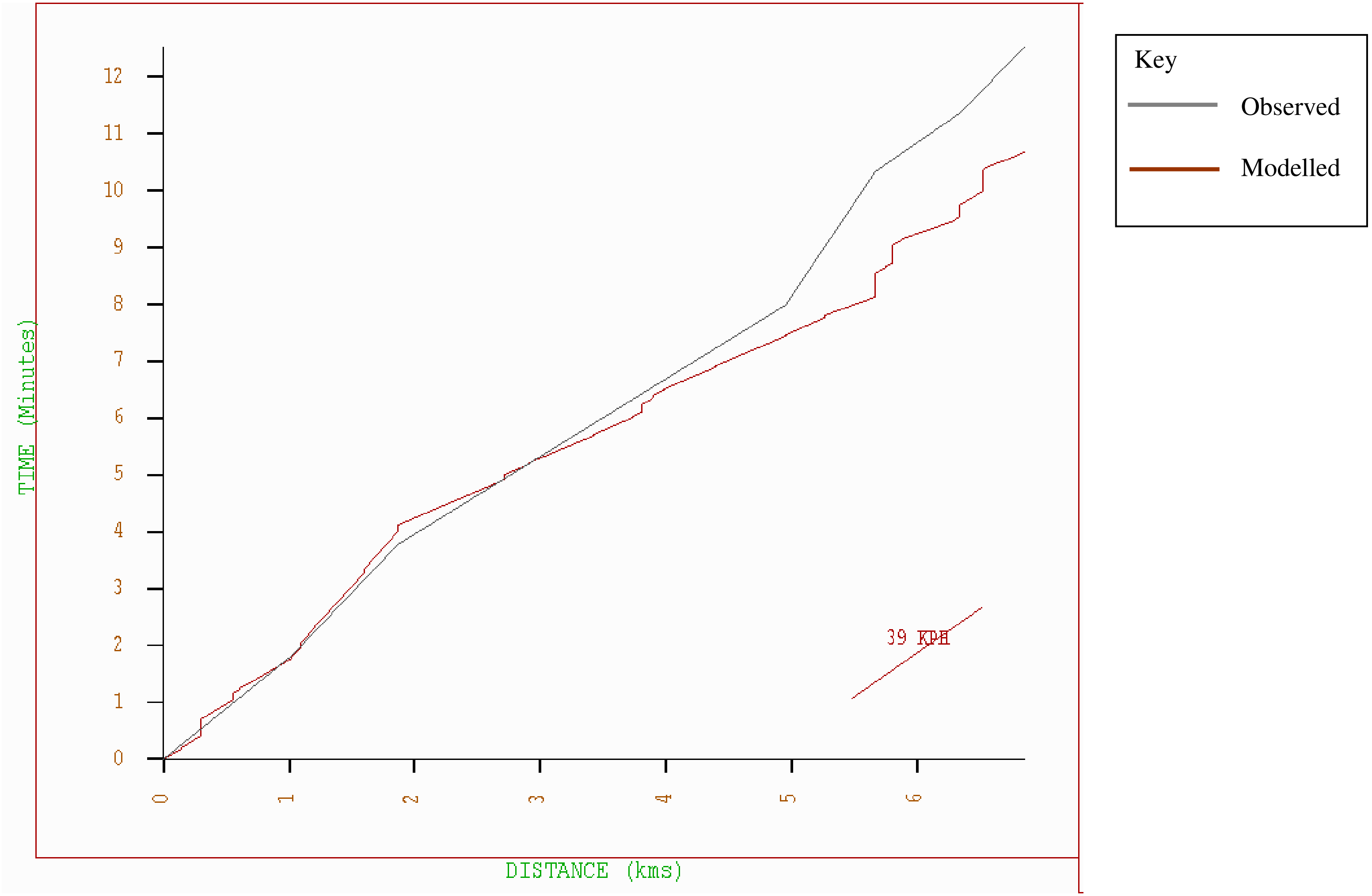

Figure 9.4: Time versus distance plot for journey time route 1

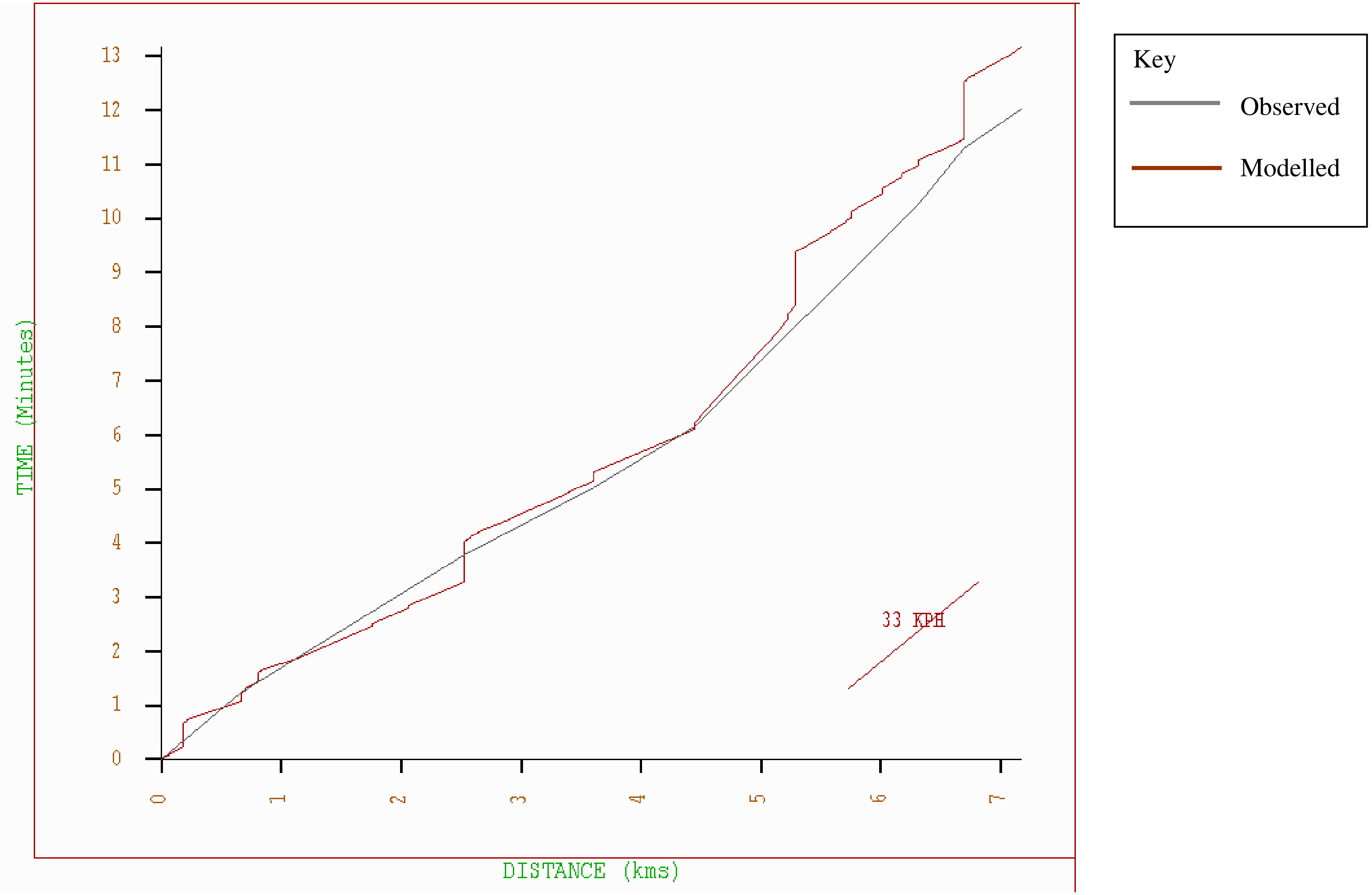

Figure 9.5: Time versus distance plot for journey time route 2

10 SUMMARY AND CONCLUSIONS

10.1 Summary of Model Requirements

The study brief for the Whiteley traffic model highlights the following modelling requirements:

- To forecast the effect of proposed schemes which alter available access routes into Whiteley;
- To forecast how traffic from additional developments in Whiteley will be distributed across the network within the context of proposed access schemes.

These modelling requirements dictate that movements into and out of Whiteley must be robust and the model must contain adequate levels of traffic demand and consequent delay in order to produce realistic routeing between Whiteley and non-Whiteley zones once access arrangements are altered as a result of option testing.

10.2 Key Conclusions

To evaluate model acceptability according to these requirements, the model has been validated across a number of screenlines, cordons, key junctions and journey time routes. This LMVR has presented the results of this validation process, allowing the following conclusions to be drawn as follows:

- The model demonstrates very good validation across all screenlines and cordons.
- The level of modelled demand at key junctions in the network has been shown to closely match observed demand.
- Turning movements at key junctions have validated well for the majority of turns evaluated.
- The model is able to reproduce realistic journey times and delays on the key routes into and out of Whiteley, and north/south through the internal model area.
- The model has achieved a very good level of demand and robust distribution of trips into and out of Whiteley.

Based on the validation targets outlined in chapter 6 of this LMVR, the 2008 base Whiteley Traffic Model provides a robust representation of 2008 traffic patterns within the study area, and that it is a suitable base for the development of a future year model to forecast how traffic from additional developments in Whiteley will be distributed across the network within the context of proposed access schemes.

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FIGURES