

## Annex T – Demand Model Report

This Annex reproduces the Demand Model Report written by Rand Europe. Chapters include information on Estimation Data; Mode-Destination Model Structure; Mode-Destination Model Results; Mode-Destination Model Validation; Frequency Models and a Summary.

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# Wycombe Transport Model

## Local Demand Model Estimation

JAMES FOX,  
CHONG WOO KIM

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EUROPE

# Preface

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RAND Europe, in partnership with Halcrow, have been commissioned by Buckinghamshire County Council to develop a new transport model for the High Wycombe Area.

A transport model was developed by Halcrow for Buckinghamshire County Council and Wycombe District Council in 1992, using survey data collected in 1991. This model has been used to establish a development and transport strategy in the Wycombe Transport Study (WTS), and subsequently to assist Wycombe District Council in reviewing development sites for the Wycombe Transport Local Plan. There is now a need for a new modelling capability in response to the local and regional influences on Wycombe, and based upon recent data.

This report documents the estimation of a new local demand model for Wycombe, and will be incorporated into the Model Development Report to be produced by Halcrow. The work to develop the local demand model has been undertaken by RAND Europe.

A total of six reports will be produced by Halcrow during the course of this study:

- a) Inception Report;
- b) Report of Survey;
- c) Existing Conditions Report;
- d) Model Development Report, of which this report will form part;
- e) Forecasting Report; and
- f) Model User Guide.

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For more information about RAND Europe or this document, please contact James Fox at:

RAND Europe  
Westbrook Centre  
Milton Road  
Cambridge  
CB4 1YG  
+44 (0)1223 353 329  
[jfox@rand.org](mailto:jfox@rand.org)

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This report documents the estimation of the local demand model for the new Wycombe Transport model. The implementation of the local demand model is reported separately.

Consistent with the requirements set out in the study brief, variable demand models have been developed for this study. The demand models have been developed from local data, namely interviews of 1750 households in High Wycombe, undertaken during 2006.

Two sets of linked models have been developed from this household interview data. First are travel frequency models that predict, by person type and journey purpose, the volume of travel on an average weekday. Second are joint mode-destination models that predict, by person type and journey purpose, the modes and destinations chosen to make this travel.

The mode-destination models are more complex in nature, and so form the main focus of this report. Chapter 2 sets out the modelling assumptions, Chapter 3 documents the data used in model estimation, and Chapter 4 details the structure of the models. Then Chapter 5 presents the results for the final model specifications, and Chapter 6 presents the validation of these final models. The frequency models are then documented separately in Chapter 7. The report concludes in Chapter 8 with a summary of the model development.

This Chapter sets out the assumptions made to develop the models of frequency and mode and destination choice. Section 2.1 lists the model purposes, Section 2.2 explains the use of tours, and Section 2.3 the modes modelled in the mode-destination choice models.

## 2.1 **Purposes**

Travel for five home-based purposes has been modelled:

- home-based work, i.e. commuting;
- home-based (employer's) business;
- home-based education;
- home-based shopping; and
- home-based other travel.

Home-based travel has been modelled using tours, which are defined in Section 2.2.

Travel for two non-home-based (NHB) purposes has also been modelled:

- NHB (employer's) business; and
- NHB other travel.

NHB travel has been modelled as trips, not tours.

## 2.2 **Tours**

Home-based travel has been modelled using tours. A home-based tour is a series of linked trips starting and finishing at the individual's home.

The principal advantages of modelling travel as tours, not trips, are the following:

- Tour based approaches model the choice of mode (and possibly destination) as a function of network conditions on both the outward *and* return legs of the tour, whereas trip based approaches model each leg independently;
- Tour based approaches model the choice of mode for the entire tour, e.g. if an individual drives to work they are highly likely to drive home again. Because trip

based approaches model each leg independently, the relationship between outward and return leg modes is missing;

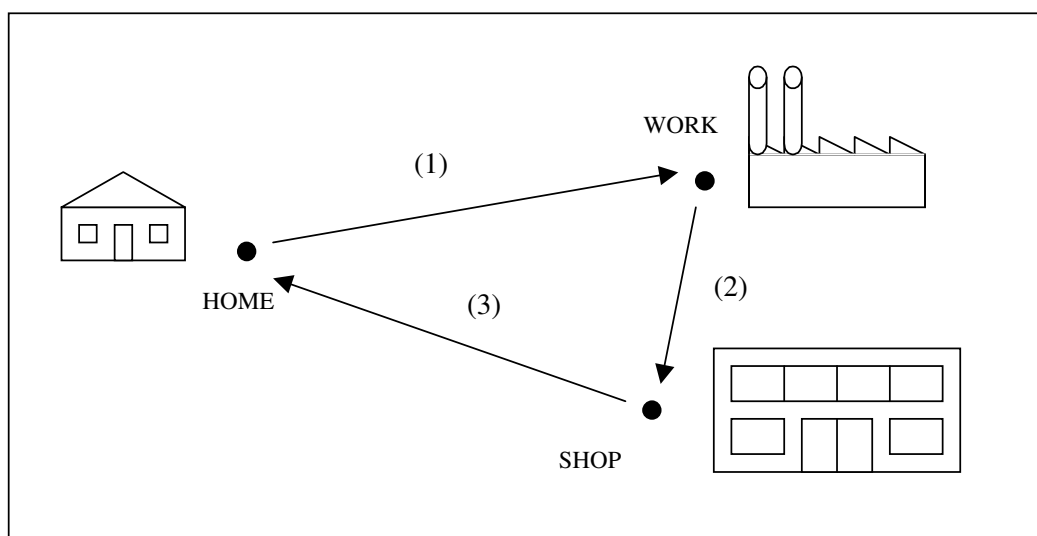
- Similarly, tour based approaches ensure mode consistency for non-home-based journeys, e.g. non home based car journeys can only be undertaken by travellers who have travelled by car to their destination; and
- Tour based approaches are usually more appropriate for modelling the costs of public transport journeys by travelcards, etc..

Some half-tours are observed in the Home Interview survey, i.e. chains of trips that start outside the home and return to home, or chains of trip that leave home but do not return. However, half-tours form a low percentage of the data<sup>1</sup> and are not modelled.

As noted above, a tour is a series of linked trips starting and finishing at the home. If a traveller makes a simple return journey then it is straightforward to determine the 'primary destination' of the tour, e.g. a home-work-home sequence of trips has its primary destination (PD) as work, and hence is a work tour. However, for more complex sets of trips, it is necessary to define rules to identify the PD of the tour.

This problem is illustrated in Figure 1.

**Figure 1: Tour Example**



In this example a worker travels directly to work in the morning, but on the way home they divert to the shops. Rules are necessary to define the PD of the tour.

To determine the PD the following purpose hierarchy is employed:

- work;
- business; and
- other purposes.

<sup>1</sup> Half tours represent 2.0 % of all tours observed in the Home Interview.

If there are ties, i.e. more than one destination is visited that lie at the same level in the purpose hierarchy, then the destination at which the most time was spent is taken as the PD. In the example given in Figure 1, work is higher in the hierarchy than shopping and so forms the PD. Therefore work is specified as the purpose of the tour, and the return trip between the home and work is modelled. Trip (2) between the workplace and the shopping location would be modelled separately as a non-home-based trip.

In the demand models developed for this project, non-home-based travel is modelled and therefore the additional kilometrage associated with such trips is represented. RAND Europe have undertaken analysis in other studies that demonstrates that the detour location is typically closer to the PD, and therefore modelling a direct return trips between the home and the PD, plus a one-way trip between the PD and the detour location, is a reasonable approximation of the exact trip kilometrage. In the context of Wycombe, it would be expected that the PD and the detour location would be both located in the city centre.

### 2.3 Modes

Five modes have been represented in the models:

- car driver;
- car passenger;
- public transport;
- walk; and
- cycle.

Representing car driver and car passenger separately enables the impact of policy on car occupancy to be assessed.

Public transport has been represented as a single mode, combining bus and train trips. The approach to combine these modes in the modelling is discussed in Section 4.1.

Including walk and cycle modes is particularly important for short distance trips, and to enable the assessment of policies that seek to increase the share of walk and cycle trips, such as increases in the costs of motorised modes.

This Chapter summarises the data that was used in the model estimation. Section 3.1 briefly describes the choice data that is the core of the model estimation, the household interview data. Sections 3.2 and 3.3 describe the level of service data extracted from the highway and public transport networks. Section 3.4 describes the approach used to model car costs, and then the chapter concludes in Section 3.5 with a brief description of the planning data used in model estimation.

### 3.1 **Choice Data**

The choice dataset for model estimation was a dedicated household interview collected during June, July, September and October of 2006. A total of 1750 households were interviewed, with person level information collected for all individuals in the household, together with details of any trips the individuals made on the survey day, i.e. this is a one-day travel survey.

The household data collected that was used in the modelling comprised:

- home zone location
- car ownership

The person data collected that was used in the modelling was;

- gender
- age
- (car) licence holding
- working status (full-time worker, part-time worker, retired etc.)
- occupation code
- industry code
- concessionary pass ownership

The trip level data that was taken, and processed into home-based tours, comprised:

- trip origin and destination zone
- trip departure and arrival times

- trip mode of travel
- trip purpose

## 3.2 Highway Level of Service Data

The highway level of service data (LOS) was generated by Halcrow using the CONTRAM assignment package. Three model time periods were represented:

- AM-peak: 07:00-10:00
- inter-peak: 12:00-14:00
- PM-peak: 16:00-19:00

The skims from CONTRAM give the total distance and total travel time for each origin-destination pair for these three time periods for use in the mode-destination modelling. Note that LOS from the inter-peak has been used to represent the entire inter-peak (10:00-16:00) as well as the off-peak (00:00-07:00, 19:00-24:00) in the demand models.

During the mode-destination model estimation, the observed travel times from the Household Interview are used to determine the LOS to model the outward and return legs. For example, if an individual travels out in the AM-peak, and returns home in the PM-peak, then LOS from these time periods is used to represent the outward and return tour legs respectively.

## 3.3 Public Transport Level-of-Service Data

The public transport LOS data was generated by Halcrow using the EMME/2 assignment package. The PT LOS does not vary with time period.

Separate networks have been built for both bus and rail. In the demand models, a single PT mode is modelled and therefore it was necessary to combine the bus and rail LOS data. The procedure used to combine the LOS is discussed in Section 4.1.

## 3.4 Car Costs

### 3.4.1 Operating Costs

Car operating costs have been calculated using the procedure set out in WebTAG Unit 3.5.6, Section 1.3.1. In summary, fuel consumption is calculated as a cubic function of speed. Consumption is then calculated from the network distance and an appropriate mean fuel cost, accounting for changes in the petrol-diesel split in the fleet over time. In this study, speeds have been calculated on an OD basis from the skimmed distances and costs, rather than using a network average.

When the modelling work was undertaken, actual 2005 fuel costs were given in WebTAG together with a forecast increase of 7.89% between 2005 and 2006. This gave an average 2006 fuel cost of 80.3 p/l in 2002 prices equivalent to 90.3 p/l in 2006 prices.

Non-fuel costs are included only for business travel. These are also calculated as per-kilometre cost calculated as a function of speed.

### 3.4.2 Parking Costs

To include model parking costs in model estimation it is necessary to create files defining the average parking cost in each destination zone, ideally split between commuters and others.

Some information on parking costs was recorded in the household interview, but the sample sizes are relatively small, and furthermore most parking is free away from the central area. Consequently parking costs are not included in model estimation.

### 3.4.3 Inflation and Income Growth

WebTAG costs in 2002 prices have been adjusted to account for growth in Retail Prices to 2006, using the RPI Index published by National Statistics. The following values have been used.

**Table 1: RPI Indices**

| Year | RPI   |
|------|-------|
| 2002 | 176.2 |
| 2006 | 198.1 |

As incomes grow in real terms over time, travellers' values-of-time increase, and therefore the sensitivity to cost declines over time. In the final models values-of-time from WebTAG were used to convert travel costs into generalised time units and it was necessary to adjust the 2002 VOTs from WebTAG to reflect 2006 values. This adjustment was performed using the adjustment factors provided in Table 3 of WebTAG Unit 3.5.6.

## 3.5 Attraction Data

For model estimation files have been produced defining the following land-use data for each model zone:

- population
- total employment
- retail employment
- service employment
- education employment

These files are used to specify the attraction variables used to measure the attractiveness of destination zones. The following table details the attraction variables used for each travel purpose. The selection of attraction variables was made based on our experience in developing disaggregate mode-destination choice models in other urban areas.

**Table 2: Attraction Variables**

| Purpose                 | Attraction Variables |
|-------------------------|----------------------|
| Commute                 | Total employment     |
| Home Business           | Total employment     |
| Home Education          | Education enrolments |
| Home Shopping           | Total employment     |
| Home Other Travel       | Population           |
| Non-Home-Based Business | Total employment     |
| Non-Home-Based Other    | Population           |
|                         | Total employment     |

For education, primary, secondary and tertiary enrolment data was supplied for use in model estimation. Different attraction variables are used depending on the age of the individual, with primary enrolments used for students aged 5-11, secondary enrolments for students aged 12-18, and tertiary enrolments for students aged 19 and above.

Ideally, retail employment would be used as the attraction variable for shopping, but it was not available for this study, and so total employment was used instead. In the PRISM model for the West Midlands, both retail and total employment data were available. Analysis of the PRISM data indicated a strong positive correlation between the two variables of +0.994, indicating that using total employment is a good assumption in the absence of retail employment information.

To model the two other travel purposes, a combination of attraction variables is used, reflecting the diverse nature of these categories. For example other travel includes visiting friends, where population is an appropriate attraction variable, as well as personal business, where total employment is more appropriate. The relative importance of the two attraction variables is determined during the model estimation.

This Chapter begins with a description of the mode and destination alternatives in the model. Section 4.2 sets out the variables represented in the mode-destination models, with descriptions of the level of service variables, the car availability variables, and other socio-economic variables. The Chapter concludes, in Section 4.3, with a discussion of the structural tests, which are run to assess the relative sensitivity in mode and destination choices.

#### 4.1 **Alternatives**

The models described here are simultaneous models of mode and destination choice. Simultaneous estimation of these responses has a number of advantages: firstly, this approach ensures consistent treatment of time and cost terms in each model component, secondly, it allows different model hierarchies to be tested explicitly and, thirdly, it introduces more variation in the time and cost terms making the procedure more statistically efficient for model estimation. Thus the alternatives represented in the models are the possible combinations of mode and destination zone.

As noted in Section 2.3, five modes have been modelled:

- car driver;
- car passenger;
- public transport;
- walk; and
- cycle.

The Household Interview (HI) data records bus and train trips separately, and separate bus and train level of service was supplied by Halcrow for the modelling.

Based on experience from the development of the Aylesbury demand models, the tours were segmented into internal tours, those with both home and primary destination within Wycombe, and external tours. those with their home-end in Wycombe but with their primary destination elsewhere, and the numbers of bus and train users analysed by this segmentation.

Of the 312 internal tours, all but one was made by bus<sup>2</sup>, and so it was decided to use the bus level of service to model internal tours.

Of the 263 tours to external destinations, 36.1% used bus and 63.9% used train, so both modes are important. Therefore the approach used to combine the level of service (LOS) was to use train LOS first, but for origin-destination pairs where train was not available, bus LOS was used instead. If neither the train nor bus alternatives had LOS, then the origin-destination pair was assumed to have no public transport services and the public transport mode was made unavailable.

To specify the availability of the model alternatives to individuals in the modelling the following conditions were used:

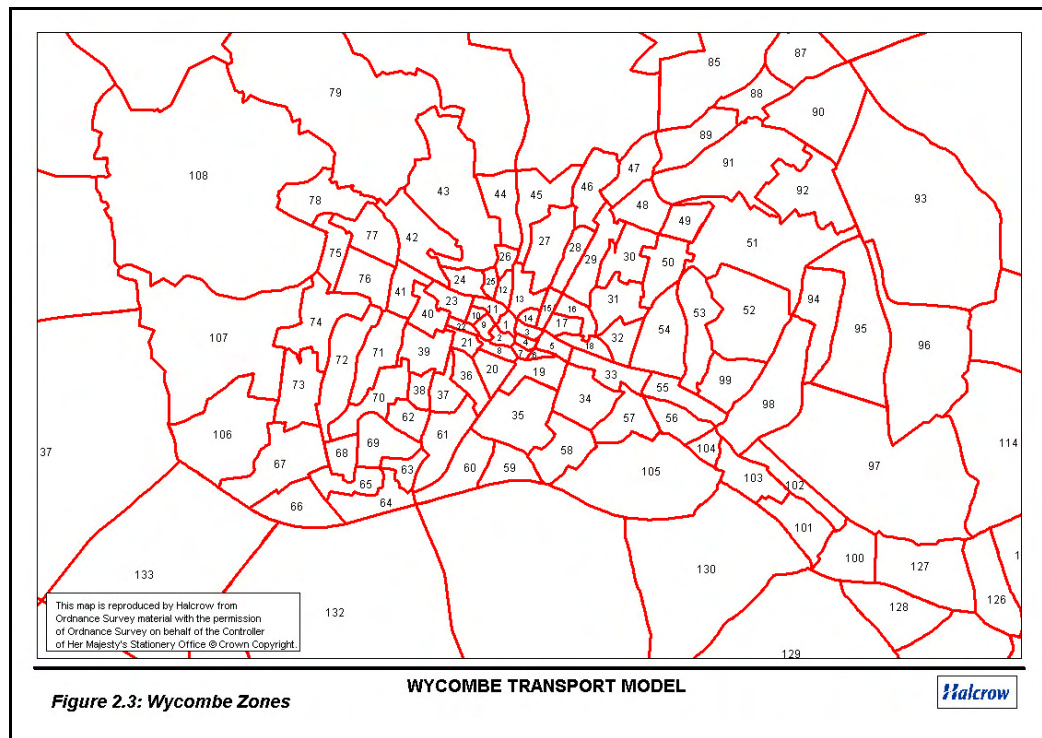
- the car driver alternative is only available to individuals from households with at least one car who have a licence;
- car passenger is available to all respondents;
- the public transport alternative is only available if there is a public transport path between the origin and destination pair in question; and
- walk and cycle modes are available to all respondents.

The destination alternatives are the 201 zones represented in the model, 108 of which cover the Wycombe area. Destinations are only available if there is a non-zero attraction variable, so some destination zones are unavailable as they contain no employment or enrolments. The zones in Wycombe are illustrated in the following figure. It can be seen that smaller zones are used to represent the city centre area more accurately.

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<sup>2</sup> Note that there is only one train station in High Wycombe,

**Figure 2: Wycombe Zone Map**



## 4.2 Variables

### 4.2.1 Level of Service Terms

In the first models, separate terms were estimated for each level of service (LOS) component as specified in the following table. The columns represent the modes, and the rows represent the various LOS data. The cell values then define the LOS parameters that enter the utility function for each mode.

**Table 3: Initial Level of Service Specification**

| LOS Component      | Car Driver        | Car Passenger      | Public Transport   | Walk               | Cycle               |
|--------------------|-------------------|--------------------|--------------------|--------------------|---------------------|
| Driving Cost       | $\beta_{Cost}$    |                    |                    |                    |                     |
| PT Fare            |                   |                    | $\beta_{Cost}$     |                    |                     |
| Car Time           | $\beta_{CarTime}$ | $\beta_{CarTime}$  |                    |                    |                     |
| PT Time            |                   |                    | $\beta_{PTIVTime}$ |                    |                     |
| Access/Egress Time |                   |                    | $\beta_{AcEgTime}$ |                    |                     |
| Wait Time          |                   |                    | $\beta_{WaitTime}$ |                    |                     |
| Interchange Time   |                   |                    | $\beta_{IntTime}$  |                    |                     |
| Distance           |                   | $\beta_{CarPDist}$ |                    | $\beta_{WalkDist}$ | $\beta_{CycleDist}$ |

LOS for intrazonals, that is tours with and origin and destination within the same zone, require careful consideration. For modes modelled with the highway LOS (car driver, car passenger, walk and cycle), LOS service is defined for intrazonals directly from the highway assignment model. Therefore intrazonal tours can be modelled, which is particularly

important for the walk and cycle modes. For public transport no LOS is defined and so intrazonals are unavailable, this presents no problems for the modelling as very few intrazonal tours are observed by public transport.

The hilliness of the Wycombe area will have a substantial impact upon the attractiveness of the walk and cycle alternatives. An improved representation of these models could be introduced into the modelling by accounting for differences in gradient on an OD basis. However, walk and cycle modes are not assigned to networks, and therefore the additional resources required for such analysis were not felt to be justified. Therefore, the walk and cycle distance terms and mode-specific constants estimated will represent averages across the Wycombe area.

#### 4.2.2 Car Availability Terms

Substantial improvements in model fit can be achieved by specifying terms relating to levels of car availability in the models, which are determined as a function of:

- individual licence holding;
- household licence holding; and
- household car ownership.

For the car driver alternative, 'car competition' terms are defined if there are more licence holders than cars in the household. In such cases, competition exists for the cars in the household and consequently the likelihood of a given individual having a car available for their journey is lower. Therefore constants are added to the models to reflect the lower probability of choosing car driver when there is car competition. Sometimes these car competition terms are specific to one car households, or to two-plus car households.

For the car passenger alternative, the probability of travelling as a passenger is substantially higher if another household member is able to provide a lift. This is possible if at least one other household member has a licence, and there are one or more cars in the household. This condition is used to specify 'passenger opportunity' terms. These passenger opportunity terms may be interacted with household size; in larger households 'competition' may exist for the lifts and so the likelihood of travelling as a passenger is lower than in two-person households.

Setting this out in notation form, define:

- $L_i(0,1)$  as individual licence holding;
- $H = \sum_i L_i$  as household licence holding, summed over individuals; and
- $C$  as household car ownership.

For car driver, the alternative is only available if  $L = 1$  and  $C \geq 1$ . Then car competition is defined as  $H > C$ .

For car passenger, the passenger opportunity term is applied if  $C \geq 1$  and  $H - L > 0$ .

### 4.2.3 Socio-Economic Terms

In addition to the licence holding and car ownership information, a substantial amount of socio-economic information is available from the household interview which allows socio-economic terms to be added. These terms take account of differences in modal preferences across the population, and also improve the model fit. The following variables are available:

- age;
- gender;
- working status (full-time worker, full-time student, retired etc.);
- occupation; and
- public transport pass ownership.

These variables have been used to test for socio-economic parameters to improve mode choice. These parameters are identified by comparing the model predictions against observed data across a range of socio-economic segmentations. This process of applying the model is performed using the estimation software.

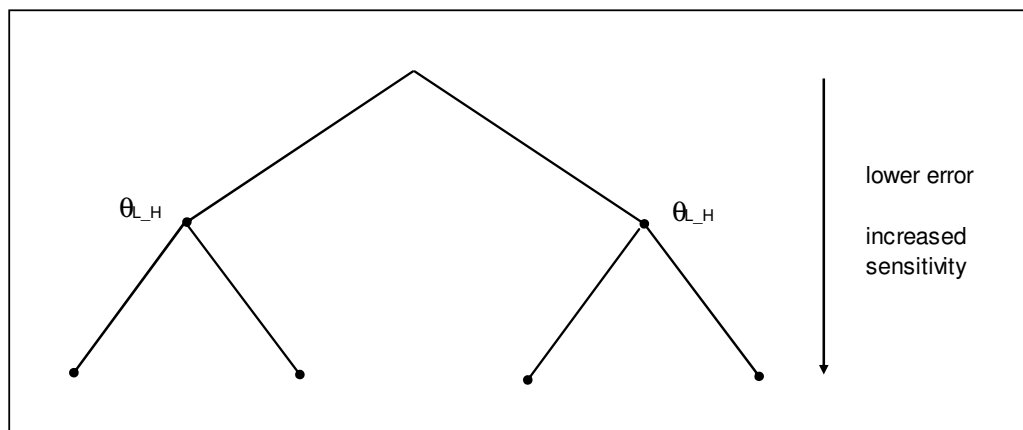
### 4.2.4 Destination Constants

Once the level of service specification has been finalised, and the car availability and socio-economic terms had been identified, observed and predicted trip length distributions were compared to assess the fit of the models. Destination constants were then added as necessary to improve the destination choice fit of the model. These terms are described in Section 5.4.

## 4.3 Scaling Tests

The model development was undertaken with multinomial models, i.e. mode and destination choice equally sensitivity to changes in utility. For the final model specifications, tests were made to assess the relative scale of mode and destination choices. To perform these tests model structures were set up as illustrated in Figure 3.

**Figure 3: Scaling Tests**



Choices represented lower down in the tree have lower levels of error, and are more sensitive to changes in utility. The scaling parameter  $\theta_{L_H}$  defines the relative levels of error in the lower and higher levels of the tree:

$$\theta_{L_H} = \frac{\sigma_L}{\sigma_H} \quad (4.1)$$

where:  $\sigma_L$  is the standard deviation in the utilities at the lower level

$\sigma_H$  is the standard deviation in the utilities at the higher level

For the structure to be valid we expect  $\sigma_H \geq \sigma_L$  which gives the condition  $0 \leq \theta_{L_H} \leq 1$ . If a model is estimated that gives  $\theta_{L_H} > 1$  then the structure is rejected, and a structure would be tested with the higher and lower levels reversed.

This chapter presents results for the final model specifications. Section 5.1 sets out the final level of service specifications used, Section 5.2 details the car availability parameters identified, and Section 5.3 lists the socio-economic parameters that have been identified. Finally, Section 5.4 discusses the results from the scaling tests to assess the relative levels of error in mode and destination choice.

The full sets of parameter values for the final models are presented in Appendix A.

Prior to presenting the model results, it is useful to summarise the mode shares in the final models. It is noted that for some purposes certain modes were dropped due to lack of data – these modes are highlighted in grey in Table 4.

**Table 4: Mode Shares by Purpose**

|                  | Commute | Business | Edu.    | Shopping | Other Travel | NHB Business | NHB Other |
|------------------|---------|----------|---------|----------|--------------|--------------|-----------|
| Observations     | 984     | 130      | 245     | 607      | 1139         | 192          | 1195      |
| Car driver       | 79.9 %  | 89.2 %   | 0.4 %   | 55.5 %   | 61.1 %       | 92.7 %       | 67.0 %    |
| Car passenger    | 6.7 %   | 4.6 %    | 44.5 %  | 20.3 %   | 16.1 %       | 3.1 %        | 14.9 %    |
| Public transport | 6.5 %   | 6.2 %    | 13.1 %  | 10.0 %   | 2.6 %        | 0.0 %        | 3.4 %     |
| Cycle            | 1.2 %   | 0.0 %    | 4.1 %   | 0.7 %    | 1.1 %        | 0.0 %        | 0.3 %     |
| Walk             | 5.7 %   | 0.0 %    | 38.0 %  | 13.5 %   | 19.1 %       | 4.2 %        | 14.4 %    |
| Total            | 100.0 % | 100.0 %  | 100.0 % | 100.0 %  | 100.0 %      | 100.0 %      | 100.0 %   |

Overall, car use by Wycombe residents is high, with only education having a PT mode share greater than 10%. Apart from education, cycle usage is also low, which may be related to the hilliness of the town.

### 5.1 Level of Service Specification

As discussed in Section 4.2.1, the initial model specifications tested separate terms for each level of service (LOS) component, the objective being to identify Wycombe-specific LOS parameters. However, the relatively small sample sizes in the Wycombe Household Interview meant it was not possible to estimate separate terms that were statistically significant.

As a result it was necessary to combine the cost, in-vehicle time and out-vehicle time components into a single generalised time term. For public transport, access and egress time, wait time and interchange time were weighted with a factor of two relative to in-vehicle time. It was assumed that car in-vehicle time and public transport in-vehicle time were weighted equally.

To convert costs into generalised time units, values-of-time (VOTs) from Tables 1 and 2 of WebTAG Unit 3.5.6 were used. To adjust the 2002 VOTs given in WebTAG to 2006 prices, the VOT growth forecasts from Table 3 of WebTAG Unit 3.5.6 were used. summaries the values used.

**Table 5: Values-of-Time**

|                  | Employer's Business | Commute | Other  |
|------------------|---------------------|---------|--------|
| 2002 (£/hr)      | 22.11               | 5.04    | 4.46   |
| 2002-2003 change | 1.98 %              | 1.58 %  | 1.58 % |
| 2003-2004 change | 2.22 %              | 1.78 %  | 1.78 % |
| 2004-2005 change | 3.21 %              | 2.57 %  | 2.57 % |
| 2005-2006 change | 2.96 %              | 2.37 %  | 2.37 % |
| 2006 (£/hr)      | 24.49               | 5.47    | 4.84   |

When models using a generalised time term were validated, there was a general tendency for the models to exhibit higher car cost elasticities in comparison to WebTAG guidance. Models with both (linear) generalised time and log generalised time terms were tested. These models gave an improved fit to the data, and more plausible elasticities, and so this generalised time specification was retained in the final models.

The LOS specifications in the final models with the generalised time formulation are summarised in Table 6.

**Table 6: Final Level-of-Service Specification**

| LOS Component                               | Car Driver                               | Car Passenger                            | Public Transport                         | Walk               | Cycle               |
|---|--|--|--|--------------------|---------------------|
| Driving cost / VOT<br>log(Driving cost/VOT) | $\beta_{CenTime}$<br>$\beta_{LnCenTime}$ |  |  |                    |                     |
| PT Fare / VOT<br>log(PT Fare / VOT)         |  |  | $\beta_{CenTime}$<br>$\beta_{LnCenTime}$ |                    |                     |
| Car Time<br>log(Car Time)                   | $\beta_{CenTime}$<br>$\beta_{LnCenTime}$ | $\beta_{CenTime}$<br>$\beta_{LnCenTime}$ |  |                    |                     |
| PT Time<br>log(PT Time)                     |  |  | $\beta_{CenTime}$<br>$\beta_{LnCenTime}$ |                    |                     |
| Acc. Eg. Time * 2<br>log(Acc. Eg. Time * 2) |  |  | $\beta_{CenTime}$<br>$\beta_{LnCenTime}$ |                    |                     |
| Wait Time * 2<br>log(Wait Time * 2)         |  |  | $\beta_{CenTime}$<br>$\beta_{LnCenTime}$ |                    |                     |
| Interch. Time * 2<br>log(Interch. Time * 2) |  |  | $\beta_{CenTime}$<br>$\beta_{LnCenTime}$ |                    |                     |
| Distance                                    |  | $\beta_{CarPDist}$                       |  | $\beta_{WalkDist}$ | $\beta_{CycleDist}$ |

Note that the  $\beta_{LnCenTime}$  terms were not significant in education, and so were dropped from the final model specification.

For both home-based and non-home based other travel, it was necessary to add an additional distance term to public transport, named  $\beta_{PT\_Dist}$ . This term is negative, and corrects for an overprediction of PT tour/trip lengths when the term is not present. The addition of these terms did not reduce the explanatory power of the two generalised time terms. It is believed that this is because the car driver share is far higher than the PT share (see Table 4), and so the generalised time terms are fitted largely to the car data.

## 5.2 Car Availability Parameters

The car availability parameters are added primarily to improve the mode choice component of the model, and in particular the predictions for car driver and car passenger alternatives.

Car availability parameters were tested in the models using the definitions given in Section 4.2.2, however for some purposes some or all of the terms were significant. Table 7 details the terms present in the final models. A plus sign indicates that the parameter is positive which means that the mode in question is more likely to be chosen for the car availability status in question, similarly a minus sign indicates the mode is less likely to be chosen.

**Table 7: Car Availability Parameters**

|                                     | Commute | Business | Edu. | Shopping | Other Travel | NHB Business | NHB Other |
|-------------------------------------|---------|----------|------|----------|--------------|--------------|-----------|
| Car driver:<br>1 car competition    | -       |          |      | -        |              |              |           |
| Car passenger:<br>pass. opportunity | +       |          | +    | +        | +            |              |           |
| Car passenger:<br>zero cars         |         | +        |      |          |              |              |           |
| Car passenger:<br>2+cars, free use  |         |          |      |          | -            |              |           |
| PT:<br>car competition,<br>2+ cars  |         | +        |      |          |              |              |           |
| Walk:<br>3+ cars                    |         |          |      |          | -            |              |           |
| Cycle:<br>1 car competition         |         |          |      |          | +            |              |           |
| Cycle:<br>Zero cars                 |         |          |      |          | +            |              |           |

For commute, the car competition dummy is large in magnitude and therefore has a substantial impact on the modal probabilities. If car is available, and the car competition term is not applied, then the probability of choosing car driver is high.

For business, car use dominates the sample. It is believed that the positive zero cars dummy on car passenger reflects the fact that is the individual does not have access to a car at home, then they are more likely to travel as a car passenger with someone else from their business.

For other travel, there is evidence that cycle usage is higher in households with lower car availability.

No car availability parameters were identified for the two NHB purposes.

### 5.3 Socio-Economic Parameters

In addition to the car availability parameters described in the previous section, socio-economic parameters have been incorporated for some purposes to reflect differences in mode preferences across the population.

For some purposes the terms added reflect differences in mode preferences with working status. These terms are set out in the following table, plus and minus signs have the same meaning as in Table 7.

**Table 8: Working Status Parameters**

|                           | Shopping | Other Travel | NHB Other |
|---------------------------|----------|--------------|-----------|
| Car passenger:<br>retired | +        |              |           |
| PT:<br>unemployed         | +        |              |           |
| Walk:<br>part-time worker |          | +            |           |
| Walk:<br>look after home  |          | +            | +         |
| Cycle:<br>unemployed      |          |              | -         |

In the shopping model, there is also a positive parameter for males on the walk alternative, and two concessionary pass parameters on public transport (positive) and walk (negative).

In the other travel model, there is also a positive concessionary pass parameter on the public transport alternative.

Finally, in the non-home-based business model there is a positive walk parameter on walk for individuals who work shifts.

### 5.4 Destination Constants

The final stage in the model development was to assess the destination choice fit of the models, by comparing observed and predicted trip lengths by mode. These terms express the *additional* attractiveness of particular destination zones, after taking into account the generalised time of travel and the attraction variable in the destination zone.

A number of patterns emerged from this analysis across different model purposes:

- travel to Wycombe destinations (zones 1 to 108) was more attractive than travel to non-Wycombe destinations;
- within Wycombe, PT (bus) was more attractive than outside Wycombe for some purposes;
- Wycombe High St was particularly attractive for bus journeys for some purposes;
- the Central London destination zone (170) was more attractive than other zones, particularly for commuting and employer's business travel; and

- the Central London destination zone was particularly attractive for PT (train) travel for certain purposes.

The destination constants identified in the final model specifications for each model purpose are summarised in Table 9.

**Table 9: Destination Constants**

|                            | Commute | Business | Edu. | Shopping | Other Travel | NHB Business | NHB Other |
|----------------------------|---------|----------|------|----------|--------------|--------------|-----------|
| Wycombe, all modes         | +       | +        |      | +        | +            | +            | +         |
| Wycombe, bus               | +       |          |      |          |              |              | +         |
| Wycombe High St, bus       |         |          |      | +        | +            |              |           |
| Central London, all modes  | +       | +        |      |          | +            | +            | +         |
| Central London, PT (train) | +       | +        |      |          | +            |              |           |

Note that for education, there was no attraction data outside of Wycombe and so non-Wycombe destinations were never available in the model. This precludes the estimation of terms expressing the *relative* attraction of Wycombe destinations, as well as the London destination terms. This explains why no education terms are present in Table 9.

### 5.5 Scaling Tests

For the final model specifications, tests were undertaken to investigate whether there were differences in the relative levels of error between mode and destination choices, using the theory set out in Section 4.3.

Structures were tested with destinations above modes, and modes above destinations. The destinations above modes structure was clearly rejected for all purposes. The results for the modes above destination structure were less conclusive, for commuting, education and other travel purposes, the models did not converge because the scaling parameters tended to zero, indicating that the levels of error in mode choice to be much higher than the levels of error in destination choice. For shopping, a significant structural parameter was obtained. For business, the modes above destination structure was rejected outright. For non-home-based business, the model failed to run at all.

The results suggested some evidence that the error in mode choice was higher than that in destination choice, but it was not possible to estimate robust structural parameters. Therefore, it was decided to test models where the structural parameters was based on evidence from WebTAG. Specifically, WebTAG Unit 3.10.3 Section 1.1.15 gives the following table of illustrative values for the sensitivity of mode choice relative to destination choice, based on a structure with mode choice above, i.e. less sensitive than, destination choice.

**Table 10: WebTAG Illustrative Values for Relative Sensitivity of Mode and Destination Choices**

| Purpose                 | Minimum | Median | Maximum | Sample |
|-------------------------|---------|--------|---------|--------|
| HB Work                 | 0.50    | 0.68   | 0.83    | 6      |
| HB Employer's Business  | 0.26    | 0.45   | 0.65    | 2      |
| HB Other                | 0.27    | 0.53   | 1.00    | 4      |
| NHB Employer's Business | 0.73    | 0.73   | 0.73    | 1      |
| NHB Other               | 0.62    | 0.81   | 1.00    | 2      |

The median values from this table were tested in the models. With the exception of HB business, the models with a WebTAG structure gave a better log-likelihood, and therefore the WebTAG structural parameters were retained, subject to the validation tests described in the next chapter.

The models were validated using a two stage procedure. First, predicted and observed tour length distributions were compared for each mode: this analysis is documented in Section 6.1. Second, model elasticities were extracted for each journey purpose and compared to the range of values quoted in WebTAG. The elasticity analysis is presented in Section 6.2.

### 6.1 **Tour Length Distributions**

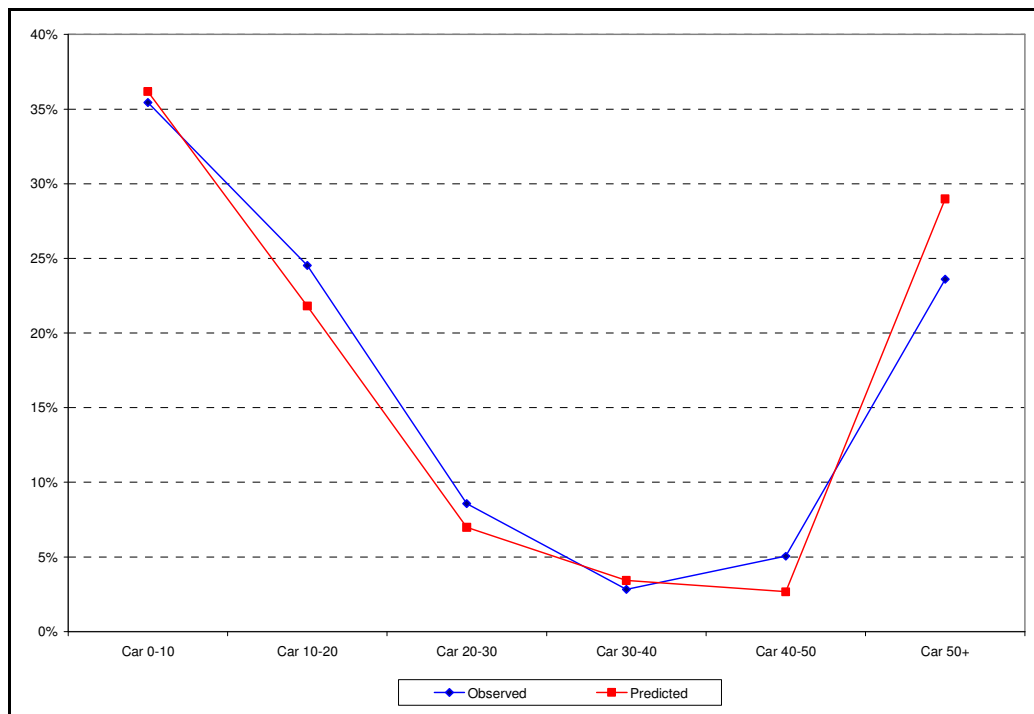
Observed and predicted tour length distributions were compared for each model purpose, and destination constants were added to the models to improve the fit to the observed distributions, as described in Section 5.4.

This section presents validation of the tour length distributions predicted by the final model specifications for car (driver and passenger combined) and public transport, as well as validation of the mean tour lengths predicted for each of the modes represented in the model.

It is emphasised that for the home-based purposes (commute, employer's business, education, shopping and other travel) the distances are return journey (tour) distances. For the non-home-based purposes (employer's business and other) they are one-way trip distances.

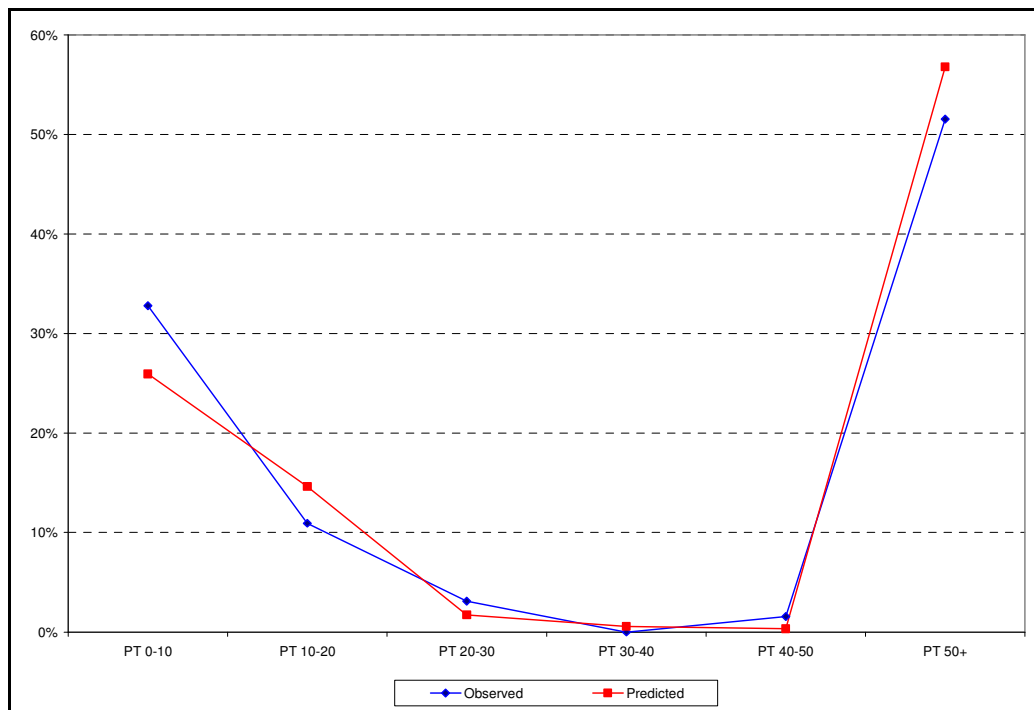
### 6.1.1 Commute

**Figure 4: Commuting Car Tour Length Distributions**



The observed distribution is matched well by the model, although there are some discrepancies for longer tours in the 40-50 and 50+ km bands.

**Figure 5: Commute PT Tour Length Distributions**



The PT distribution peaks at 50+ km, as a result of tours to Central London, and the model predicts this quite well as a result of the London destination terms. There is a slight underprediction of 0-10km trips, which will correspond to bus trips within Wycombe.

Table 11 compares the observed and predicted tour lengths by mode.

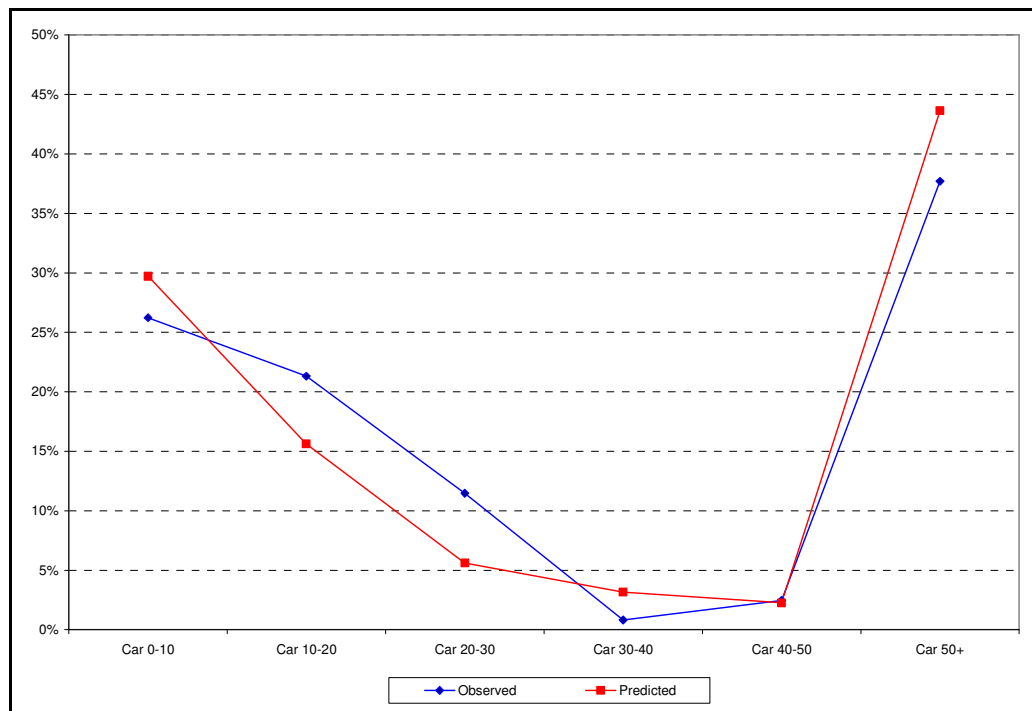
**Table 11: Commute Mean Tour Lengths (km)**

| Mode             | Observed | Predicted |
|------------------|----------|-----------|
| Car driver       | 37.9     | 39.4      |
| Car passenger    | 15.6     | 15.8      |
| Public transport | 61.8     | 73.5      |
| Cycle            | 8.9      | 8.9       |
| Walk             | 3.9      | 3.8       |
| Total            | 35.7     | 37.6      |

Public transport is overpredicted, otherwise the mean tour lengths are accurately predicted.

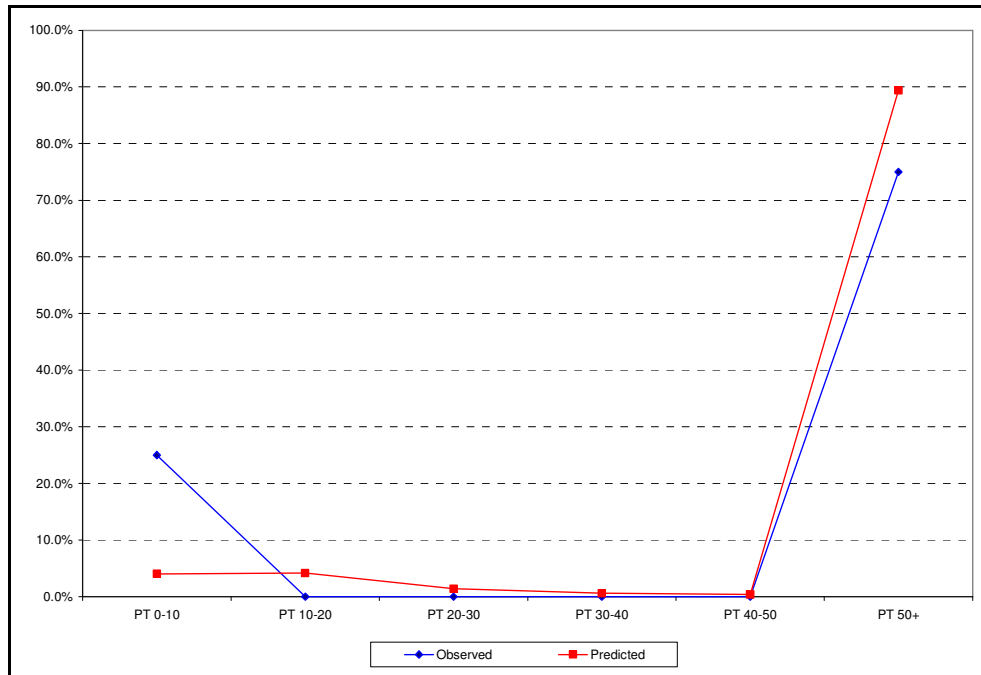
### 6.1.2 Employer’s Business

**Figure 6: Employer’s Business Car Tour Length Distributions**



The observed distribution has a first peak in the first band, for trips within Wycombe, and then a second larger peak for trips to London in the 50+ km band. Overall, the model matches this distribution well, with the good fit in the car 50+ band largely due to the London destination constant.

**Figure 7: Employer’s Business PT Tour Length Distributions**



The observed distribution is lumpy, as there are only eight PT observations. Overall the model fit is reasonable, in particular the dominance of the Central London destination zone is recognised.

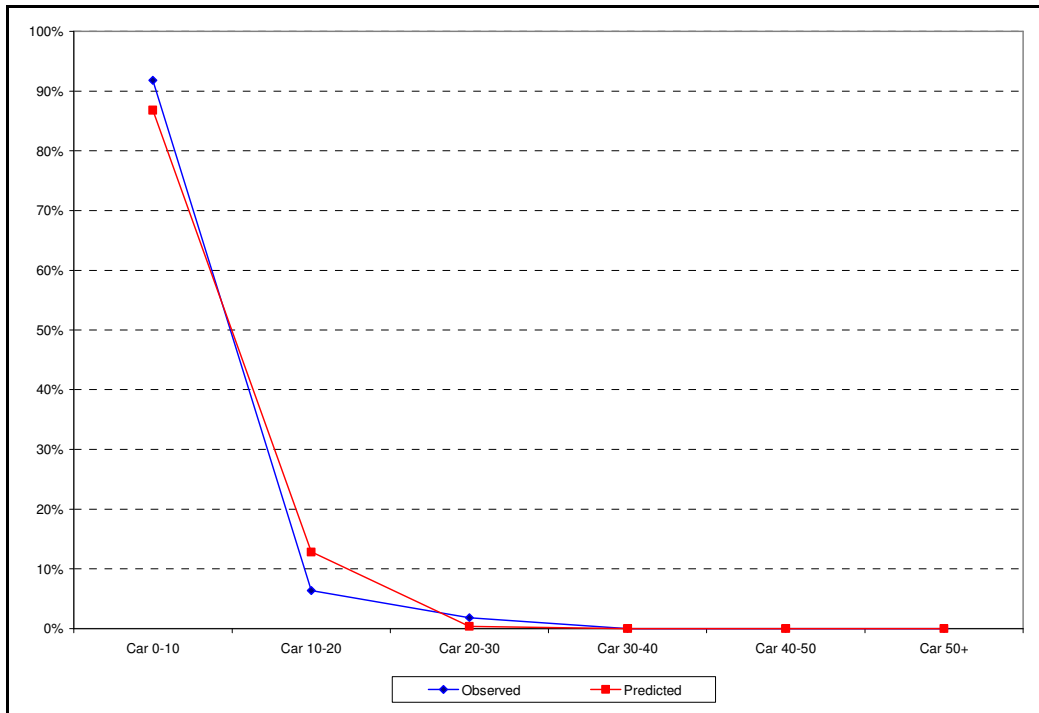
**Table 12: Employer’s Business Mean Tour Lengths (km)**

| Mode             | Observed | Predicted |
|------------------|----------|-----------|
| Car driver       | 91.4     | 87.1      |
| Car passenger    | 15.7     | 15.6      |
| Public transport | 85.7     | 129.9     |
| Total            | 87.6     | 86.4      |

Mean trip lengths are predicted accurately for the two car modes, which are chosen for 94% of the observations in the estimation sample. Public transport tour lengths are overpredicted, but it is again emphasised that the observed sample is small.

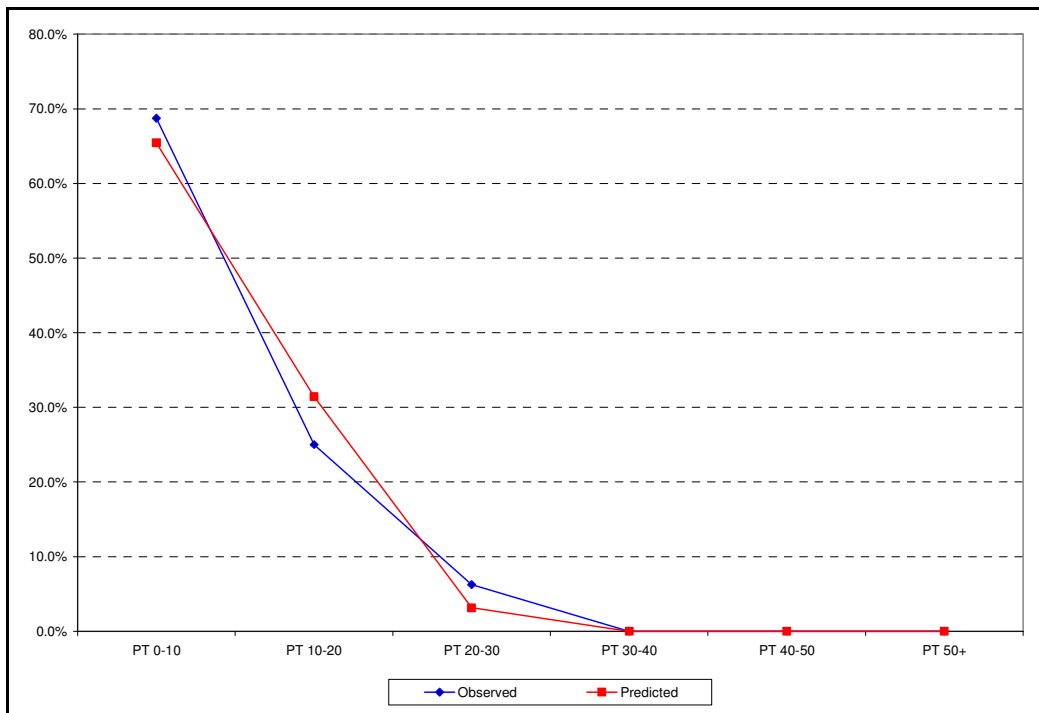
### 6.1.3 Education

**Figure 8: Education Car Tour Length Distributions**



Car tour lengths are short, as only education tours made within Wycombe are modelled. The predicted distribution matches the observed reasonably well. Note that the majority of these tours are car passenger, i.e. children taken to and from school by their parents.

**Figure 9: Education PT Tour Length Distributions**



PT tour distances are longer on average than those for car. The predicted distribution matches the observed well.

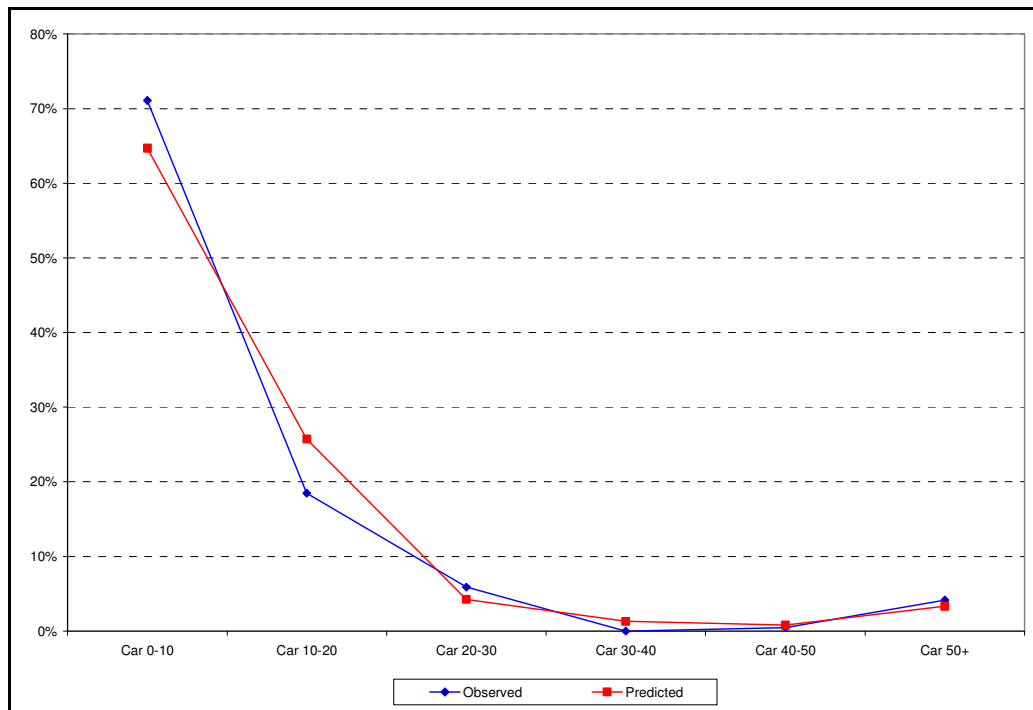
**Table 13: Education Mean Tour Lengths (km)**

| Mode             | Observed | Predicted |
|------------------|----------|-----------|
| Car driver       | 3.5      | 9.1       |
| Car passenger    | 5.6      | 5.7       |
| Public transport | 8.9      | 9.0       |
| Cycle            | 6.8      | 7.7       |
| Walk             | 3.5      | 3.4       |
| Total            | 5.3      | 5.4       |

Observed car driver tour distances are over-predicted, but the observed value is based on a single observation, and so cannot be interpreted as a representative mean. Tour lengths for the principal modes of car passenger, public transport and walk are accurately predicted.

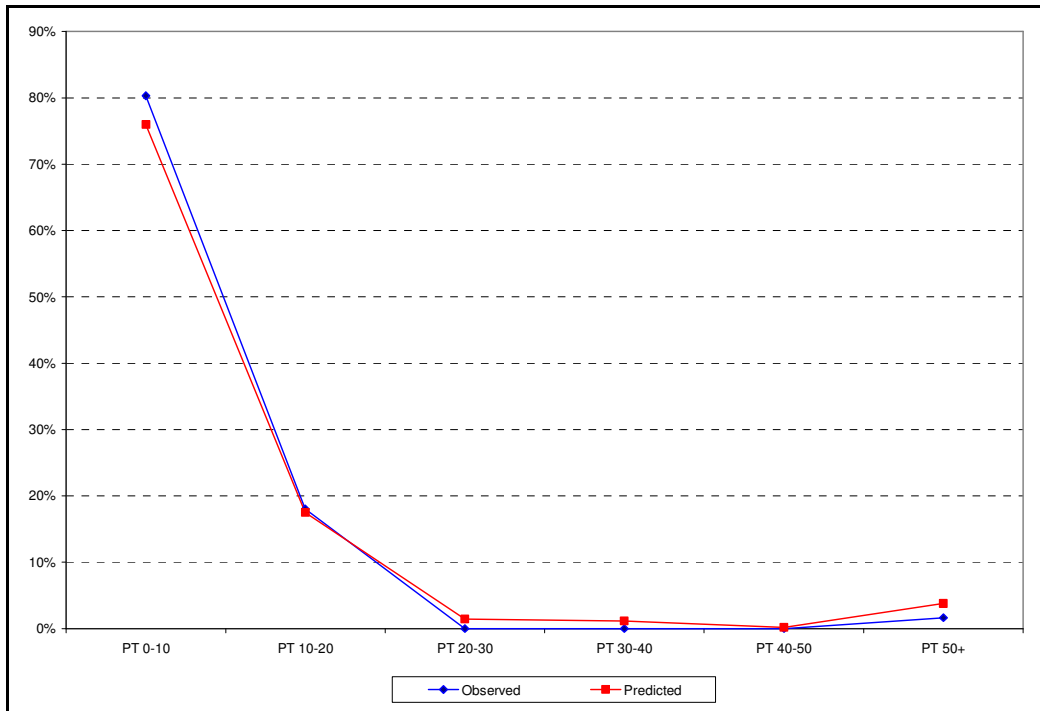
#### 6.1.4 Shopping

**Figure 10: Shopping Car Tour Length Distributions**



The shopping distribution has a small peak at 50+ km, corresponding to London, although nothing like as pronounced as the commute and employer's business distributions. Overall, the observed distribution is matched well by the model, with a slight underprediction of the shortest trips.

**Figure 11: Shopping PT Tour Length Distributions**



The observed public transport distribution is matched closely by the model.

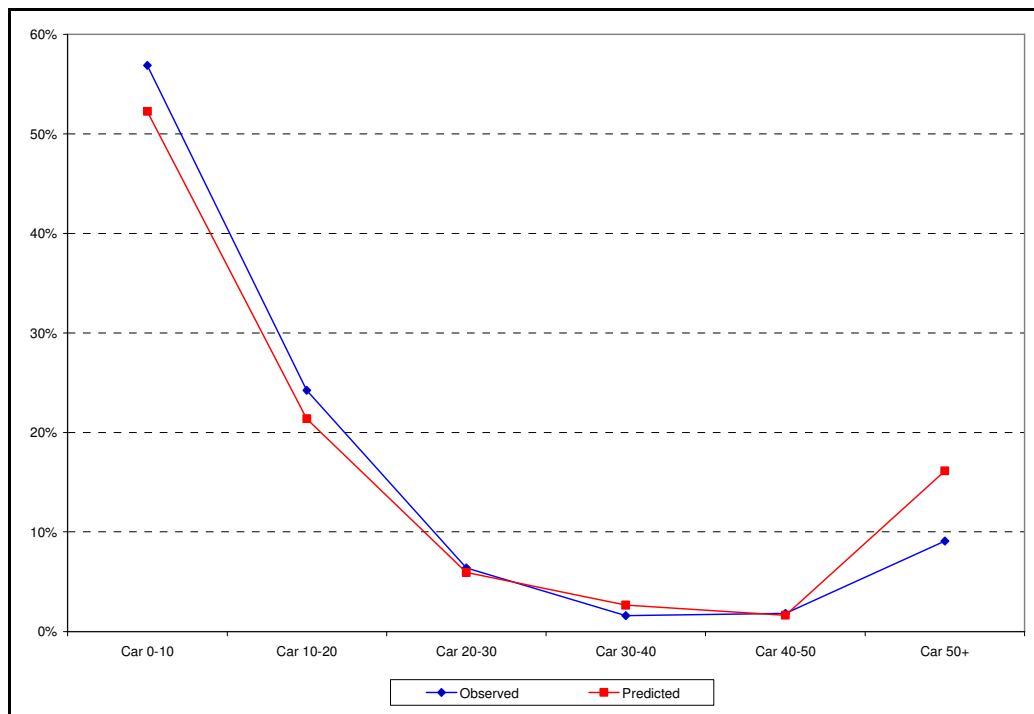
**Table 14: Shopping Mean Tour Lengths (km)**

| Mode             | Observed | Predicted |
|------------------|----------|-----------|
| Car driver       | 10.9     | 11.1      |
| Car passenger    | 10.1     | 10.2      |
| Public transport | 9.3      | 10.0      |
| Cycle            | 4.6      | 3.6       |
| Walk             | 4.1      | 4.1       |
| Total            | 9.6      | 9.8       |

Mean tour lengths are predicted well for all modes.

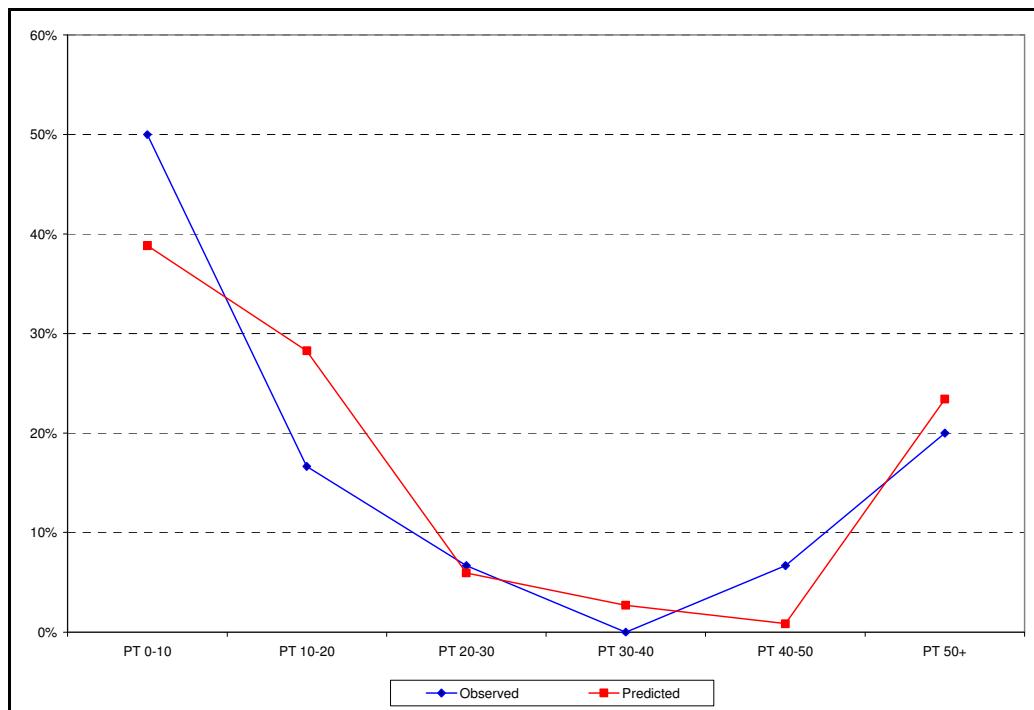
### 6.1.5 Other Travel

**Figure 12: Other Travel Car Tour Length Distributions**



Overall, the observed car distribution is matched well, although there is an overprediction of tours in the 50+ km band, which includes London.

**Figure 13: Other Travel PT Tour Length Distributions**



The observed PT distribution matched reasonably by the model.

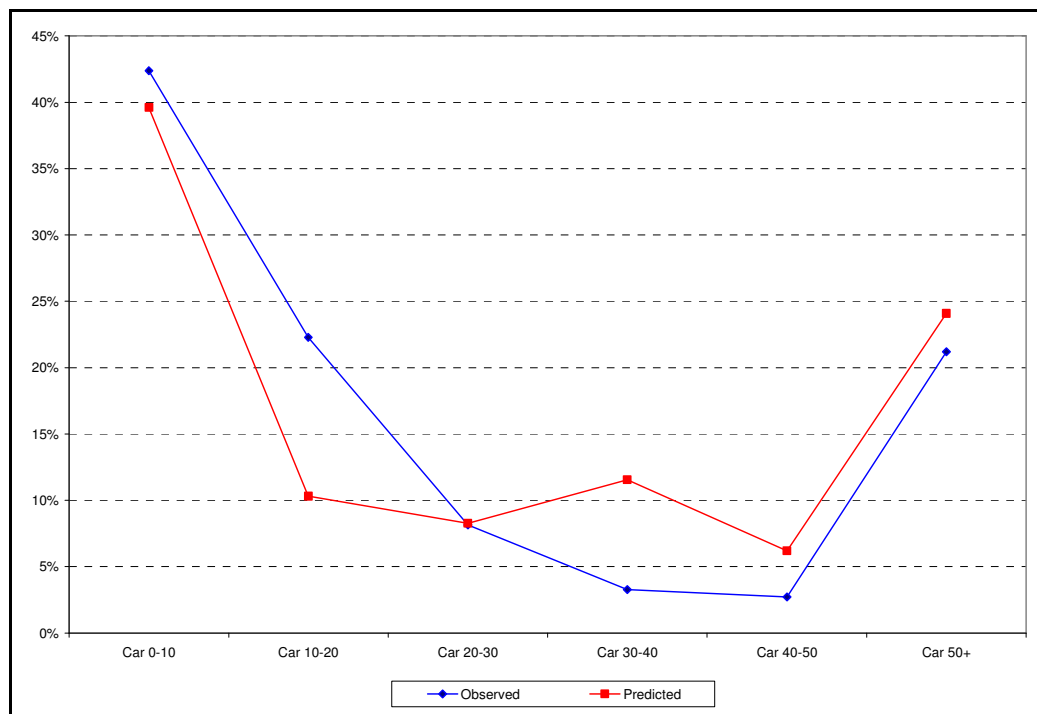
**Table 15: Other Travel Mean Tour Lengths (km)**

| Mode             | Observed | Predicted |
|------------------|----------|-----------|
| Car driver       | 18.0     | 20.8      |
| Car passenger    | 33.2     | 33.1      |
| Public transport | 28.8     | 29.7      |
| Cycle            | 5.7      | 5.9       |
| Walk             | 3.6      | 3.4       |
| Total            | 17.9     | 19.5      |

The fit is good for all modes. PT tour lengths were significantly overpredicted before the PT distance term was added.

6.1.6 Non-Home-Based Employer’s Business

**Figure 14: NHB Employer’s Business Car Trip Length Distributions**



The observed distribution is predicted reasonably well. Trips in the 10-20 km band are noticeably under-predicted, whereas trips in the 30-40km band are overpredicted.

There were no NHB employer’s business PT observations.

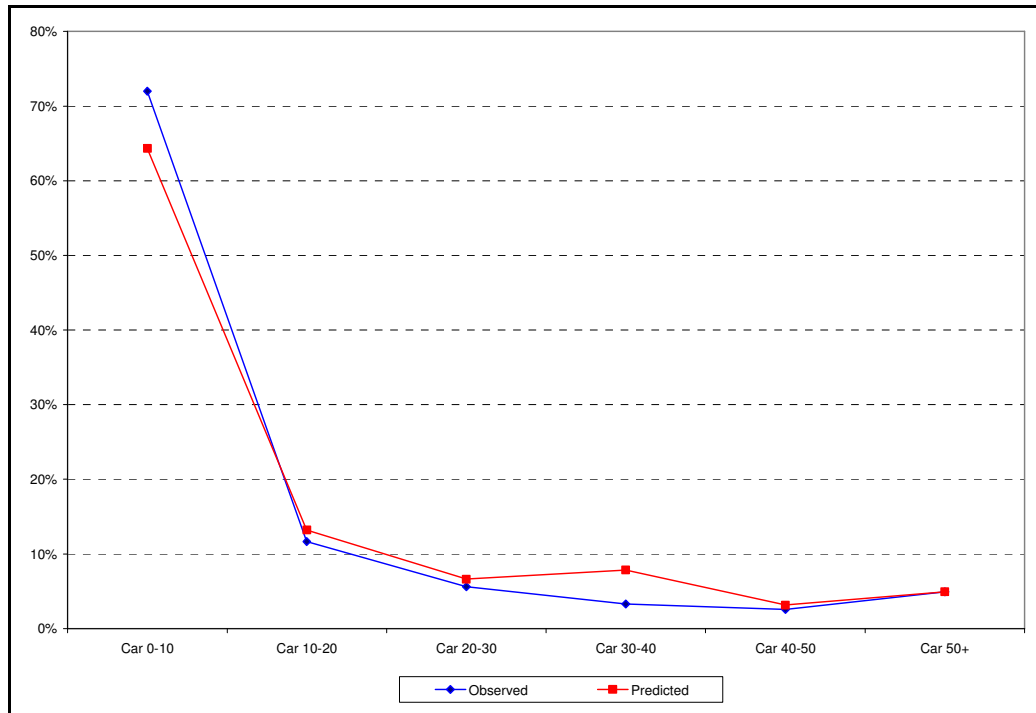
**Table 16: NHB Employer’s Business Mean Trip Lengths (km)**

| Mode          | Observed | Predicted |
|---------------|----------|-----------|
| Car driver    | 37.5     | 37.9      |
| Car passenger | 37.7     | 51.9      |
| Walk          | 6.2      | 6.3       |
| Total         | 36.2     | 37.1      |

Mean car driver and walk trip distances are accurately predicted. A car passenger distance parameter was tested for car passenger to correct the overprediction, but the term was not significant (there are only six car passenger observations in the household interview data).

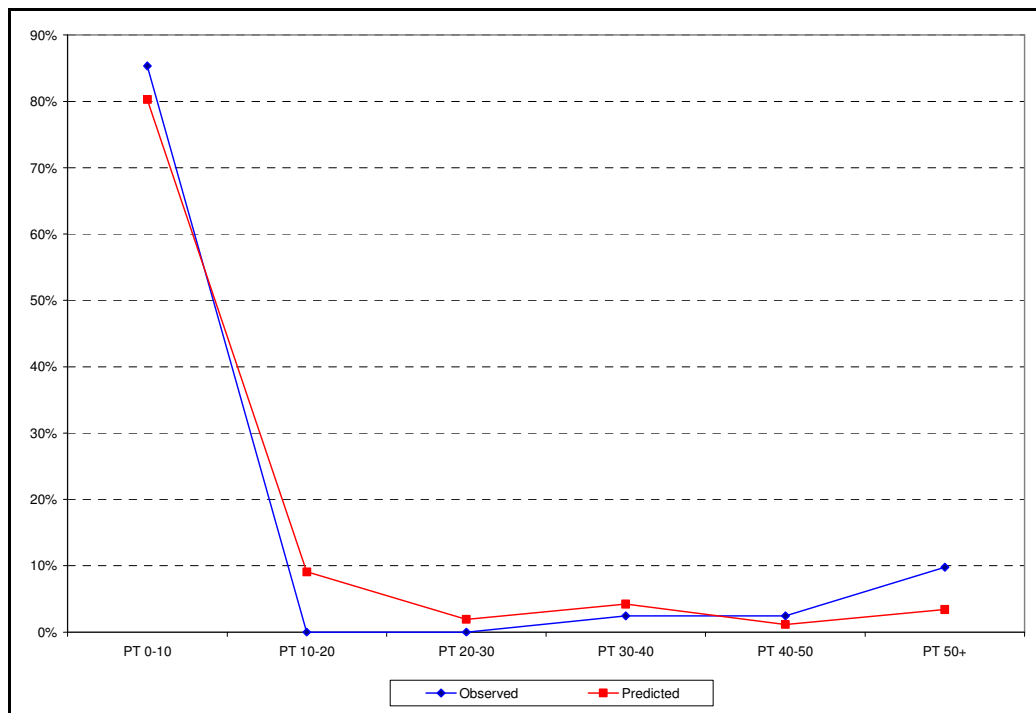
### 6.1.7 Non-Home-Based Other Travel

**Figure 15: NHB Other Car Trip Length Distributions**



The observed distribution is matched reasonably well by the model, although there is some underprediction of short trips.

**Figure 16: NHB Other PT Trip Length Distributions**



The observed distribution is lumpy, with no trips observed between 10 and 30 km. Given this lumpiness the predicted distribution matches quite well.

Observed and predicted trip lengths are compared for each of the five modes in Table 17.

**Table 17: NHB Employer’s Business Mean Trip Lengths (km)**

| Mode             | Observed | Predicted |
|------------------|----------|-----------|
| Car driver       | 10.5     | 10.5      |
| Car passenger    | 13.6     | 14.6      |
| Public transport | 12.9     | 12.7      |
| Cycle            | 4.9      | 5.0       |
| Walk             | 2.4      | 2.4       |
| Total            | 11.8     | 12.4      |

Mean trip lengths are predicted accurately for each mode except car passenger, where there is a slight overprediction. Before the addition of a PT distance term, PT trip distances were substantially overpredicted.

## 6.2 Model Elasticities

To assess the sensitivity of the models, elasticity tests have been run to assess the impact of increases in four key policy variables.

The policy tests that have been run are:

- a 10% increase in car cost;
- a 10% increase in car time;
- a 10% increase in PT fare; and
- a 10% increase in PT in-vehicle time.

The 10% increases are applied uniformly across all origin-destination pairs.

Consistent with WebTAG advice, the elasticities are then calculated using the constant elasticity formulation:

$$E_{m,p} = \frac{\ln\left(\frac{D_{m,p}}{D_{m,b}}\right)}{\ln\left(\frac{110}{100}\right)} \tag{6.1}$$

where:  $E_{p,m}$  is the elasticity for mode  $m$  under policy  $p$

$D_{p,m}$  is the demand for mode  $m$  under policy  $p$

$D_{p,b}$  is the demand for mode  $m$  in the base case

Three sets of elasticities are summarised in the following table. The tour elasticities are determined by summing demand by mode, and assess the impact on mode shift. The kilometrage elasticities are determined by summing the number of kilometres by mode, and assess the impact of mode and destination shifts. Finally the tour length elasticities are

calculated as the difference of the tour and kilometrage values and assess the impact of destination shifting.

It should be emphasised that the elasticities are first order elasticities, that is to say they do not take into account network effects. In implementation, where the model will be applied iteratively so that changes in demand impact on the supply costs, the elasticities may be lower due to network effects damping the model response.

Table 18 presents car cost elasticities for car driver. It should be noted that for non-business purposes, the only costs are fuel and so these are equivalent to fuel cost elasticities. However, for employer's business purposes, non-fuel costs are included in the car costs.

**Table 18: Car Cost Elasticities, Impact on Car Driver**

|             | Commute | Business | Education | Shopping | Other | NHB Business | NHB Other |
|-------------|---------|----------|-----------|----------|-------|--------------|-----------|
| Tours       | -0.04   | -0.01    | -0.07     | -0.07    | -0.08 | -0.02        | -0.08     |
| Kilometres  | -0.57   | -0.17    | -0.11     | -0.39    | -0.44 | -0.17        | -0.33     |
| Tour Length | -0.53   | -0.16    | -0.04     | -0.32    | -0.36 | -0.15        | -0.25     |

WebTAG Unit 3.10.4 para. 1.6.11 quotes an average fuel cost elasticity of -0.3, with variation by journey purpose in the range -0.1 to -0.4 with employer's business close to -0.1 and more discretionary trip purposes nearer -0.4. It should be noted that these fuel cost elasticity values will include responses such as changes in car ownership, whereas the elasticity in the table above only incorporate changes in mode and destination.

Overall, the car cost kilometrage elasticities above are in line with this range of values. Both business purposes have low elasticities of -0.17, whereas the discretionary purposes of shopping and other travel have values around -0.4. Education has a relatively low kilometrage elasticity, but the ability to switch destination for this purpose is limited as many children attend their nearest school.

The commuting model is more elastic than the WebTAG guidance, and a number of alternative specifications were tested to try to obtain more plausible elasticities, but without success. It is possible that the sample of London commuters is biasing the elasticity upwards, as long distance trips typically have higher elasticities. One possible option to account for this would have been to segment the commute model sample, for example separating out London commuters or different occupation groups, however the relatively small sample sizes mean there is not sufficient data for this approach in this study.

In general the tour length elasticities are considerably higher than the tour elasticities, and so the main response to car cost increases is destination shifting. This is relevant when considering policies such as increased parking charges that seek to achieve a mode shift away from car.

**Table 19: Car Time Elasticities, Impact on Car Driver**

|             | Commute | Business | Education | Shopping | Other | NHB Business | NHB Other |
|-------------|---------|----------|-----------|----------|-------|--------------|-----------|
| Tours       | -0.03   | -0.02    | -0.09     | -0.05    | -0.05 | -0.02        | -0.03     |
| Kilometres  | -0.36   | -0.30    | -0.15     | -0.31    | -0.22 | -0.31        | -0.14     |
| Tour Length | -0.33   | -0.28    | -0.06     | -0.26    | -0.17 | -0.29        | -0.11     |

WebTAG Unit 3.10.4, para. 1.6.12 states that journey time elasticities will vary much more than the fuel cost elasticities, but should be checked to ensure that the model does not produce values greater than two.

The values above are all considerably less than two. Education is again the least elastic, with other purposes having kilometrage elasticities in the range -0.2 to -0.4.

As was observed in the car cost elasticity runs, the main response to car time increases is destination, rather than mode, shifting.

Public transport (PT) elasticities are presented next. PT was not modelled in the NHB business model, so no elasticities are presented for this purpose.

**Table 20: PT Fare Elasticities, Impact on PT**

|             | Commute | Business | Education | Shopping | Other | NHB<br>Other |
|-------------|---------|----------|-----------|----------|-------|--------------|
| Tours       | -0.20   | -0.02    | -0.27     | -0.29    | -0.20 | -0.38        |
| Kilometres  | -0.30   | -0.04    | -0.31     | -0.52    | -0.28 | -0.51        |
| Tour Length | -0.10   | -0.02    | -0.04     | -0.23    | -0.08 | -0.13        |

WebTAG Unit 3.10.4 para. 1.6.13 reports that public transport fare elasticities for the number of trips typically lie in the range -0.2 to -0.4 for changes taking place within 12 months, and up to -0.9 for a longer period. Values for discretionary purposes are typically higher than those for mandatory purposes.

The values for tours in Table 21 incorporate both mode and destination choice responses, and so should be viewed as longer term elasticities. With this interpretation, the values in Table 20 are low compared to WebTAG guidance, although consistent with RAND Europe’s experience in other model systems.

It is noteworthy that, with the exception of business, the mode shift elasticities are quite a lot higher than the tour length elasticities. Thus policies which impact on the cost of PT would be expected to have a noticeable impact on the PT mode share.

**Table 21: PT In-Vehicle-Time Elasticities, Impact on PT**

|             | Commute | Business | Education | Shopping | Other | NHB<br>Other |
|-------------|---------|----------|-----------|----------|-------|--------------|
| Tours       | -0.09   | -0.05    | -0.20     | -0.19    | -0.14 | -0.26        |
| Kilometres  | -0.11   | -0.04    | -0.26     | -0.26    | -0.13 | -0.27        |
| Tour Length | -0.02   | 0.01     | -0.06     | -0.07    | 0.01  | -0.01        |

Home-based business is again the least elastic model. The mode shift elasticities are significantly higher than the destination shift (tour length) values, and so policies that improve PT journey time would be expected to yield reasonable improvements in the PT mode share.

Frequency models have also been estimated from the 2006 Household Interview (HI) data. Separate models have been estimated for each of the five home-based tour purposes, and for the two non-home-based trip purposes.

The frequency models predict, for each journey purpose, the number of full tours/trips an individual makes on a weekday, as a function of the population by socio-economic segment and accessibility in the individual's home zone.

Section 7.1 summarises the estimation structure used for the frequency models. Section 7.2 summarises the model development stages, and then Section 7.3 summarises the model results.

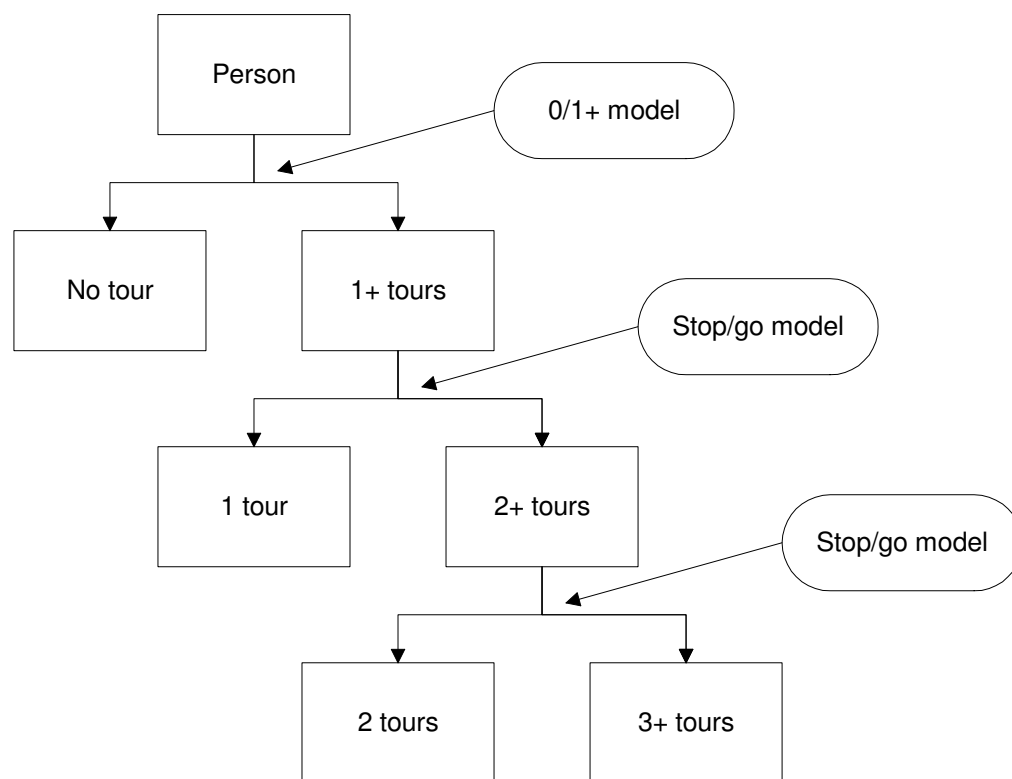
## 7.1 **Model Structure**

Frequency is modelled using two linked sub-models:

- the first sub-model is a 'zero/one plus' model which predicts the probability that an individual will make any tours, i.e. the model predicts whether an individual participates in an activity;
- the second sub-model is a 'stop/go' model which predicts the numbers of tours that an individual will make given that they make at least one tour, i.e. the model predicts the level of activity participation.

The model structure is illustrated in Figure 17.

**Figure 17: Tour Frequency Model Structure**



In the 0/1+ model, utilities are defined for the ‘no tours’ alternative and therefore the model terms reflect the increased probability of *not* making a tour. Therefore negative model terms imply an increased probability of making a tour.

In the stop/go model utilities are defined for the stop alternatives (i.e. 1 tour, 2 tours) and therefore in this model the model terms reflect the probability of *not* making additional tours. This means that negative model terms imply an increased probability of making multiple tours.

A structural parameter, Theta, links the models at each stage. However, the default is to estimate the model with this parameter constrained to be zero, which means that at each level the utilities, and hence the predicted choices, are independent of those of the level beneath.

## 7.2 Model Development

The first stage in the model development is to estimate a model with constants only. The constants are placed on the ‘no tours’ and ‘stop’ alternatives, and ensure that the overall observed tour rate is reproduced by the model.

Next, socio-economic terms were tested to reflect differences in the frequency of tour making across individuals. Most of these terms are placed on the ‘no tours’ alternative, and influence the 0/+ decision, i.e. the decision whether or not to make tours. Some socio-economic terms are also added to the ‘stop’ utilities in the stop/go model, but because few individuals are observed to make multiple tours it is more difficult to identify such terms.

The final stage in the model development was to test accessibility. This was done using a logsum measure from the mode-destination models, which varies according to the home zone and socio-economic characteristics segment of the individual, and measures the accessibility over all available modes and destinations. Car availability plays an important role in the logsum measure, as individuals with access to a car have significantly higher levels of accessibility than those without.

### 7.3 Model Results

The following subsections present the results for each journey purpose. Each section starts by summarising the estimation samples, before detailing the parameters identified in the final model specification. Full parameter results are provided in Appendix B.

#### 7.3.1 Commute

The commute model was estimated from the sample of 2222 individuals who are aged 16 and above, and who lie in one of the following four working status categories:

- full time employment (over 30 hours per week);
- part time employment (up to and including 30 hours per week);
- on a government training scheme; and
- at college full time.

Individuals who are at college full time are included because a substantial minority are observed to make work tours. These individuals are believed to be students with part time jobs.

The numbers of daily commute tours observed by these 2222 individuals are summarised in the following table.

**Table 22: Observed Commute Tour Frequency**

| Number of Tours | Count | Percent |
|-----------------|-------|---------|
| Zero            | 977   | 44.0 %  |
| One             | 1210  | 54.5 %  |
| Two             | 34    | 1.5 %   |
| Three           | 1     | 0.0 %   |
| Total           | 2222  | 100.0 % |

The mean work tour frequency is 0.58 tours per weekday. Over 98% of individuals make either zero or one tours, thus there is a lot of information on the zero/one plus choice, but little information for the stop/go model.

The parameters identified in the final frequency model specification are summarised in Table 23.

**Table 23: Commute Tour Frequency Model Terms**

| Parameter  | Sign | Interpretation   |
|------------|------|--|
| none       | +    | Constant on zero tours alternative   |
| none_FT    | -    | Full time workers less likely to make zero tours <sup>3</sup>  |
| none_PT    | -    | Part time workers less likely to make zero tours <sup>3</sup>  |
| none_occ9  | +    | Individuals with 'elementary' occupations more likely to make zero tours   |
| none_ind78 | -    | Individuals employed in 'banking, finance and insurance' or 'Public administration, education and health' less likely to make zero tours |
| none_lsum  | -    | Individuals with higher accessibility less likely to make zero tours   |
| stop       | +    | Constant on stop alternatives  |

The full-time worker term is larger in magnitude than the part-time worker term. Thus full-time workers are predicted to have the highest commute tour frequency rates, followed by part time workers, and then the lowest rates are predicted for those on government training schemes, and full time students.

The logsum term is not significant at a 95% level (the t-ratio is 1.3), but has been retained in the model as the magnitude of the term is plausible in comparison with other RAND Europe model systems. The presence of the term implies that improvements in transport accessibility will result in small increases in the numbers of predicted work tours.

### 7.3.2 Employer's Business

The employer's business model was estimated from the same sample of 2222 individuals as the commute model, described in Section 7.3.1. The numbers of employer's business tours observed by these 2222 individuals are summarised in Table 24.

**Table 24: Observed Employer's Business Tour Frequency**

| Number of Tours | Count | Percent |
|-----------------|-------|---------|
| Zero            | 2051  | 92.3%   |
| One             | 159   | 7.2%    |
| Two             | 12    | 0.5%    |
| Total           | 2222  | 100.0 % |

The mean employer's business tour frequency is 0.08 tours per weekday. Most individuals make zero tours, and so there is little data on multiple tour making.

The parameters identified in the final model specification are summarised in Table 25.

<sup>3</sup> Relative to those on government training schemes, and full time students.

**Table 25: Employer’s Business Tour Frequency Model Terms**

| Parameter  | Sign | Interpretation  |
|------------|------|---|
| none       | +    | Constant on zero tours alternative                                      |
| none_carav | -    | Individuals with a car available are less likely to make zero tours     |
| none_male  | -    | Males are less likely to make zero tours                                |
| none_FTstu | +    | Full time students are more likely to make zero tours                   |
| none_ind4  | -    | Individuals employed in construction are less likely to make zero tours |
| none_lsum  | -    | Individuals with higher accessibility less likely to make zero tours    |
| stop       | +    | Constant on stop alternatives   |

The logsum parameter is significant ( $t=2.3$ ) and relatively large in magnitude, implying that accessibility has an important impact of employer’s business tour frequency. An important component of this is related to car availability, as individuals with access to a car have higher accessibilities. It is noted that a significant car availability dummy was estimated in addition to the accessibility parameter.

### 7.3.3 Education

The education frequency model was estimated from a sample of 724 full-time students aged 5 and above. The numbers of education tours observed by these 724 individuals are summarised in Table 26.

**Table 26: Observed Education Tour Frequency**

| Number of Tours | Count | Percent |
|-----------------|-------|---------|
| Zero            | 174   | 24.0 %  |
| One             | 542   | 74.9 %  |
| Two             | 8     | 1.1 %   |
| Total           | 724   | 100.0 % |

The mean education tour frequency is 0.77 tours per weekday. Three-quarters of individuals make one tour, and only a few make two tours.

The parameters identified in the final model specification are summarised in Table 27.

**Table 27: Education Tour Frequency Model Terms**

| Parameter  | Sign | Interpretation  |
|------------|------|---|
| none       | +    | Constant on zero tours alternative  |
| none_age19 | +    | Individuals aged 19 and above more likely to make zero tours              |
| none_ind10 | +    | Individuals with industry code ‘education’ more likely to make zero tours |
| stop       | +    | Constant on stop alternatives   |

The age term reflects the fact that primary and secondary age children are likely to go to school daily during term-term, whereas full time at higher education institutions do not necessarily attend on a daily basis. The industry term may reflect the fact that individuals who work at educational establishments are less likely to attend adult education classes themselves.

### 7.3.4 Shopping

The shopping frequency model was estimated from a sample of 3838 individuals aged 5 and above. The numbers of shopping tours made by these 3838 individuals are summarised in Table 28.

**Table 28: Observed Shopping Tour Frequency**

| Number of Tours | Count | Percent |
|-----------------|-------|---------|
| Zero            | 3214  | 83.7 %  |
| One             | 578   | 15.1 %  |
| Two             | 42    | 1.1 %   |
| Three           | 4     | 0.1 %   |
| Total           | 3838  | 100.0 % |

The mean shopping tour frequency is 0.18 tours per weekday. Although over 80% of individuals make zero tours, the numbers of individuals making two or more tours is higher than for commute, employer's business and education purposes.

The parameters identified in the final model specification are summarised in Table 27.

**Table 29: Shopping Tour Frequency Model Terms**

| Parameter  | Sign | Interpretation  |
|------------|------|---|
| none       | +    | Constant on zero tours alternative  |
| none_FTwrk | +    | Full time workers more likely to make zero tours                            |
| none_FTstu | +    | Full time students more likely to make zero tours                           |
| none_emp56 | -    | Persons looking after home, and the retired, less likely to make zero tours |
| none_ageod | -    | Persons aged 80 and above less likely to make zero tours                    |
| none_lsum  | -    | Individuals with higher accessibility less likely to make zero tours        |
| stop       | +    | Constant on stop alternatives   |

### 7.3.5 Other Travel

The other travel frequency model was estimated from a sample of 3838 individuals aged 5 and above. The numbers of other travel tours made by these 3838 individuals are summarised in Table 28.

**Table 30: Observed Other Travel Tour Frequency**

| Number of Tours | Count | Percent |
|-----------------|-------|---------|
| Zero            | 2887  | 75.2 %  |
| One             | 676   | 17.6 %  |
| Two             | 198   | 5.2 %   |
| Three           | 57    | 1.5 %   |
| Four            | 15    | 0.4 %   |
| Five            | 4     | 0.1 %   |
| Six             | 1     | 0.0 %   |
| Total           | 3838  | 100.0 % |

The mean other travel tour frequency is 0.35 tours per weekday. Three-quarters of individuals make zero tours, but there are far more individuals making multiple tours than for the other purposes, and therefore there is more information for the 'stop/go' model.

The parameters identified in the final model specification are summarised in Table 31.

**Table 31: Other Travel Tour Frequency Model Terms**

| Parameter  | Sign | Interpretation   |
|------------|------|--|
| none       | +    | Constant on zero tours alternative   |
| none_FTwrk | +    | Full time workers more likely to make zero tours   |
| none_LkAHm | -    | Persons looking after home less likely to make zero tours                                  |
| none_nocar | +    | Individuals from zero car households more likely to make zero tours                        |
| none_copt2 | +    | Individuals with no licence, but in car owning households, more likely to make zero tours  |
| none_copt6 | +    | Individuals in households with 2+ cars and car competition more likely to make zero tours  |
| none_40_80 | -    | Individuals aged 40-80 are less likely to make zero tours                                  |
| stop       | +    | Constant on stop alternatives  |
| tour_male  | +    | Males more likely to 'stop', i.e. less likely to make multiple tours                       |
| tour_LkAHm | -    | Persons looking after home more likely to make multiple tours                              |
| tour_copt5 | -    | Individuals in households with 2+ cars and free car use more likely to make multiple tours |

### 7.3.6 Non-Home-Based Employer's Business

The non-home-based (NHB) employer's business travel frequency model was estimated from a sample of 2210 persons who are aged 16 and above, and who lie in one of the following four working status categories:

- full time employment (over 30 hours per week);
- part time employment (up to and including 30 hours per week);
- on government training scheme; and
- at college full time.

This definition ensures consistency with the commute and home-employer's business models. The numbers of NHB employer's business trips made by these 2210 individuals are summarised in Table 32.

**Table 32: Observed NHB Business Trip Frequency**

| Number of Trips | Count | Percent |
|-----------------|-------|---------|
| 0               | 2079  | 94.1 %  |
| 1               | 53    | 2.4 %   |
| 2               | 44    | 2.0 %   |
| 3               | 14    | 0.6 %   |
| 4               | 4     | 0.2 %   |
| 5               | 4     | 0.2 %   |
| 6               | 7     | 0.3 %   |
| 7               | 2     | 0.1 %   |
| 8               | 1     | 0.0 %   |
| 9               | 2     | 0.1 %   |
| Total           | 2210  | 100.0 % |

The mean NHB employer's business trip frequency is 0.14 trips per weekday. Ninety-four percent of individuals make zero trips, but 3.5% make two or more trips, and in some cases as many as nine trips. For NHB employer's business, multiple trip making would be expected for certain professions, e.g. plumbers, travelling salespersons.

The parameters identified in the final model specification are summarised in Table 33.

**Table 33: NHB Employer's Business Trip Frequency Model Terms**

| Parameter  | Sign | Interpretation  |
|------------|------|---|
| none       | +    | Constant on zero trips alternative                                      |
| none_emp24 | +    | Part time workers and full time students more likely to make zero tours |
| none_nolic | +    | Individuals with no licence more likely to make zero tours              |
| none_40_80 | -    | Individuals aged 40-80 are less likely to make zero tours               |
| stop       | +    | Constant on stop alternatives   |

### 7.3.7 Non-Home-Based Other Travel

The non-home-based (NHB) other travel frequency model was estimated from a sample of 3681 individuals aged 5 and above. The numbers of NHB other trips made by these 3681 individuals are summarised in Table 34.

**Table 34: Observed NHB Business Trip Frequency**

| Number of Trips | Count | Percent |
|-----------------|-------|---------|
| Zero            | 2848  | 77.4%   |
| One             | 489   | 13.3%   |
| Two             | 235   | 6.4%    |
| Three           | 72    | 2.0%    |
| Four            | 25    | 0.7%    |
| Five            | 6     | 0.2%    |
| Six             | 3     | 0.1%    |
| Seven           | 1     | 0.0%    |
| Eight           | 1     | 0.0%    |
| Nine            | 1     | 0.0%    |
| Total           | 3681  | 100.0%  |

The mean trip frequency is 0.37 trips per weekday. Three-quarters of individuals make zero trips, but 9% make two or more trips.

The parameters identified in the final model specification are summarised in Table 33.

**Table 35: NHB Other Trip Frequency Model Terms**

| Parameter  | Sign | Interpretation   |
|------------|------|--|
| none       | +    | Constant on zero trips alternative   |
| none_PTwrk | -    | Part time workers less likely to make zero tours   |
| none_FTstu | +    | Full time students more likely to make zero tours  |
| none_LkAHm | -    | Individuals looking after the home less likely to make zero tours  |
| none_copt3 | -    | Individuals with a licence, living in households with one car and free car use, less likely to make zero tours |
| none_car02 | -    | Individuals living in households with two cars are less likely to make zero tours                              |
| none_nolic | +    | Individuals with no licence more likely to make zero tours   |
| none_ocu04 | -    | Individuals with occupation code 'administrative & secretarial' less likely to make zero tours                 |
| none_male  | +    | Males more likely to make zero tours   |
| stop       | +    | Constant on stop alternatives  |
| trip_femal | -    | Females less likely to 'stop', i.e. more likely to make multiple tours   |

### **Mode-Destination Models**

Mode-destination models have been developed for the new Wycombe local demand model for seven travel purposes. In these models, it was not possible to estimate a full set of local level-of-service parameters, so generalised time formulations were used instead, using values-of-time from WebTAG. Both linear generalised time and log generalised time terms were used, adding the log term improved both the fit to the data and the plausibility of the model elasticities.

A number of car availability parameters have been identified in the models. The presence of these terms means future growth in car ownership will result in increases in the car driver and car passenger shares. Socio-economic parameters have also been added to the models to reflect different mode preferences by segment, in particular with working status.

To improve the trip length distributions of the models, destination constants were added for travel within Wycombe, and travel to Central London. For purposes such as commuting and employer's business, travel to Central London is a significant component, and so the presence of these terms results in a substantial improvement in the fit to the observed trip length distributions.

The models have used a structure with modes above destinations, using scaling parameters from WebTAG, but based also on Wycombe-specific model results.

The models have been validated by comparing observed and predicted trip length distributions, and examining the elasticity of the models to cost and time changes. Following the addition of the destination constants, the fit to the observed trip length distributions is generally good, although in some cases the observed PT distributions are uneven in shape, and the models are unable to match these distributions exactly. The car cost elasticities are generally consistent with WebTAG guidance, with employer's business models being least elastic, and discretionary travel purposes most elastic, as suggested in WebTAG. The commute elasticities may be slightly high. All elasticities, however, reflect first order elasticities only, and therefore may be lower when secondary network impacts are taken into account. The PT fare elasticities are felt to be reasonable, but are lower than the long term values given in WebTAG. The car and PT time elasticities are reasonable.

## Frequency Models

Frequency models have been developed for the new Wycombe local demand model for seven travel purposes. These models predict the number of tours or trips made on an average weekday, as a function of individuals' socio-economic characteristics, and some purposes the accessibility in the home zone. The models comprise two linked sub-models, the first predicting the decision to make any tours, 'zero/one-plus', and the second predicting the number of tours made conditional on making at least one, 'stop/go'.

The key socio-economic effects identified in the models are variations in mean tour rates with car availability, employment status and age.

For the five home-based purposes, the impact of accessibility was tested by using a 'logsum' accessibility measure, taken from the mode-destination models. The logsums are measured over all available modes and destinations, and vary according to the individual's home zone and segment. Significant terms were identified for home-work, home-employer's business and home-shopping purposes. The presence of these terms means that future improvements in accessibility will lead to small increases in the total volume of travel, similarly if accessibility decreases due to increasing congestion, small reductions in the total volume of travel will be predicted.

## **APPENDICES**

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# Appendix A: Mode Destination Model Results

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## Commute

|                      |             |
|----------------------|-------------|
| File                 | COM_v41.F12 |
| Converged            | True        |
| Observations         | 984         |
| Final log (L)        | -5743.9     |
| D.O.F.               | 17          |
| Rho <sup>2</sup> (0) | 0.144       |
| Rho <sup>2</sup> (c) | -0.180      |
| Prepared             | 24 Feb 09   |
| Estimated            | 24 Feb 09   |
| Scaling              | 1.0000      |

### Level of Service Terms:

|            |         |         |
|------------|---------|---------|
| GenTime    | -0.0045 | (-10.8) |
| LnGenTime  | -0.697  | (-11.6) |
| CarP_dist  | -0.0311 | (-4.8)  |
| Cycle_dist | -0.122  | (-2.7)  |
| Walk_dist  | -0.454  | (-7.8)  |

### Car Availability Terms:

|         |       |        |
|---------|-------|--------|
| CarComp | -2.29 | (-7.1) |
| PassOpt | 1.71  | (2.1)  |

### Mode Specific Constants:

|       |       |         |
|-------|-------|---------|
| CarP  | -5.86 | (-7.4)  |
| PT    | -3.73 | (-9.5)  |
| Cycle | -7.80 | (-12.5) |
| Walk  | -3.74 | (-9.6)  |

### Destination Constants:

|           |        |        |
|-----------|--------|--------|
| DestWycom | 1.71   | (16.9) |
| BusWycom  | 1.09   | (2.7)  |
| Dest170   | 1.80   | (7.4)  |
| Dest170PT | 4.34   | (9.6)  |
| IZ        | -0.455 | (-1.2) |
| WALK_IZ   | 1.65   | (2.9)  |

### Attraction Term:

|        |      |     |
|--------|------|-----|
| TotEmp | 1.00 | (*) |
|--------|------|-----|

### Scaling Parameter:

|           |       |     |
|-----------|-------|-----|
| Theta_M_D | 0.680 | (*) |
|-----------|-------|-----|

## Employer's Business

|                      |            |  |
|----------------------|------------|--|
| File                 | EB_v18.F12 |  |
| Converged            | True       |  |
| Observations         | 130        |  |
| Final log (L)        | -748.8     |  |
| D.O.F.               | 11         |  |
| Rho <sup>2</sup> (0) | 0.083      |  |
| Rho <sup>2</sup> (c) | -0.411     |  |
| Prepared             | 17 Feb 09  |  |
| Estimated            | 17 Feb 09  |  |
| Scaling              | 1.0000     |  |

### Level of Service Terms:

|           |         |        |
|-----------|---------|--------|
| GenTime   | -0.0017 | (-1.7) |
| LnGenTime | -0.991  | (-6.5) |
| CarP_dist | -0.0326 | (-1.5) |

### Car Availability Terms:

|            |      |       |
|------------|------|-------|
| NoCar_CP   | 7.87 | (2.4) |
| CarComp_PT | 3.68 | (1.8) |

### Mode Specific Constants:

|      |       |        |
|------|-------|--------|
| CarP | -6.93 | (-6.1) |
| PT   | -6.30 | (-5.2) |

### Destination Constants:

|           |       |       |
|-----------|-------|-------|
| Dest170   | 2.67  | (6.6) |
| Dest170PT | 3.67  | (4.0) |
| DestWycom | 1.22  | (4.1) |
| IZ        | 0.747 | (1.2) |

### Attraction Term:

|        |      |     |
|--------|------|-----|
| TotEmp | 1.00 | (*) |
|--------|------|-----|

### Scaling Parameter:

|           |       |     |
|-----------|-------|-----|
| Theta_M_D | 0.450 | (*) |
|-----------|-------|-----|

## Education

|                      |             |
|----------------------|-------------|
| File                 | EDU_v21.F12 |
| Converged            | True        |
| Observations         | 245         |
| Final log (L)        | -674.4      |
| D.O.F.               | 11          |
| Rho <sup>2</sup> (0) | 0.337       |
| Rho <sup>2</sup> (c) | 0.102       |
| Prepared             | 12 Feb 09   |
| Estimated            | 12 Feb 09   |
| Scaling              | 1.0000      |

### Level of Service Terms:

|            |         |        |
|------------|---------|--------|
| GenTime    | -0.0185 | (-3.6) |
| CarP_dist  | -0.239  | (-7.3) |
| Cycle_dist | -0.140  | (-1.6) |
| Walk_dist  | -0.567  | (-8.8) |
| WALK_IZ    | 2.83    | (7.8)  |
| CARP_IZ    | 0.762   | (1.8)  |

### Car Availability Terms:

|         |      |       |
|---------|------|-------|
| PassOpt | 4.77 | (2.4) |
|---------|------|-------|

### Mode Specific Constants:

|       |        |        |
|-------|--------|--------|
| CarP  | -0.504 | (-0.2) |
| PT    | 3.07   | (1.4)  |
| Cycle | -1.32  | (-0.6) |
| Walk  | 4.62   | (2.3)  |

### Attraction Term:

|          |      |     |
|----------|------|-----|
| EduEnrol | 1.00 | (*) |
|----------|------|-----|

### Scaling Parameter:

|           |       |     |
|-----------|-------|-----|
| Theta_M_D | 0.530 | (*) |
|-----------|-------|-----|

## Shopping

|                      |              |
|----------------------|--------------|
| File                 | SHOP_v31.F12 |
| Converged            | True         |
| Observations         | 607          |
| Final log (L)        | -3138.2      |
| D.O.F.               | 21           |
| Rho <sup>2</sup> (0) | 0.238        |
| Rho <sup>2</sup> (c) | -0.269       |
| Prepared             | 17 Feb 09    |
| Estimated            | 17 Feb 09    |
| Scaling              | 1.0000       |

### Level of Service Terms:

|            |         |        |
|------------|---------|--------|
| GenTime    | -0.0199 | (-7.2) |
| LnGenTime  | -0.744  | (-8.5) |
| CarP_dist  | -0.0257 | (-3.2) |
| Cycle_dist | -0.466  | (-2.2) |
| Walk_dist  | -0.388  | (-8.4) |

### Car Availability Terms:

|         |       |        |
|---------|-------|--------|
| CarComp | -1.46 | (-3.4) |
| PassOpt | 3.49  | (5.4)  |

### Socio-Economic Parameters:

|             |       |        |
|-------------|-------|--------|
| CarP_retir  | 1.67  | (3.8)  |
| PT_Unemploy | 3.72  | (4.1)  |
| Pass_PT     | 2.45  | (3.8)  |
| Walk_male   | 2.11  | (4.3)  |
| Walk_pass   | -1.59 | (-2.4) |

### Mode Specific Constants:

|       |       |         |
|-------|-------|---------|
| CarP  | -7.36 | (-10.5) |
| PT    | -2.12 | (-4.0)  |
| Cycle | -9.85 | (-7.3)  |
| Walk  | -5.06 | (-9.7)  |

### Destination Constants:

|           |        |        |
|-----------|--------|--------|
| DestWycom | 2.41   | (16.1) |
| BusHighSt | 2.30   | (7.4)  |
| IZ        | -0.798 | (-1.7) |
| CYCLE_IZ  | 3.02   | (2.3)  |
| WALK_IZ   | 3.12   | (5.7)  |

### Attraction Term:

|        |      |     |
|--------|------|-----|
| TotEmp | 1.00 | (*) |
|--------|------|-----|

### Scaling Parameter:

|           |       |     |
|-----------|-------|-----|
| Theta_M_D | 0.530 | (*) |
|-----------|-------|-----|

## Other Travel

|                      |               |
|----------------------|---------------|
| File                 | OTHER_v39.F12 |
| Converged            | True          |
| Observations         | 1139          |
| Final log (L)        | -6568.6       |
| D.O.F.               | 26            |
| Rho <sup>2</sup> (0) | 0.154         |
| Rho <sup>2</sup> (c) | -0.114        |
| Prepared             | 23 Feb 09     |
| Estimated            | 23 Feb 09     |
| Scaling              | 1.0000        |

### Level of Service Terms:

|            |         |         |
|------------|---------|---------|
| GenTime    | -0.0044 | (-6.3)  |
| LnGenTime  | -1.13   | (-23.3) |
| CarP_dist  | -0.0017 | (-1.3)  |
| PT_dist    | -0.0066 | (-1.2)  |
| Cycle_dist | -0.266  | (-3.5)  |
| Walk_dist  | -0.529  | (-16.3) |

### Car Availability Terms:

|            |       |        |
|------------|-------|--------|
| PassgerOpt | 2.32  | (4.0)  |
| CP_CarFree | -1.74 | (-4.5) |
| Cy_1CarCom | 3.74  | (3.1)  |
| Cycl_NoCar | 2.96  | (2.1)  |
| ManyCarWlk | -2.38 | (-3.3) |

### Socio-Economic Parameters:

|            |      |       |
|------------|------|-------|
| PT_pass    | 3.56 | (4.8) |
| PTWkrWalk  | 1.80 | (4.5) |
| H_WifeWalk | 2.57 | (7.0) |

### Mode Specific Constants:

|       |       |         |
|-------|-------|---------|
| CarP  | -5.59 | (-10.2) |
| PT    | -4.63 | (-8.9)  |
| Cycle | -10.8 | (-11.0) |
| Walk  | -3.87 | (-12.8) |

### Destination Constants:

|           |        |        |
|-----------|--------|--------|
| DestWycom | 1.69   | (17.8) |
| BusHighSt | 2.72   | (4.3)  |
| Dest170   | 0.876  | (1.7)  |
| Dest170PT | 2.87   | (2.8)  |
| IZ        | 0.0283 | (0.1)  |
| CARP_IZ   | -0.281 | (-0.6) |
| WALK_IZ   | 1.71   | (6.3)  |

### Attraction Terms:

|        |       |       |
|--------|-------|-------|
| L_S_M  | 1.00  | (*)   |
| TotEmp | 0.309 | (2.6) |

### Scaling Parameter:

|           |       |     |
|-----------|-------|-----|
| Theta_M_D | 0.530 | (*) |
|-----------|-------|-----|

### Non-Home-Based Employer's Business

|                      |               |  |
|----------------------|---------------|--|
| File                 | NHBEB_v20.F12 |  |
| Converged            | True          |  |
| Observations         | 192           |  |
| Final log (L)        | -1055.9       |  |
| D.O.F.               | 11            |  |
| Rho <sup>2</sup> (0) | 0.136         |  |
| Rho <sup>2</sup> (c) | -0.243        |  |
| Prepared             | 23 Feb 09     |  |
| Estimated            | 23 Feb 09     |  |
| Scaling              | 1.0000        |  |

#### Level of Service Terms:

|           |         |        |
|-----------|---------|--------|
| GenTime   | -0.0119 | (-5.1) |
| LnGenTime | -0.888  | (-7.2) |
| Walk_dist | -0.138  | (-2.8) |

#### Socio-Economic Parameters:

|            |      |       |
|------------|------|-------|
| Shifts_WLK | 1.13 | (1.0) |
|------------|------|-------|

#### Mode Specific Constants:

|      |       |        |
|------|-------|--------|
| CarP | -5.13 | (-8.5) |
| Walk | -5.56 | (-6.4) |

#### Destination Constants:

|           |       |       |
|-----------|-------|-------|
| DestWycom | 1.92  | (9.6) |
| Dest170   | 1.54  | (3.0) |
| IZ        | 2.07  | (7.5) |
| CARP_IZ   | 0.634 | (0.5) |
| WALK_IZ   | 2.78  | (3.3) |

#### Attraction Terms:

|        |      |     |
|--------|------|-----|
| TotEmp | 1.00 | (*) |
|--------|------|-----|

#### Scaling Parameter:

|           |       |     |
|-----------|-------|-----|
| Theta_M_D | 0.730 | (*) |
|-----------|-------|-----|

### Non-Home-Based Other Travel

|                      |                  |
|----------------------|------------------|
| File                 | NHBOTHER_v31.F12 |
| Converged            | True             |
| Observations         | 1195             |
| Final log (L)        | -6847.7          |
| D.O.F.               | 20               |
| Rho <sup>2</sup> (0) | 0.158            |
| Rho <sup>2</sup> (c) | -0.117           |
| Prepared             | 23 Feb 09        |
| Estimated            | 23 Feb 09        |
| Scaling              | 1.0000           |

#### Level of Service Terms:

|            |         |         |
|------------|---------|---------|
| GenTime    | -0.0176 | (-8.2)  |
| LnGenTime  | -0.832  | (-14.6) |
| CarP_dist  | -0.0234 | (-4.5)  |
| PT_dist    | -0.0200 | (-2.1)  |
| Cycle_dist | -0.209  | (-1.4)  |
| Walk_dist  | -0.610  | (-13.2) |

#### Socio-Economic Parameters:

|            |      |       |
|------------|------|-------|
| Pass_PT    | 1.44 | (3.3) |
| Hwife_wk   | 1.17 | (3.6) |
| Cycl_unemp | 3.11 | (2.0) |

#### Mode Specific Constants:

|       |       |         |
|-------|-------|---------|
| CarP  | -3.30 | (-21.8) |
| PT    | -3.49 | (-5.5)  |
| Cycle | -9.18 | (-7.7)  |
| Walk  | -2.50 | (-11.3) |

#### Destination Constants:

|           |       |        |
|-----------|-------|--------|
| DestWycom | 2.10  | (25.5) |
| BusWycom  | 2.14  | (3.5)  |
| Dest170   | 1.11  | (2.4)  |
| IZ        | 1.36  | (9.0)  |
| CARP_IZ   | 0.400 | (1.4)  |
| WALK_IZ   | 0.520 | (2.0)  |

#### Attraction Terms:

|        |       |       |
|--------|-------|-------|
| L_S_M  | 1.00  | (*)   |
| TotEmp | 0.728 | (6.8) |

#### Scaling Parameter:

|           |       |       |
|-----------|-------|-------|
| Theta_M_D | 0.810 | (*)   |
| L_S_M     | 1.00  | (*)   |
| TotEmp    | 0.754 | (7.1) |

|           |       |     |
|-----------|-------|-----|
| Theta_M_D | 0.810 | (*) |
|-----------|-------|-----|

## Appendix B: Frequency Model Results

---

### Commute

|                      |               |
|----------------------|---------------|
| File                 | WTF_v3_57.F12 |
| Converged            | True          |
| Observations         | 2222          |
| Final log (L)        | -1395.8       |
| D.O.F.               | 7             |
| Rho <sup>2</sup> (0) | 0.610         |
| Rho <sup>2</sup> (c) | 0.173         |
| Prepared             | 24 Feb 09     |
| Estimated            | 24 Feb 09     |
| Scaling              | 1.0000        |
| theta                | 0 (*)         |

#### Terms on Zero Tours:

|            |        |         |
|------------|--------|---------|
| none       | 3.45   | (6.8)   |
| none_FT    | -3.43  | (-13.4) |
| none_PT    | -2.64  | (-9.7)  |
| none_occ9  | 1.03   | (3.6)   |
| none_ind78 | -0.619 | (-5.2)  |
| none_lsum  | -0.102 | (-1.4)  |

#### Terms on Stop Alternatives:

|      |      |        |
|------|------|--------|
| stop | 3.54 | (21.0) |
|------|------|--------|

### Employer's Business

|                      |             |
|----------------------|-------------|
| File                 | WTF_v19.F12 |
| Converged            | True        |
| Observations         | 2222        |
| Final log (L)        | -585.2      |
| D.O.F.               | 7           |
| Rho <sup>2</sup> (0) | 0.810       |
| Rho <sup>2</sup> (c) | 0.094       |
| Prepared             | 10 Sep 08   |
| Estimated            | 10 Sep 08   |
| Scaling              | 1.0000      |
| theta                | 0 (*)       |

#### Terms on Zero Tours:

|            |        |        |
|------------|--------|--------|
| none       | 6.14   | (5.4)  |
| none_carav | -0.703 | (-4.3) |
| none_male  | -0.824 | (-4.5) |
| none_FTstu | 1.93   | (2.6)  |
| none_ind4  | -1.20  | (-4.0) |
| none_lsum  | -0.489 | (-2.6) |

#### Terms on Stop Alternatives:

|      |      |       |
|------|------|-------|
| stop | 2.66 | (8.9) |
|------|------|-------|

## Education

|                      |             |
|----------------------|-------------|
| File                 | WTF_v25.F12 |
| Converged            | True        |
| Observations         | 724         |
| Final log (L)        | -389.0      |
| D.O.F.               | 4           |
| Rho <sup>2</sup> (0) | 0.612       |
| Rho <sup>2</sup> (c) | 0.118       |
| Prepared             | 18 Feb 09   |
| Estimated            | 18 Feb 09   |
| Scaling              | 1.0000      |
| theta                | 0 (*)       |

### Terms on Zero Tours:

|            |       |         |
|------------|-------|---------|
| none       | -1.76 | (-12.4) |
| none_age19 | 2.16  | (9.6)   |
| none_ind10 | 0.342 | (1.8)   |

### Terms on Stop Alternatives:

|      |      |        |
|------|------|--------|
| stop | 4.23 | (11.9) |
|------|------|--------|

## Shopping

|                      |             |
|----------------------|-------------|
| File                 | WTF_v24.F12 |
| Converged            | True        |
| Observations         | 3838        |
| Final log (L)        | -1543.0     |
| D.O.F.               | 7           |
| Rho <sup>2</sup> (0) | 0.750       |
| Rho <sup>2</sup> (c) | 0.180       |
| Prepared             | 18 Feb 09   |
| Estimated            | 18 Feb 09   |
| Scaling              | 1.0000      |
| theta                | 0 (*)       |

### Terms on Zero Tours:

|            |        |        |
|------------|--------|--------|
| none       | 2.80   | (5.7)  |
| none_FTwkr | 1.21   | (8.2)  |
| none_FTstu | 1.82   | (7.1)  |
| none_emp56 | -1.02  | (-8.1) |
| none_ageod | -0.540 | (-5.3) |
| none_lsum  | -0.214 | (-2.5) |

### Terms on Stop Alternatives:

|      |      |        |
|------|------|--------|
| stop | 2.52 | (17.2) |
|------|------|--------|

**Other Travel**

|                      |             |     |
|----------------------|-------------|-----|
| File                 | WTF_v33.F12 |     |
| Converged            | True        |     |
| Observations         | 3838        |     |
| Final log (L)        | -2703.9     |     |
| D.O.F.               | 12          |     |
| Rho <sup>2</sup> (0) | 0.661       |     |
| Rho <sup>2</sup> (c) | 0.081       |     |
| Prepared             | 18 Feb 09   |     |
| Estimated            | 18 Feb 09   |     |
| Scaling              | 1.0000      |     |
| theta                | 0           | (*) |

**Terms on Zero Tours:**

|            |        |        |
|------------|--------|--------|
| none       | 0.460  | (6.6)  |
| none_FTwr  | 1.47   | (14.4) |
| none_LkAHm | -0.583 | (-4.2) |
| none_nocar | 0.894  | (4.8)  |
| none_copt2 | 1.31   | (11.9) |
| none_copt6 | 0.517  | (3.2)  |
| none_40_60 | -0.480 | (-4.9) |
| none_per56 | -0.330 | (-2.8) |

**Terms on Stop Alternatives:**

|            |        |        |
|------------|--------|--------|
| stop       | 1.04   | (9.4)  |
| tour_male  | 0.593  | (4.1)  |
| tour_LkAKk | -0.494 | (-3.2) |
| tour_copt5 | -0.388 | (-3.1) |

**Non-Home-Based Employer's Business**

|                      |             |     |
|----------------------|-------------|-----|
| File                 | WTF_v11.F12 |     |
| Converged            | True        |     |
| Observations         | 2210        |     |
| Final log (L)        | -673.1      |     |
| D.O.F.               | 5           |     |
| Rho <sup>2</sup> (0) | 0.873       |     |
| Rho <sup>2</sup> (c) | 0.031       |     |
| Prepared             | 2 Feb 09    |     |
| Estimated            | 2 Feb 09    |     |
| Scaling              | 1.0000      |     |
| theta                | 0           | (*) |

**Terms on Zero Tours:**

|            |       |        |
|------------|-------|--------|
| none       | 2.44  | (24.1) |
| none_emp24 | 1.04  | (3.7)  |
| none_nolic | 1.57  | (3.0)  |
| none_ind2  | -1.58 | (-3.7) |

**Terms on Stop Alternatives:**

|      |        |        |
|------|--------|--------|
| stop | -0.261 | (-2.2) |
|------|--------|--------|

### Non-Home-Based Other Travel

|                      |             |
|----------------------|-------------|
| File                 | WTF_v19.F12 |
| Converged            | True        |
| Observations         | 3681        |
| Final log (L)        | -2785.1     |
| D.O.F.               | 10          |
| Rho <sup>2</sup> (0) | 0.684       |
| Rho <sup>2</sup> (c) | 0.025       |
| Prepared             | 25 Jun 08   |
| Estimated            | 25 Jun 08   |
| Scaling              | 1.0000      |
| theta                | 0 (*)       |

#### Terms on Zero Tours:

|            |        |        |
|------------|--------|--------|
| none       | 1.51   | (16.6) |
| none_PTwr  | -0.448 | (-3.6) |
| none_FTstu | 0.386  | (3.2)  |
| none_LkAHm | -0.300 | (-2.7) |
| none_copt3 | -0.779 | (-5.6) |
| none_car02 | -0.595 | (-6.6) |
| none_ocu04 | -0.659 | (-3.4) |
| none_male  | 0.400  | (4.7)  |

#### Terms on Stop Alternatives:

|            |        |        |
|------------|--------|--------|
| stop       | 0.711  | (7.4)  |
| trip_femal | -0.356 | (-3.0) |

## Annex U – Public Transport Assignment Report

This Annex provides details of the public transport model development, calibration and validation for the local model. This should be read in conjunction with the Highway Model report (Annex S) and the Regional Model report which provides details of public transport modelling at that scale (Annex R).

**Buckinghamshire County Council**  
Wycombe Transport Model  
Public Transport Model Validation Report  
February 2006

**Halcrow Group Limited**

**Buckinghamshire County Council**  
Wycombe Transport Model  
Public Transport Model Validation Report  
February 2006

**Halcrow Group Limited**

**Halcrow Group Limited**  
Vineyard House 44 Brook Green London W6 7BY  
Tel +44 (0)20 7602 7282 Fax +44 (0)20 7603 0095  
[www.halcrow.com](http://www.halcrow.com)

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**Halcrow Group Limited**  
Vineyard House 44 Brook Green London W6 7BY  
Tel +44 (0)20 7602 7282 Fax +44 (0)20 7603 0095  
[www.halcrow.com](http://www.halcrow.com)

**Buckinghamshire County Council**  
Wycombe Transport Model  
Public Transport Model Validation Report

**Contents Amendment Record**

This report has been issued and amended as follows:

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| Issue | Revision | Description | Date | Signed |
|-------|----------|-------------|------|--------|
| 1     | 1        |             |      |        |

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---

# 1 Introduction

## 1.1 **Background to the Study**

Halcrow, in association with RAND Europe and Count on Us have been appointed by Buckinghamshire County Council (BCC) with respect to the development of a modelling capability for the Wycombe area. A transport model was developed by Halcrow for BCC and Wycombe District Council (WDC) in 1992. This used survey data collected in 1991 and 1992 and the model was used to assist the local authorities establish a development and transport strategy in the Wycombe Transport Study (WTS). This model is termed WTS1.

However given the changes in the demographic and travel characteristics in the area, and the age of the data within the original model there is now a need for a new modelling capability in response to the new local and regional influences in Wycombe. The modelling framework consists of new highway, public transport and demand forecasting models. This report outlines the development of the new public assignment transport model. Separate reports outline the other elements of the modelling framework including:

- BCC Regional Model;
- Wycombe Highway Model;
- Wycombe Demand Model; and
- Local Microsimulation models.

## 1.2 **Objectives of the Study**

The development of the new transport modelling structure for Wycombe was to meet the following objectives:

- the model should be developed using up-to-date survey information on demographic and travel characteristics- thus new surveys were required in the Wycombe area to meet this objective;
- the model structure should be developed in line with the Department for Transport's latest modelling advice given in WebTAG, particularly related to VaDMA (Variable demand modelling advice);
- the model should replicate existing travel conditions;
- the matrix building processes need to take explicit account of disruption due to roadworks during the surveying period, drawing upon other survey data collected prior to the period of disruption;
- the model structure should be able to assess the impact of external influences on Wycombe such as development along the Thames Valley corridor, in

---

Aylesbury and Milton Keynes and wider transport initiatives such as national road user charging as an example;

- the model structure should be able to assess the impact of alternative development scenarios that may be considered for the Local Development Framework;
- the model structure should be able to assess the impact of alternative transport strategies (both local and regional); and
- the model should be used to analyse the impacts of transport strategies and individual transport schemes in sufficient detail to establish whether the projects are likely to be justified with regard to the Government's appraisal criteria (NATA). This means the model needs to be able to provide outputs for analysis under the five overarching objectives of environment, safety, efficiency, accessibility and integration.

Therefore, the modelling structure that has been developed takes account of:

- changes in land-use, demographic and social trends including changes in GDP and its effect on car ownership;
- the effects of information technology and other 'soft' policies on overall travel demand;
- changes in mode choice and route choice decisions;
- changes in transport infrastructure including park-and-ride; and
- changes in policy measures such as changes in fare levels, road pricing and supply of parking.

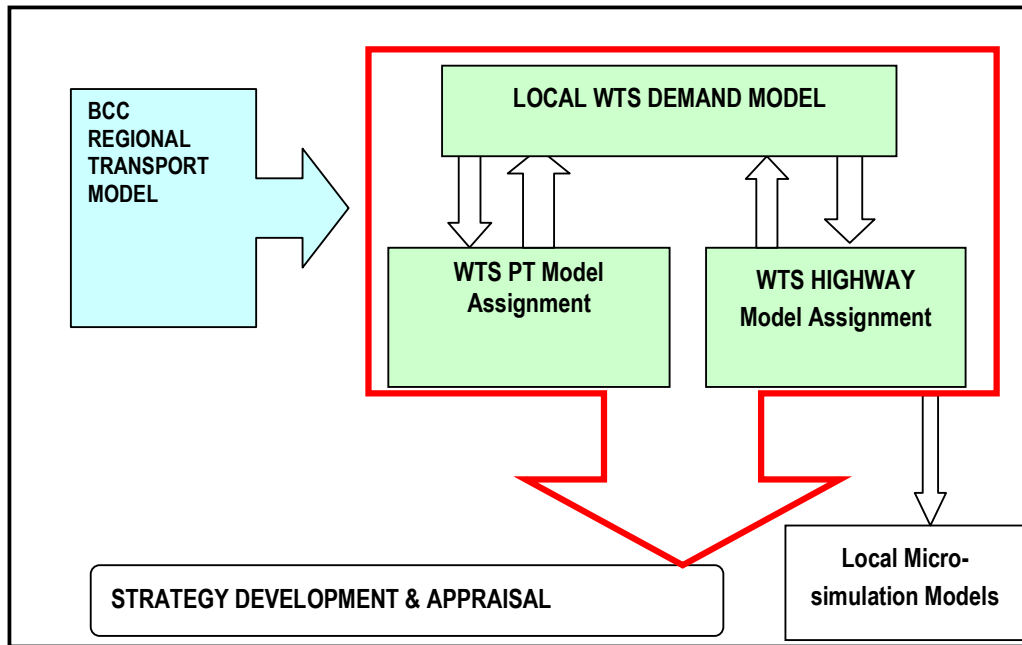
Thus, in order to fulfil this structure and meet the objectives of the project, the collection of new data was undertaken to establish a snapshot of conditions in 2006. The new model is referred to as WTS2.

### 1.3

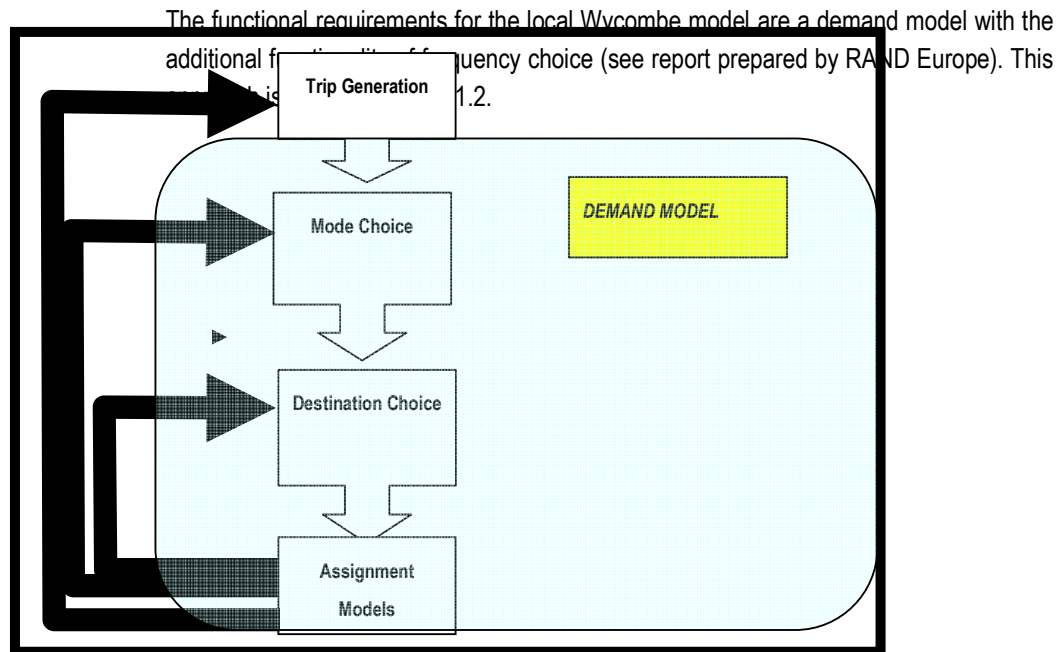
#### **Model Structure**

The WTS2 modelling hierarchy used to meet the objectives of the study is shown in Figure 1.1. This consists of a local demand model which provides forecasts of demand for each relevant scenario, and provides information to highway and public transport assignment models which in turn feed travel time information back to the local demand model for mode split assessment.

In addition, a regional transport model is available for Buckinghamshire having been developed as part of the Aylesbury Transport Model development, and this can provide the local Wycombe model with the impact of wider area demand influences. Finally, at a later stage, it would be possible to develop local area micro-simulation models for local operational analysis of specific areas.



**Figure 1.1: Wycombe Modelling Hierarchy**



### **Figure 1.2: Modelling Approach**

The first three elements represent the local demand model (see separate report produced by RAND Europe). A series of iterative loops are needed from the assignment models to the other stages in order to model changes in travel behaviour and allow variable demand to be properly represented. In particular feedback from the highway assignment model to the demand model is necessary in order that the impact of congestion on the highway network on travellers' choices is properly represented.

#### **1.4**

### **Structure of the Report**

This report outlines the development of the public transport model. The report is divided into six sections. This Section is followed by Section 2 on model software, with Section 3 outlining the development of the network. Section 4 outlines the development of the matrices while section 5 outlines the calibration and validation of the PT assignment model.

## 2 Model Software

### 2.1

#### **General**

In order to evaluate the Local Development Framework, assist in the assessment of public transport improvements and define an outline strategy for implementation, the building of a public transport model was considered necessary for Wycombe. This model is able to test the impact of changes in the public transport configuration (in terms of network and travel cost changes) as well as the impact of forecast future year flows on all new and existing links.

EMME was used to code both the PT network and bus services. Its superior graphical interface and ease of use was the reason for the selection:

- It allows for the rastering of images beneath the network which greatly improves both the presentation of traffic data and improves the understanding by network modeller.
- The point-and-click system of network editing makes it much faster to update the network should changes be required.

### 2.2

#### **Data Inputs**

In order to develop the transport model, a number of data items were required. These included data on the public transport vehicle and service information and demand patterns. Much of the data were collected from existing data sources. A list of data items needed for input to the EMME transport model is given in the following section.

### 2.3

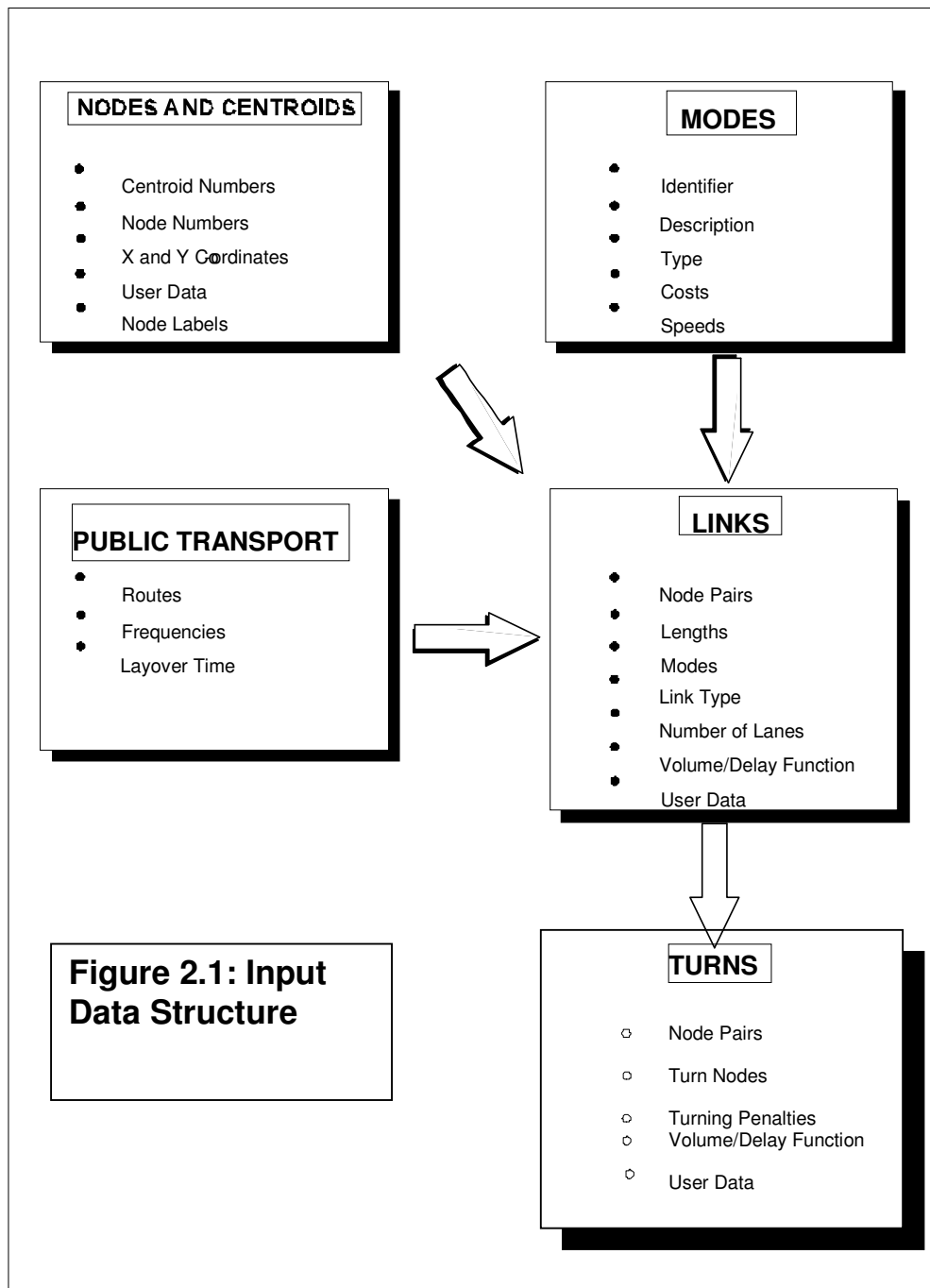
#### **Structure of EMME**

The format of the data inputs as specified by EMME requires the following data files:

- Public transport network link definition;
- Travel matrices by purpose;
- Modes of travel;
- Volume delay functions;
- Bus/coach service information; and
- Rail service information.

The data files are read into a databank. Once in the bank, data can be manipulated as required and assignments executed. An assignment is the loading of the trip matrix onto the public transport networks. The results of assignments can be processed to establish the robustness of the model at producing accurate and realistic estimates of existing and future flows.

Figure 2.1 summaries the linkage between the various data inputs.



## 3 Network Development

### 3.1

#### **General**

This section of the report summarises the transport model data coding and format of the data input. The network coding falls into the area of nodes and links, modes, junctions, zone centroids and public transport routes. The data sources used to derive the input data are listed and the approach and methodology for processing the data is explained.

The network structure is node and link based. The nodes are points such as junctions, bus stops and stations. A link is defined as the connection between two nodes to represent a road or rail section.

### 3.2

#### **Modelled Areas**

The Wycombe modelling hierarchy has a wide spatial coverage. The relationship between the various models discussed in Section 1 is shown in Figure 3.1. The Buckinghamshire Regional Model covers a wide area including the whole of Buckinghamshire, and extends from the Thames Valley and Oxford to the South Midlands, and includes commuter routes to Central London (see BCC Regional Model Report).

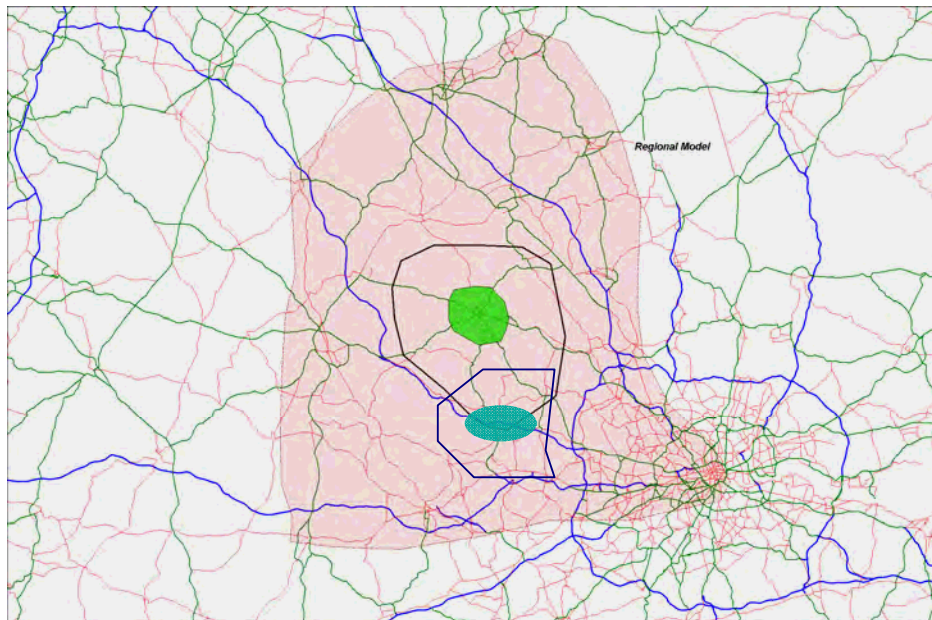
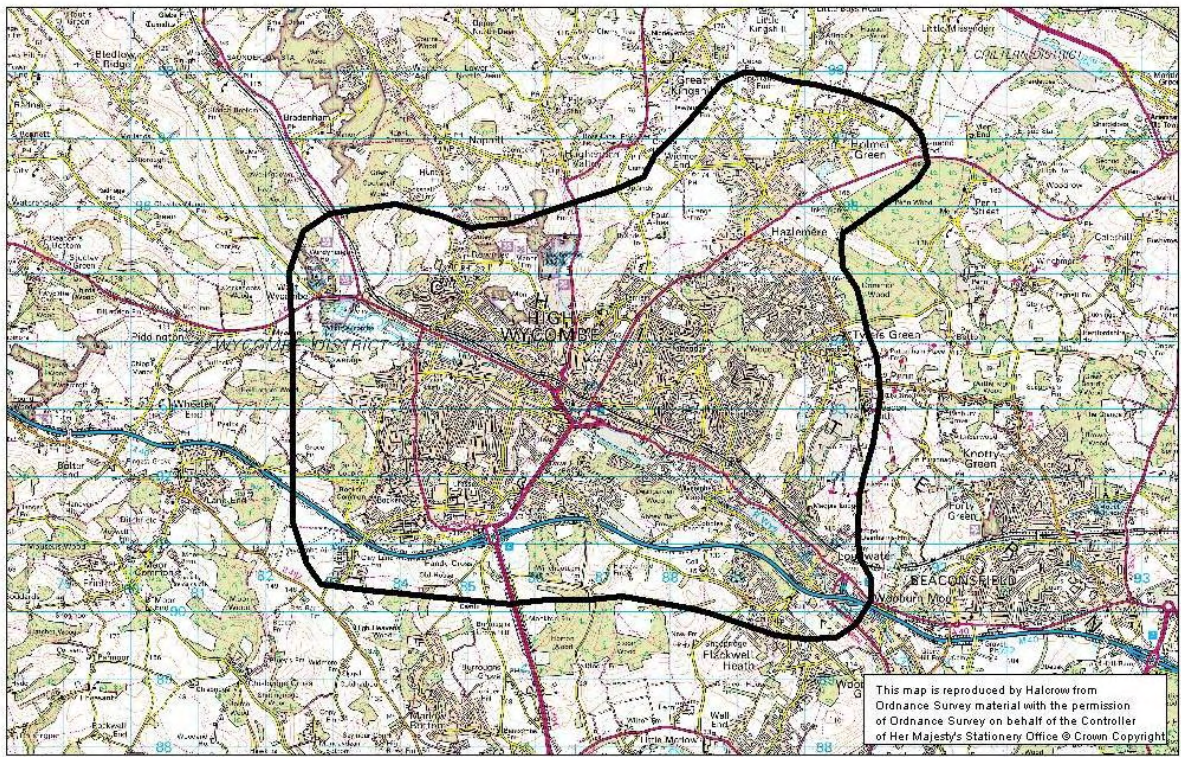


Figure 3.1: BCC Model Areas

The local WTS2 highway assignment model has a core model area with a wider buffer area. The extent of the core model area is shown in more detail in Figure 3.2 and represents the area defined by BCC as the Wycombe Transportation Study area. This includes the urban area of Wycombe with the neighbouring villages of Hazlemere, Holmer Green, Penn and Widmer End. Whilst not directly in the Wycombe Transportation Study area, Flackwell Heath was coded in detail in the model. This is due to routes such as Daws Hill Lane and Treadaway Hill which form ‘rat runs’ away from the main corridors such as the A40 and A404. The PT model uses this as a core area but includes all the services to High Wycombe.

**Figure 3.2: Wycombe Model Area**



*Figure 1: Study Area*

WYCOMBE TRANSPORT MODEL



### 3.3

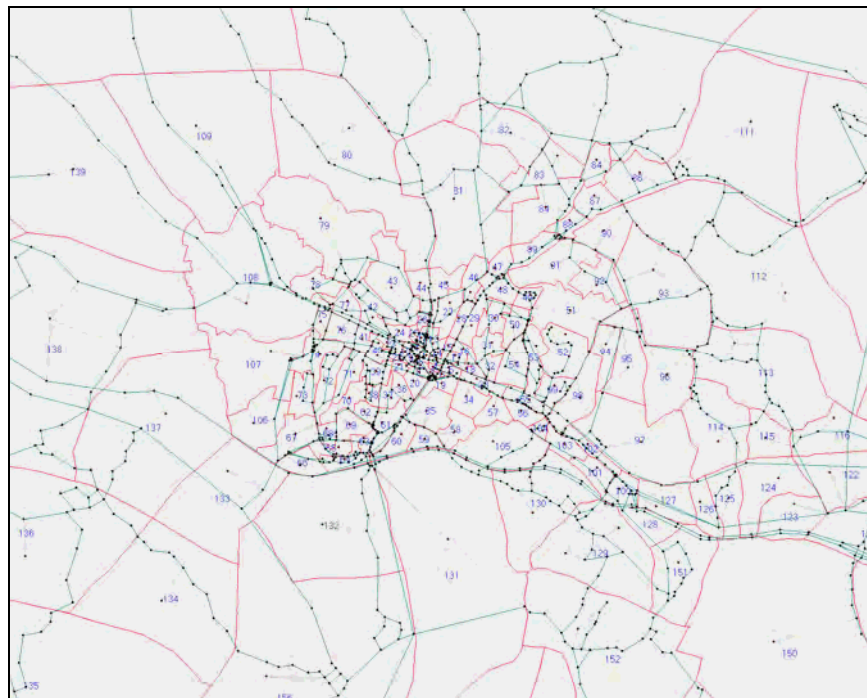
#### **Zone System**

The original WTS1 highway model was developed by Halcrow for BCC and WDC in 1992. WTS1 had 101 zones for Wycombe which were based on enumeration district boundaries. Outside of this area the zone system becomes more aggregate with a further 96 zones representing the wider area surrounding the town.

This original highway model was used as a starting point in the development of the new WTS2 model. Following a review of the area, the basic zone system used in WTS1 was retained for much of the new WTS2 model, with additional zones added in the town centre and in the new development areas of the town, such as Wycombe Marsh. In the outer area changes were made to the zones in Oxfordshire to add more detail.

With these changes made to the zone system the WTS2 model contains 104 zones for Wycombe, and a further 97 zones representing the wider area surrounding the town. Table 3.1 show how the modelled area was divided up into zones. Appendix A provides a listing of the zones. At different stages of analysis the zones have been allocated to sectors, such as for matrix building. These stages will be outlined later in the report. For the Core Area Zones, WDC are able to provide land use data sets for the base year and forecast year scenarios as appropriate.

Figure 3.3 shows the location of each of the zones in the study area.



**Figure 3.3: High Wycombe Zone Structure**

| <b>Table 3.1 – Highway Model Zone System</b> |                          |
|--|--------------------------|
| <b>Core Area Zones</b>                       | <b>Buffer Area Zones</b> |
| 1 – 78                                       | 79 – 82                  |
| 83 – 85                                      | 86                       |
| 87 – 108                                     | 109 – 126                |
| 127  | 128 – 201                |

### 3.4

#### **Travel Modes**

Three main travel modes were defined within the model, namely:

- b – bus;
- l- London underground; and
- t – rail.

Separate modes were defined so that separate trip matrices and vehicle travel (or operating) costs could be assigned to the network. Where appropriate, certain modes were restricted from being assigned to a link (e.g. bus only link).

In addition, public transport trips use auxiliary transit links to gain access to the main Public Transport network. The following auxiliary link types were used:

- u – London underground (access off the main network in London);
- w – walk;
- r – rail (such as trips on rail services from Manchester which join the main modelled network at Birmingham);
- a- motor access (assumed as bus/car average).

Rail, bus and coach services were allocated to a vehicle type. This contained information on the seating and total capacity of vehicle. The capacities used in the base year model are shown in Table 3.2. Where new stock is introduced in the future year, appropriate capacities will be used.

| Vehicle ID | Type of vehicle  | Seating capacity | Total capacity |
|------------|------------------|------------------|----------------|
| 1          | 6 car Class 165  | 572              | 1326           |
| 2          | Inter City 125   | 450              | 1404           |
| 3          | 6 car Class 166  | 550              | 1330           |
| 4          | 3 car Class 165  | 288              | 665            |
| 5          | Class 221        | 376              | 978            |
| 6          | 2 car Class 165  | 140              | 164            |
| 7          | Class 319        | 598              | 1026           |
| 8          | Heathrow Express | 496              | 853            |
| 9          | Class 170        | 346              | 753            |
| 10         | Class 313        | 456              | 1192           |
| 11         | Class 310        | 228              | 596            |
| 13         | Class 220        | 188              | 489            |
| 14         | Class 221        | 188              | 489            |
| 21         | minibus          | 15               | 25             |
| 22         | Single deck bus  | 34               | 51             |
| 23         | Double deck bus  | 72               | 88             |
| 51         | LUL Metropolitan | 448              | 1554           |
| 52         | LUL Jubilee      | 200              | 1112           |
| 58         | LUL Central      | 272              | 1581           |
| 54         | LUL Piccadilly   | 264              | 1262           |

**Table 3.2: Seating and Total Capacity of Public Transport Vehicles**

### 3.5

#### **Rail Network**

The coverage of the rail network is shown by figure 3.4. This replicates the network in the Regional Model since rail demands are fed from the regional model. The network includes:

- All lines to the London termini at Marylebone; and
- Cross country services from Birmingham

The rail network definition includes:

- Initial node number;
- Terminal node number; and
- Link length in kilometres.

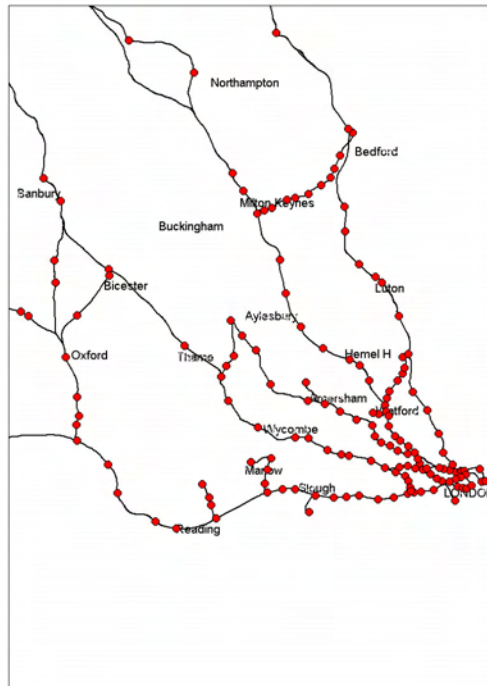


Figure 3.4: Rail Network

A transit line file was developed which includes the definition of all rail services assumed in the model. For each service the following is defined:

- A vehicle type;
- Service headway;
- Default line speed (or travel time between station); and
- Stopping locations for the service.

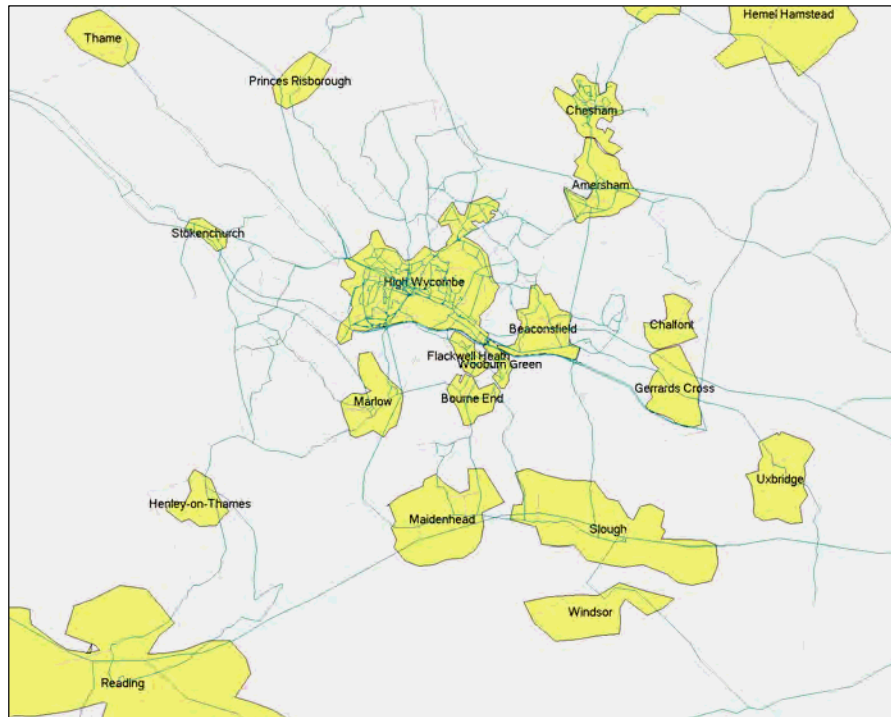
### 3.6

#### **Bus Network**

For the local bus network a more detailed representation of the bus service network was derived than is included in the BCC regional model. Bus service information was collected from the Buckinghamshire County Council website in the form of the pdf document: High Wycombe Area Local Transport Guide (August 2005 edition).

The Contram highway network of Wycombe was converted into a form that could be read into EMME. The network was then modified and expanded using EMME to account for the missing sections of the bus network according to data gleaned from the High Wycombe Transport Guide. Where possible node numbers were made consistent between the highway and public transport networks.

The entire lengths of all the bus routes, located in the guide, were coded into the network to give both a realistic representation of the network and to accurately reflect the length of the route. EMME automatically calculates the length of the route as links and nodes are being coded in. This reduced the need for links representing bus routes to towns outside to High Wycombe boundary. The network for buses is shown in figure 3.5.



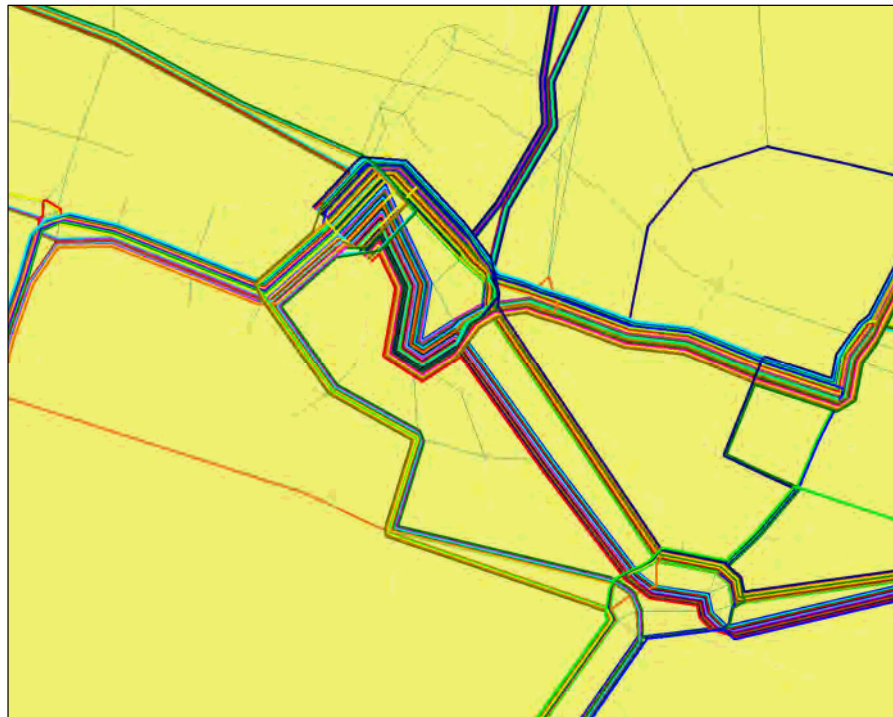
**Figure 3.5: Bus Network Links**

The bus routes were coded into Transit line files. Figure 3.6 shows the bus routes incorporated into the model. Headway and speeds were determined from the timetable. Average speeds were estimated by dividing the length of the journey by time taken to complete the entire bus journey. Appendix B provides the transit line summaries for each of the time periods.

Figure 3.6 Bus routes in High Wycombe and surrounding towns



Figure 3.6a: Bus Routes in High Wycombe





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## 4 Matrix Development,

### 4.1 *Introduction*

This chapter describes the development of the trip matrices for the local public transport assignment model. The BCC regional model had matrices developed for rail trips. Trips that passed through High Wycombe station (as boarders and alighters) were used within the local model. To supplement these trips information was required on bus usage.

### 4.2 *Data sets*

The local model required the development of bus trip matrices for the morning, inter, and evening peaks in 2006. These were to supplement the rail demands that were developed for the regional model. Data were drawn from several sources:

- The 2006 Bus Survey Interviews and services counts were used to estimate trips to and from the centre of High Wycombe;
- The 2001 Census Journey to work database was used to both estimate work trips between the centre of High Wycombe the rest of the study area so a comparison could be made with the bus survey; and estimate work trips between zones other than the centre of High Wycombe.
- The 2006 Household interview survey was used to estimate trips between all zones and for all purposes. Trips between the centre of High Wycombe and the rest of the study area were compared against the bus survey and Census Journey to work data.

The 2006 bus survey contained data on:

- Bus stop location;
- Bus service number;
- Time of the interview;
- Origin Location
- Mode of travel to bus station;
- Destination Location
- Journey Purpose; and
- Frequency of travel.

However, before this analysis could be conducted, the survey data needed to be thoroughly investigated for irregularities. Therefore a process was undertaken whereby:

- Post codes were checked for validity;

- Post codes were estimated from location descriptions where data was missing, invalid, or incomplete.

The investigation found that a small number of the survey records had incomplete location data. Out of 655 survey records, 10 records (2%) had no origin description at all. All those boarding at the bus station were assumed to have an origin post code of HP112ER. A record must contain both an origin postcode and destination postcode for the purpose of conducting a trip length frequency analysis.

Trip matrices and trip length frequencies were developed for passengers boarding at Wycombe bus station (separated by purpose). Table 4.1 shows the counts of boarders and alighters at the bus station by periods of the survey. It is noted that at the bus station there is an imbalance between the boarders and alighters. This is due to people alighting in the High Street but few board in the High Street, preferring to board buses in the bus station.

As passengers were only surveyed in one direction, i.e. those boarding buses and leaving the station, it was necessary to transpose some of the trip to develop a full matrix. The survey was used to provide information on the other journey leg. Matrices were developed for a number of trip purposes including:

- Home Based Work
- Home Based Business
- Home Based Shopping
- Home Based Education
- Home Based Other
- Non-Home Based

Table 4.1: Bus Service Count Data

| BUS NO.            | AMP 3hrs   |            | ITP 6 hrs    |              | PMP 2hrs   |            | TOTAL        |              |
|--------------------|------------|------------|--------------|--------------|------------|------------|--------------|--------------|
|                    | OFF        | ON         | OFF          | ON           | OFF        | ON         | OFF          | ON           |
| 1                  | 10         | 5          | 2            | 22           | 8          | 8          | 20           | 35           |
| 2                  | 0          | 0          | 4            | 0            | 0          | 10         | 4            | 10           |
| 3                  | 4          | 1          | 2            | 0            | 0          | 0          | 6            | 1            |
| 4                  | 20         | 35         | 31           | 54           | 17         | 20         | 69           | 108          |
| 30                 | 0          | 14         | 13           | 33           | 0          | 4          | 13           | 51           |
| 31                 | 144        | 20         | 114          | 221          | 54         | 111        | 312          | 352          |
| 33                 | 237        | 93         | 253          | 409          | 78         | 297        | 568          | 800          |
| 36                 | 0          | 4          | 4            | 0            | 0          | 0          | 4            | 4            |
| 74                 | 24         | 31         | 50           | 90           | 25         | 44         | 99           | 164          |
| 75                 | 0          | 6          | 0            | 0            | 0          | 0          | 0            | 6            |
| 100                | 2          | 28         | 7            | 32           | 3          | 7          | 12           | 66           |
| 158                | 0          | 0          | 2            | 2            | 0          | 0          | 2            | 2            |
| 275                | 0          | 0          | 0            | 0            | 2          | 0          | 2            | 0            |
| 305                | 0          | 2          | 0            | 5            | 0          | 0          | 1            | 7            |
| 306                | 5          | 1          | 2            | 5            | 1          | 1          | 8            | 7            |
| 307                | 9          | 24         | 15           | 69           | 0          | 0          | 24           | 93           |
| 308                | 0          | 1          | 14           | 18           | 0          | 0          | 14           | 19           |
| 309                | 0          | 0          | 0            | 5            | 4          | 29         | 4            | 34           |
| 315                | 0          | 5          | 0            | 12           | 7          | 6          | 7            | 24           |
| 317                | 37         | 35         | 29           | 71           | 28         | 64         | 94           | 171          |
| 320                | 0          | 0          | 1            | 0            | 0          | 0          | 1            | 0            |
| 321                | 9          | 1          | 0            | 0            | 0          | 0          | 9            | 1            |
| 323                | 51         | 45         | 23           | 78           | 8          | 45         | 82           | 168          |
| 324                | 0          | 25         | 31           | 40           | 18         | 20         | 50           | 85           |
| 326                | 211        | 99         | 176          | 328          | 60         | 158        | 447          | 586          |
| 328                | 36         | 76         | 37           | 79           | 2          | 38         | 74           | 194          |
| 329                | 19         | 46         | 62           | 67           | 22         | 46         | 102          | 159          |
| 331                | 3          | 0          | 0            | 0            | 0          | 1          | 3            | 1            |
| 333                | 0          | 6          | 0            | 0            | 3          | 2          | 3            | 8            |
| 338                | 4          | 4          | 0            | 3            | 0          | 1          | 4            | 8            |
| 339                | 14         | 7          | 30           | 27           | 0          | 7          | 44           | 41           |
| 340                | 18         | 0          | 17           | 31           | 0          | 9          | 35           | 40           |
| 342                | 1          | 0          | 23           | 16           | 0          | 0          | 24           | 16           |
| 345                | 0          | 13         | 7            | 32           | 0          | 11         | 7            | 56           |
| 348                | 8          | 14         | 24           | 4            | 0          | 8          | 32           | 26           |
| 353                | 0          | 0          | 0            | 0            | 0          | 0          | 0            | 0            |
| 362                | 12         | 2          | 30           | 1            | 22         | 19         | 63           | 22           |
| 400                | 16         | 51         | 11           | 40           | 0          | 9          | 27           | 100          |
| 631                | 0          | 2          | 0            | 0            | 9          | 0          | 9            | 2            |
| 643                | 0          | 0          | 9            | 0            | 0          | 0          | 9            | 0            |
| 651                | 0          | 0          | 0            | 2            | 0          | 0          | 0            | 2            |
| 663                | 0          | 2          | 21           | 0            | 0          | 0          | 21           | 2            |
| 737                | 7          | 12         | 4            | 16           | 1          | 3          | 13           | 31           |
| 908                | 0          | 0          | 0            | 0            | 0          | 0          | 0            | 0            |
| A40                | 6          | 37         | 20           | 35           | 27         | 7          | 53           | 80           |
| <b>Grand Total</b> | <b>908</b> | <b>749</b> | <b>1,068</b> | <b>1,847</b> | <b>401</b> | <b>987</b> | <b>2,377</b> | <b>3,583</b> |

## 4.3

**Matrix Development**

The proportions of trips in each time period by purpose are shown in Table 4.2. These show that in the AM and PM direction the largest proportion of trips are home based work trips. In the morning there is a large proportion of education trips while in the interpeak there are large proportions of shopping and other trips.

However, it is noted that there were too few business based trips in the survey to yield sensible results when the survey is factored up to create full trip matrices. Trip distribution was therefore assumed to be the same as for the full trip matrix i.e. Business trip were assumed to have the same distribution as total trips albeit a very low number.

**Table 4.2: Trip Purpose Proportions**

| Purpose                     | Direction                  | 12 hour     | AM          | IP          | PM          |
|-----------------------------|----------------------------|-------------|-------------|-------------|-------------|
| <b>Home Based Work</b>      | Home to Work               | 16%         | 41%         | 6%          | 1%          |
|                             | Work to Home               | 9%          | 1%          | 4%          | 45%         |
| <b>Home Based Business</b>  | Home to Employers Business | 0%          | 0%          | 0%          | 0%          |
|                             | Employers Business to Home | 0%          | 0%          | 0%          | 0%          |
| <b>Home Based Shopping</b>  | Home to Shopping           | 17%         | 6%          | 25%         | 9%          |
|                             | Shopping to Home           | 17%         | 6%          | 25%         | 9%          |
| <b>Home Based Education</b> | Home to Education          | 9%          | 27%         | 1%          | 0%          |
|                             | Education to Home          | 7%          | 0%          | 11%         | 10%         |
| <b>Home Based Other</b>     | Home to Other              | 9%          | 7%          | 10%         | 8%          |
|                             | Other to Home              | 9%          | 7%          | 10%         | 8%          |
| <b>Non-Home Based</b>       | Employer to Other          | 0%          | 0%          | 0%          | 1%          |
|                             | Other to Employer Business | 0%          | 0%          | 0%          | 1%          |
|                             | Other Non-Home Based       | 6%          | 3%          | 8%          | 7%          |
|                             |                            | <b>100%</b> | <b>100%</b> | <b>100%</b> | <b>100%</b> |

Factors were used to expand the survey matrix [after the transposing process] to a partial matrix ( $M_{ST}$ ) representing bus trips to the bus station. The factors were calculated by dividing the total count and are shown in table 4.3. For the interpeak the reverse direction matrix was assumed to be the same as the inbound demands for that period (with the exception of school trips which were taken from the morning peak matrix). For the Morning peak inbound trips these were taken as a factor of the evening peak

outbound trips and similarly for the Evening peak inbound trips from the Morning peak outbound trips..

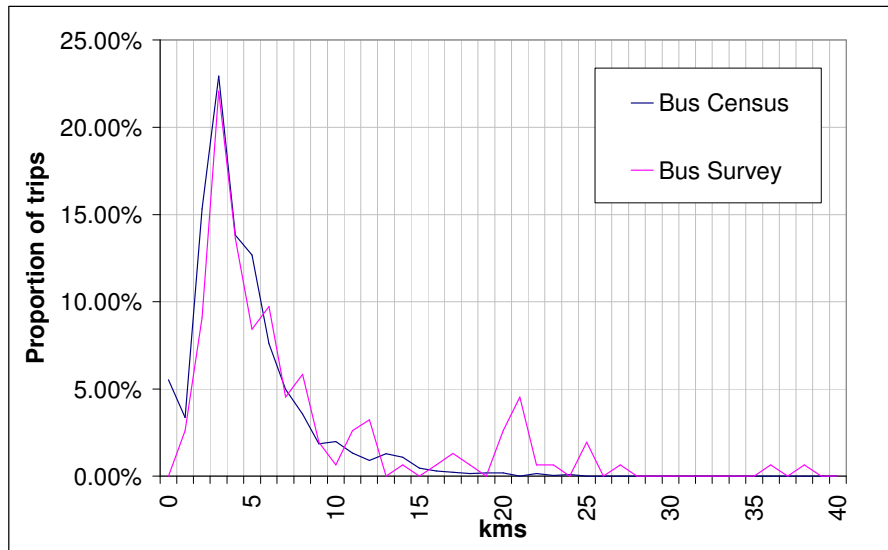
**Table 4.3: Derivation of expansion factors Interview Direction**

| Period    | Interview | Count | Expansion |
|-----------|-----------|-------|-----------|
| Am Peak   | 129       | 749   | 5.81      |
| Interpeak | 239       | 1,847 | 7.73      |
| PM peak   | 141       | 987   | 7.00      |

The combination of the two direction matrices gives the inbound and outbound demands to the town centre.

Trip Length Frequencies for the Journey to Work Census bus trips data and trips from the bus survey were compared. The results are shown in Figure 4.1. The frequencies match each other closely with exceptions occurring at 0 km's, 22 km's and 25 km's. Over 5% of the census results indicated the same origin and destination ward so the trip lengths of less than 1 km's. The spikes in surveyed results at 22km and 25km indicate trips to and from Aylesbury and Reading. These trips are not included in the census JtW data analysis as a cut off of those trips within a 20km radius of Wycombe city centre were selected for analysis.

Given the closeness of fit between the two sets of data it was considered a reasonable assumption that other trip purpose could be factored off the JtW results



**Figure 4.1: Trip Length Frequency Comparison: Census vs. Survey (Journey to Work)**

The next stage was to include the JtW demands for trips not using the town centre (bus station). The task of converting the JtW data into the WTS zone system was undertaken using MS Access (due to the large number of records involved). The first stage was to create full trip matrices by purpose and then create the individual time period matrices by reference to the household survey data. The latter data set allowed the proportion of bus trips by purpose and time period to be established.

As the JtW trip length frequencies tracked very closely to data from the bus survey it was possible to make factor the JtW matrix using proportions from the bus survey, to obtain trip matrices for other trip matrices.

The matrix totals for the period bus matrices are:

- Morning Peak 3hours= 2644
- Interpeak 6 hrs = 3538
- Evening Peak 3 hours = 2108

These period matrices were converted to hourly matrices prior to assignment.

Two additional elements are then incorporated into the PT matrices. These are the park and ride trips which have an origin zone representing the Park and ride car park at Cressex and a town centre destination. Finally the rail elements provided by the regional model are incorporated into the assignment.

## 5 Calibration and Validation

### 5.1 Calibration

Once the network had been fully assembled (as described in **Chapter 3**), and all services, modes and stopping patterns were coded, the model was calibrated to reflect the 'real' network used by passengers. Various checks were undertaken such as network connectivity, vehicle specifications, centroid connectors and link definitions.

### 5.2 Assignment Procedures

The assignment uses the service information and the demand matrices. It is a multipath assignment based on the computation which seeks to minimise the total expected travel time (including waiting, walking and in-vehicle time). The program determines the most attractive public transport between an origin and a destination. The program then determines the probability of using alternative routes. Where the probability of using alternative routes is high, the program allocates demand to each service.

### 5.3 Validation

The exercise of validating the public transport model featured the comparison of modelled and observed boarding data and modelled and actual travel times. Where possible, poor correlations were improved by modifying within reasonable bounds the network, network parameters or vehicle specifications.

When comparing the observed and modelled flows we used the GEH statistics as a measure of goodness-of-fit. The statistic is defined by the following formulae, where V1 and V2 are two different values of number of boarders for a station (i.e. modelled and observed).

$$GEH = \sqrt{\frac{(V2 - V1)^2}{0.5(V1 + V2)}}$$

### 5.4 Passenger Boardings

Given that the main focus of bus movements in the town is to the bus station this has been the focus of the validation. The observed data used for validation comprised boarding counts and was obtained from the bus counts at the bus station. The validation was undertaken for three time periods as shown in table 5.1. These show that the GEH statistic is below 2.0 in all cases except the alighting count for the Interpeak period. In this case a number of people alight at the High Street stops rather than continuing their journey to the bus station.

Table 5.2 shows the validation of the rail assignment. This mirrors the assignment carried out in the regional model. From these tables the flows through the main interchanges have been found to be satisfactory.

**Table 5.1: Validation Bus Station**

| Period | Model | Survey | Difference | % diff | GEH |
|--------|-------|--------|------------|--------|-----|
| AM     |       |        |            |        |     |
| Board  | 298   | 320    | -22        | -7%    | 1.3 |
| Alight | 372   | 341    | 31         | 9%     | 1.6 |
| IP     |       |        |            |        |     |
| Board  | 296   | 316    | -20        | -6%    | 1.1 |
| Alight | 257   | 175    | 82         | 47%    | 5.6 |
| PM     |       |        |            |        |     |
| Board  | 480   | 494    | -15        | -3%    | 0.7 |
| Alight | 123   | 107    | 16         | 15%    | 1.5 |

**Table 5.2: Validation High Wycombe Rail Station Boarding Information**

| Period | Model | Survey | Difference | % diff | GEH |
|--------|-------|--------|------------|--------|-----|
| AM     | 549   | 472    | 77         | 16%    | 3.4 |
| IP     | 152   | 112    | 40         | 36%    | 3.5 |
| PM     | 278   | 190    | 88         | 46%    | 5.7 |

## Appendix A- Zone Descriptions

| <b>Zone</b> | <b>Model Zone</b> | <b>Name</b>               |
|-------------|-------------------|---------------------------|
| 1           | 5001              | Frogmoor                  |
| 2           | 5002              | The Octagon               |
| 3           | 5003              | Castle Street             |
| 4           | 5004              | High Street               |
| 5           | 5005              | Easton Street             |
| 6           | 5006              | Queen Victoria Road       |
| 7           | 5007              | The Swan                  |
| 8           | 5008              | Wycombe College           |
| 9           | 5009              | Bridge Street             |
| 10          | 5010              | Brook Street              |
| 11          | 5011              | Dovecot                   |
| 12          | 5012              | Morrisons- Bellfield Road |
| 13          | 5013              | Priory Avenue             |
| 14          | 5014              | Priory Avenue             |
| 15          | 5015              | Dovecot                   |
| 16          | 5016              | Benjamin Road             |
| 17          | 5017              | Totteridge Lane           |
| 18          | 5018              | Gordon Road               |
| 19          | 5019              | Wycombe Abbey             |
| 20          | 5020              | Wycombe Hospital          |
| 21          | 5021              | Desborough Road           |
| 22          | 5022              | Desborough Road           |
| 23          | 5023              | Arnison Avenue            |
| 24          | 5024              | Garratts Way              |
| 25          | 5025              | Micklefield Way           |
| 26          | 5026              | Hughenden Avenue          |
| 27          | 5027              | Hamilton Road             |
| 28          | 5028              | Amersham Hill             |
| 29          | 5029              | Amersham Hill             |
| 30          | 5030              | Bowerdean Road North      |
| 31          | 5031              | Bowerdean Road            |
| 32          | 5032              | Bowerdean Road South      |
| 33          | 5033              | Gordon Road               |
| 34          | 5034              | Totteridge Road           |
| 35          | 5035              | Daws Hill                 |
| 36          | 5036              | Shelley Road              |
| 37          | 5037              | Shelley Road              |
| 38          | 5038              | Deeds Grove               |
| 39          | 5039              | Desborough                |
| 40          | 5040              | Green Street              |
| 41          | 5041              | Desborough Park Road      |
| 42          | 5042              | Downley West              |
| 43          | 5043              | Coates Lane               |
| 44          | 5044              | Coates Lane               |
| 45          | 5045              | Green Hill                |

| <b>Zone</b> | <b>Model Zone</b> | <b>Name</b>           |
|-------------|-------------------|-----------------------|
| 46          | 5046              | Royal Grammar School  |
| 47          | 5047              | Terriers              |
| 48          | 5048              | Totteridge Lane North |
| 49          | 5049              | Totteridge Lane       |
| 50          | 5050              | Shelley Road          |
| 51          | 5051              | Kings Wood            |
| 52          | 5052              | Micklefield           |
| 53          | 5053              | Micklefield           |
| 54          | 5054              | Micklefield           |
| 55          | 5055              | Ercol                 |
| 56          | 5056              | Wycombe Marsh         |
| 57          | 5057              | Rye                   |
| 58          | 5058              | RAF Daws Hill         |
| 59          | 5059              | Daws Hill Lane        |
| 60          | 5060              | Sports Centre         |
| 61          | 5061              | Cressex Schools       |
| 62          | 5062              | Booker                |
| 63          | 5063              | Cressex Road          |
| 64          | 5064              | Cressex Island        |
| 65          | 5065              | Cressex school        |
| 66          | 5066              | Holmer Farm           |
| 67          | 5067              | Booker                |
| 68          | 5068              | Turnpike Lane         |
| 69          | 5069              | Cressex               |
| 70          | 5070              | Cressex North         |
| 71          | 5071              | Charborough Road      |
| 72          | 5072              | Castlefield           |
| 73          | 5073              | Booker Hill           |
| 74          | 5074              | Sands West            |
| 75          | 5075              | Chapel Lane           |
| 76          | 5076              | Abercromby Avenue     |
| 77          | 5077              | Downley               |
| 78          | 5078              | Downley West          |
| 79          | 5079              | Downley               |
| 80          | 5080              | Naphill               |
| 81          | 5081              | Hughenden valley      |
| 82          | 5082              | Great Kingshill       |
| 83          | 5083              | Widmer End            |
| 84          | 5084              | Hazlemere Shops       |
| 85          | 5085              | Holmer Green West     |
| 86          | 5086              | Holmer Green          |
| 87          | 5087              | Holmer Green          |
| 88          | 5088              | Eastern Dene          |
| 89          | 5089              | Hazlemere             |
| 90          | 5090              | Inkerman Farm         |
| 91          | 5091              | Rose Avenue North     |
| 92          | 5092              | Rose Avenue South     |
| 93          | 5093              | Common Wood           |

| <b>Zone</b> | <b>Model Zone</b> | <b>Name</b>            |
|-------------|-------------------|------------------------|
| 94          | 5094              | Penn                   |
| 95          | 5095              | Penn Pond              |
| 96          | 5096              | Penn                   |
| 97          | 5097              | Wycombe Heights        |
| 98          | 5098              | Gomm Valley            |
| 99          | 5099              | Micklefield Road       |
| 100         | 5100              | Loudwater              |
| 101         | 5101              | Kingsmead Road         |
| 102         | 5102              | North of A40 Loudwater |
| 103         | 5103              | Kingsmead              |
| 104         | 5104              | Wycombe Marsh          |
| 105         | 5105              | Abbey Barn             |
| 106         | 5106              | Booker Common          |
| 107         | 5107              | Sands                  |
| 108         | 5108              | West Wycombe           |
| 109         | 5109              | Saunderton             |
| 110         | 5110              | Great Missenden        |
| 111         | 5111              | Seer Green             |
| 112         | 5112              | Winchmore Hill         |
| 113         | 5113              | Knotty Green           |
| 114         | 5114              | Forty Green            |
| 115         | 5115              | Beaconsfield New Town  |
| 116         | 5116              | Beaconsfield New Town  |
| 117         | 5117              | Seer Green             |
| 118         | 5118              | Jordans                |
| 119         | 5119              | West Gerrards Cross    |
| 120         | 5120              | Wilton Park            |
| 121         | 5121              | Beaconsfield Old Town  |
| 122         | 5122              | East Beaconsfield      |
| 123         | 5123              | Beaconsfield Old Town  |
| 124         | 5124              | Beaconsfield           |
| 125         | 5125              | Wooburn                |
| 126         | 5126              | Wooburn Moor           |
| 127         | 5127              | Wooburn Moor           |
| 128         | 5128              | Wooburn Green North    |
| 129         | 5129              | Flackwell              |
| 130         | 5130              | West Flackwell         |
| 131         | 5131              | Little Marlow          |
| 132         | 5132              | Marlow Bottom          |
| 133         | 5133              | Wycombe Air Park       |
| 134         | 5134              | Wooburn Common         |
| 135         | 5135              | Slough                 |
| 136         | 5136              | Frieth                 |
| 137         | 5137              | Lane End               |
| 138         | 5138              | Piddington             |
| 139         | 5139              | Maidenhead             |
| 140         | 5140              | Princes Risborough     |
| 141         | 5141              | Chesham                |

| <b>Zone</b> | <b>Model Zone</b> | <b>Name</b>        |
|-------------|-------------------|--------------------|
| 142         | 5142              | Amersham           |
| 143         | 5143              | Coleshill          |
| 144         | 5144              | Chalfont St Giles  |
| 145         | 5145              | Chalfont           |
| 146         | 5146              | Gerrards Cross     |
| 147         | 5147              | Fulmer             |
| 148         | 5148              | Farnham Common     |
| 149         | 5149              | Hedgerley          |
| 150         | 5150              | Littleworth Common |
| 151         | 5151              | Wooburn Green      |
| 152         | 5152              | Bourne End         |
| 153         | 5153              | Hedsor             |
| 154         | 5154              | Cookham East       |
| 155         | 5155              | Cookham            |
| 156         | 5156              | Marlow             |
| 157         | 5157              | Henley             |
| 158         | 5158              | Frieth             |
| 159         | 5159              | Stokenchurch       |
| 160         | 5160              | Long Crendon       |
| 161         | 5161              | Aylesbury          |
| 162         | 5162              | Tring              |
| 163         | 5163              | Leighton Buzzard   |
| 164         | 5164              | Luton              |
| 165         | 5165              | Berkhampsted       |
| 166         | 5166              | Hemel Hempstead    |
| 167         | 5167              | St Albans          |
| 168         | 5168              | Watford            |
| 169         | 5169              | Hertsmere          |
| 170         | 5170              | Central London     |
| 171         | 5171              | North London       |
| 172         | 5172              | Ealing             |
| 173         | 5173              | Uxbridge           |
| 174         | 5174              | Iver               |
| 175         | 5175              | Hayes              |
| 176         | 5176              | Hounslow           |
| 177         | 5177              | Staines            |
| 178         | 5178              | Langley            |
| 179         | 5179              | Slough             |
| 180         | 5180              | Taplow             |
| 181         | 5181              | Maidenhead East    |
| 182         | 5182              | Maidenhead         |
| 183         | 5183              | Windsor            |
| 184         | 5184              | Ascot              |
| 185         | 5185              | Bracknell          |
| 186         | 5186              | Hurley             |
| 187         | 5187              | Twyford            |
| 188         | 5188              | Reading            |
| 189         | 5189              | Oxford             |

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| <b>Zone</b> | <b>Model Zone</b> | <b>Name</b>        |
|-------------|-------------------|--------------------|
| 190         | 5190              | Milton Keynes      |
| 191         | 5191              | East London        |
| 192         | 5192              | South London       |
| 193         | 5193              | Surrey             |
| 194         | 5194              | South East England |
| 195         | 5195              | North Hampshire    |
| 196         | 5196              | South Hampshire    |
| 197         | 5197              | Dorset             |
| 198         | 5198              | South West         |
| 199         | 5199              | North West England |
| 200         | 5200              | East Anglia        |
| 201         | 5201              | Yorkshire          |

## Appendix B- Transit Line Information

**Table 1: Morning Peak Transit Line Summary**

| line   | description             | mode | veh.<br>Type | hdwy<br>(min) | speed | length | no.of<br>segs |
|--------|-------------------------|------|--------------|---------------|-------|--------|---------------|
| 001F1  | HW-Bourne End           | b    | 12           | 40            | 21.17 | 10.94  | 60            |
| 001R3  | Bourne End-HW           | b    | 12           | 40            | 26.26 | 10.56  | 63            |
| 001R4  | Bourne End-HW           | b    | 12           | 120           | 22.46 | 11.23  | 68            |
| 002F2  | GR8 Kingshill-HW        | b    | 12           | 120           | 15.16 | 7.58   | 36            |
| 002R3  | HW-GR8 Mssndn           | b    | 12           | 120           | 22.90 | 13.74  | 49            |
| 004F1  | HW-Chesham              | b    | 12           | 30            | 28.75 | 23.48  | 102           |
| 004R2  | Chesham-HW              | b    | 12           | 40            | 28.76 | 23.97  | 108           |
| 031F1  | Penn-HW-Downley         | b    | 12           | 12            | 20.66 | 15.15  | 78            |
| 031F2  | HW-Downley              | b    | 12           | 60            | 25.33 | 5.91   | 28            |
| 031R3  | Downley-HW-Penn         | b    | 12           | 120           | 37.72 | 14.46  | 76            |
| 031R4  | HW-Penn                 | b    | 12           | 120           | 12.78 | 9.16   | 49            |
| 031R5  | Downley-HW              | b    | 12           | 120           | 13.88 | 5.09   | 31            |
| 033F1  | Totteridge-Castlefie    | b    | 12           | 9.23          | 14.49 | 7.73   | 50            |
| 033F2  | HW-Castlefield          | b    | 12           | 60            | 14.61 | 3.41   | 16            |
| 033R1  | Castlefield-Tttridge    | b    | 12           | 9.23          | 13.03 | 6.95   | 43            |
| 074F1  | HW-Slough               | b    | 12           | 30            | 30.25 | 26.72  | 85            |
| 074F2  | Beaconsf-Slough         | b    | 12           | 120           | 21.94 | 12.80  | 36            |
| 074R10 | Beaconsfield-HW         | b    | 12           | 120           | 35.40 | 12.98  | 58            |
| 074R8  | Slough-Beaconsfield     | b    | 12           | 120           | 33.66 | 16.83  | 40            |
| 074R9  | Slough-HW               | b    | 12           | 20            | 29.40 | 26.95  | 94            |
| 100F1  | Cressex Island-HW<br>PR | b    | 12           | 10            | 13.72 | 3.43   | 27            |
| 100R3  | HW-Cressex PR           | b    | 12           | 10.91         | 12.17 | 4.26   | 31            |
| 275F1  | HW-Oxford               | b    | 12           | 60            | 35.15 | 41.59  | 58            |
| 275R4  | Oxford-Stokenchurch     | b    | 12           | 120           | 23.06 | 15.76  | 13            |
| 275R5  | Oxford-HW               | b    | 12           | 120           | 43.86 | 41.67  | 60            |
| 301F1  | HW-Flackwell            | b    | 12           | 40            | 17.29 | 6.34   | 48            |
| 301R2  | Flackwell-HW            | b    | 12           | 60            | 18.34 | 6.42   | 51            |
| 305F1  | HW-Uxbridge             | b    | 12           | 120           | 24.99 | 31.65  | 95            |
| 305F2  | Beaconsfield-Uxbridg    | b    | 12           | 120           | 16.57 | 21.54  | 45            |
| 305R3  | Uxbridge-Beaconsfiel    | b    | 12           | 120           | 39.56 | 21.54  | 45            |
| 306F1  | Totteridge-HW           | b    | 12           | 120           | 14.61 | 4.87   | 37            |
| 307F1  | Hollis-HW               | b    | 12           | 60            | 19.92 | 8.63   | 49            |
| 307R2  | no description          | b    | 12           | 40            | 21.45 | 7.15   | 38            |
| 308C1  | HW-Deeds Grove          | b    | 12           | 120           | 19.95 | 6.65   | 41            |
| 317F1  | HW-Maidenhead           | b    | 12           | 24            | 23.35 | 18.68  | 84            |
| 317F2  | HW-Bourne End           | b    | 12           | 30            | 29.84 | 10.94  | 60            |
| 317R3  | coach                   | b    | 12           | 24            | 26.40 | 10.56  | 63            |
| 317R4  | Maidenhead-HW           | b    | 12           | 40            | 18.22 | 18.83  | 90            |
| 323F1  | Aylesbury-HW            | b    | 12           | 24            | 35.87 | 27.50  | 81            |
| 323R3  | HW-Aylesbury            | b    | 12           | 30            | 28.32 | 27.38  | 74            |
| 324F1  | Aylesbury-HW            | b    | 12           | 120           | 27.11 | 27.11  | 80            |
| 324R4  | HW-Aylesbury            | b    | 12           | 40            | 32.39 | 26.99  | 73            |
| 326F1  | Booker-HW-Micklefiel    | b    | 12           | 12            | 19.57 | 12.07  | 81            |
| 326F2  | HW-Micklefield          | b    | 12           | 120           | 22.09 | 5.89   | 48            |

| line   | description             | mode | veh.<br>Type | hdwy<br>(min) | speed | length | no.of<br>segs |
|--------|-------------------------|------|--------------|---------------|-------|--------|---------------|
| 326R3  | Micklefield-Booker      | b    | 12           | 12            | 15.23 | 11.42  | 81            |
| 326R5  | Reading-HW              | b    | 12           | 0.01          | 25.00 | 36.08  | 97            |
| 327F1  | Flackwell Heath-HW      | b    | 12           | 120           | 21.48 | 12.53  | 79            |
| 328F1  | HW-Reading              | b    | 12           | 60            | 28.87 | 44.75  | 113           |
| 328R4  | Henley-HW               | b    | 12           | 120           | 32.89 | 23.57  | 67            |
| 328R5  | Reading-HW              | b    | 12           | 120           | 31.03 | 45.51  | 116           |
| 329F1  | HW-Reading              | b    | 12           | 60            | 28.26 | 35.32  | 94            |
| 329R4  | Marlow-HW               | b    | 12           | 120           | 38.23 | 11.47  | 43            |
| 329R5  | Reading-HW              | b    | 12           | 60            | 26.08 | 36.08  | 97            |
| 331F1  | Chinnor-Marlowhill S    | b    | 12           | 120           | 22.45 | 16.09  | 57            |
| 331F2  | Thame-HW                | b    | 12           | 120           | 25.20 | 20.16  | 46            |
| 333C1  | HW-Speen (circ)         | b    | 12           | 120           | 23.60 | 23.60  | 104           |
| 333C2  | HW-Speen (circ)         | b    | 12           | 120           | 24.46 | 21.20  | 89            |
| 339F1  | Lane End-HW             | b    | 12           | 40            | 21.49 | 10.03  | 42            |
| 339F2  | Cressex Rd-HW           | b    | 12           | 120           | 18.78 | 4.07   | 23            |
| 339F3  | Lane End-Crendon St     | b    | 12           | 120           | 29.78 | 10.92  | 49            |
| 339F4  | Lane End-HW             | b    | 12           | 120           | 21.43 | 10.00  | 39            |
| 339R5  | HW-Lane End             | b    | 12           | 40            | 27.16 | 9.96   | 39            |
| 339R6  | HW-Cressex              | b    | 12           | 120           | 20.10 | 4.02   | 23            |
| 339R7  | HW-Lane End             | b    | 12           | 120           | 27.16 | 9.96   | 39            |
| 342F1  | HW-Ibstone              | b    | 12           | 30            | 47.40 | 20.54  | 45            |
| 345F1  | GR8 Missenden-HW        | b    | 12           | 120           | 26.83 | 13.86  | 60            |
| 345R2  | HW-GR8 Missenden        | b    | 12           | 60            | 29.96 | 15.48  | 54            |
| 348F1  | GR8 Missenden-HW        | b    | 12           | 40            | 20.33 | 15.25  | 57            |
| 362F1  | HW-Amersham Sch         | b    | 12           | 120           | 22.68 | 15.12  | 63            |
| 372F1  | HW-Chesham              | b    | 12           | 60            | 25.40 | 23.71  | 104           |
| 372F2  | HW-Chesham              | b    | 12           | 60            | 24.12 | 25.73  | 111           |
| 372R4  | Chesham-HW              | b    | 12           | 120           | 28.20 | 21.15  | 91            |
| 372R5  | Holmer Gr-HW            | b    | 12           | 120           | 18.16 | 6.66   | 41            |
| 372R6  | Chesham-HW              | b    | 12           | 120           | 20.54 | 23.96  | 109           |
| 372R7  | Chesham-HW              | b    | 12           | 40            | 20.77 | 25.96  | 115           |
| 393F1  | Newland Park-HW         | b    | 12           | 120           | 31.53 | 23.65  | 82            |
| 393R3  | HW-Newland Park         | b    | 12           | 120           | 27.16 | 23.99  | 85            |
| 400F1  | HW-Stokenchurch         | b    | 12           | 120           | 48.71 | 12.99  | 33            |
| 400F12 | Spring Lane-HW          | b    | 12           | 0.01          | 0.01  | 5.17   | 30            |
| 400F4  | HW Sports-Bourne<br>End | b    | 12           | 120           | 14.90 | 6.21   | 30            |
| 400F5  | Stokenchurch-Bourne     | b    | 12           | 120           | 22.28 | 23.02  | 81            |
| 400F6  | HW-Spring Lane          | b    | 12           | 120           | 18.44 | 4.61   | 26            |
| 400F9  | Bourne End-HW           | b    | 12           | 120           | 17.93 | 9.56   | 46            |
| 400R10 | Bourne End-HW           | b    | 12           | 120           | 21.24 | 9.56   | 46            |
| 757F1  | Stansted-HW-Oxford      | b    | 12           | 120           | 49.03 | 85.81  | 129           |
| 757R2  | Oxford-HW-Stansted      | b    | 12           | 120           | 42.87 | 85.73  | 125           |
| A40F1  | HW-Heathrow             | b    | 12           | 30            | 29.77 | 32.25  | 91            |
| A40R2  | Heathrow-HW             | b    | 12           | 30            | 39.08 | 32.57  | 103           |
| CRSXEP | Cressex-HW Rail         | b    | 12           | 10.91         | 20.51 | 3.76   | 25            |
| CRSXR2 | HW Rail-Cressex         | b    | 12           | 10            | 14.77 | 3.20   | 21            |

Table 2: Inter Peak Transit Line Summary

| line   | description          | mode | veh.<br>Type | hdwy<br>(min) | speed | length | no.of<br>segs |
|--------|----------------------|------|--------------|---------------|-------|--------|---------------|
| 001F1  | HW-Bourne End        | b    | 12           | 420           | 27.35 | 10.94  | 60            |
| 001F2  | HW-Bourne End        | b    | 12           | 105           | 29.03 | 11.61  | 65            |
| 001F5  | HW-Bourne End        | b    | 12           | 420           | 29.67 | 11.87  | 60            |
| 001R10 | Bourne End-HW        | b    | 12           | 420           | 17.34 | 10.69  | 56            |
| 001R7  | Bourne End-HW        | b    | 12           | 420           | 28.4  | 11.36  | 61            |
| 001R8  | Woburn -Post Office  | b    | 12           | 420           | 31.14 | 5.19   | 18            |
| 001R9  | Bourne End-HW        | b    | 12           | 84            | 28.08 | 11.23  | 68            |
| 002F1  | GR8 Missndn-HW       | b    | 12           | 420           | 24.41 | 13.83  | 53            |
| 002F2  | GR8 Kingshll-HW      | b    | 12           | 105           | 19.77 | 7.58   | 36            |
| 002R3  | HW-GR8 Mssndn        | b    | 12           | 420           | 22.9  | 13.74  | 49            |
| 002R4  | HW-GR8 Kingshall     | b    | 12           | 105           | 18.73 | 7.49   | 32            |
| 004F1  | HW-Chesham           | b    | 12           | 60            | 28.75 | 23.48  | 102           |
| 004R2  | Chesham-HW           | b    | 12           | 46.67         | 29.35 | 23.97  | 108           |
| 031F1  | Penn-HW-Downley      | b    | 12           | 17.5          | 20.2  | 15.15  | 78            |
| 031R3  | Downley-HW-Penn      | b    | 12           | 24.71         | 20.18 | 14.46  | 76            |
| 033F1  | Totteridge-Castlefie | b    | 12           | 17.5          | 14.96 | 7.73   | 50            |
| 033R1  | Castlefield-Tttridge | b    | 12           | 18.26         | 13.03 | 6.95   | 43            |
| 074F1  | HW-Slough            | b    | 12           | 84            | 27.64 | 26.72  | 85            |
| 074F3  | HW-Beaconsfield      | b    | 12           | 210           | 24.65 | 9.86   | 45            |
| 074F4  | HW-Slough            | b    | 12           | 84            | 30.25 | 26.72  | 85            |
| 074F5  | HW-Beaconsfield      | b    | 12           | 105           | 24.65 | 9.86   | 45            |
| 074R10 | Beaconsfield-HW      | b    | 12           | 70            | 31.15 | 12.98  | 58            |
| 074R9  | Slough-HW            | b    | 12           | 46.67         | 30.51 | 26.95  | 94            |
| 100F2  | Cressex Island-HW PR | b    | 12           | 19.09         | 20.65 | 4.13   | 31            |
| 100R3  | HW-Cressex PR        | b    | 12           | 16.15         | 18.26 | 4.26   | 31            |
| 275F1  | HW-Oxford            | b    | 12           | 210           | 42.29 | 41.59  | 58            |
| 275R4  | Oxford-Stokenchurch  | b    | 12           | 420           | 23.06 | 15.76  | 13            |
| 275R5  | Oxford-HW            | b    | 12           | 210           | 43.86 | 41.67  | 60            |
| 301F1  | HW-Flackwell         | b    | 12           | 70            | 15.22 | 6.34   | 48            |
| 301R2  | Flackwell-HW         | b    | 12           | 70            | 16.75 | 6.42   | 51            |
| 305F1  | HW-Uxbridge          | b    | 12           | 140           | 27.13 | 31.65  | 95            |
| 305F2  | Beaconsfield-Uxbridg | b    | 12           | 210           | 26.93 | 21.54  | 45            |
| 305R3  | Uxbridge-Beaconsfiel | b    | 12           | 210           | 33.91 | 21.54  | 45            |
| 305R4  | Uxbridge-HW          | b    | 12           | 210           | 18.46 | 31.66  | 99            |
| 306F1  | Totteridge-HW        | b    | 12           | 70            | 14.61 | 4.87   | 37            |
| 306R2  | HW-Totteridge        | b    | 12           | 70            | 14.36 | 4.07   | 28            |
| 307F1  | Hollis-HW            | b    | 12           | 35            | 19.92 | 8.63   | 49            |
| 307R2  | no description       | b    | 12           | 38.18         | 21.45 | 7.15   | 38            |
| 308/9A | HW-Middlebrook/Downl | b    | 12           | 84            | 31.01 | 12.92  | 68            |
| 308/9B | HW-Plomer-HW-Micklef | b    | 12           | 420           | 32.71 | 12.54  | 63            |
| 308C1  | HW-Deeds Grove       | b    | 12           | 105           | 19.95 | 6.65   | 41            |
| 309R2  | HW-St Hughs          | b    | 12           | 420           | 22.27 | 6.31   | 36            |
| 317F1  | HW-Maidenhead        | b    | 12           | 84            | 22.42 | 18.68  | 84            |
| 317F2  | HW-Bourne End        | b    | 12           | 84            | 27.35 | 10.94  | 60            |
| 317R4  | Maidenhead-HW        | b    | 12           | 70            | 21.73 | 18.83  | 90            |
| 323F1  | Aylesbury-HW         | b    | 12           | 60            | 32.35 | 27.5   | 81            |

| line       | description          | mode | veh.<br>Type | hdwy<br>(min) | speed | length | no.of<br>segs |
|------------|----------------------|------|--------------|---------------|-------|--------|---------------|
| 323R3      | HW-Aylesbury         | b    | 12           | 60            | 31.59 | 27.38  | 74            |
| 324F1      | Aylesbury-HW         | b    | 12           | 60            | 31.89 | 27.11  | 80            |
| 324R4      | HW-Aylesbury         | b    | 12           | 60            | 31.14 | 26.99  | 73            |
| 326F1      | Booker-HW-Micklefiel | b    | 12           | 16.8          | 17.24 | 12.07  | 81            |
| 326R3      | Micklefield-Booker   | b    | 12           | 17.5          | 15.93 | 11.42  | 81            |
| 327F1      | Flackwell Heath-HW   | b    | 12           | 420           | 21.48 | 12.53  | 79            |
| 327F4      | Robinsons Rd-HW      | b    | 12           | 105           | 16.63 | 6.93   | 54            |
| 327R2      | WH-Robinson Rd       | b    | 12           | 140           | 16.27 | 6.78   | 49            |
| 327R3      | HW-Flackwell Heath   | b    | 12           | 420           | 26.68 | 12.45  | 77            |
| 328F1      | HW-Reading           | b    | 12           | 60            | 33.56 | 44.75  | 113           |
| 328R6      | Reading-HW           | b    | 12           | 84            | 28.11 | 36.08  | 97            |
| 329F1      | HW-Reading           | b    | 12           | 60            | 28.26 | 35.32  | 94            |
| 329R5      | Reading-HW           | b    | 12           | 70            | 28.86 | 36.08  | 97            |
| 331R4      | HW-Thame             | b    | 12           | 420           | 28.89 | 20.22  | 44            |
| 333C2      | HW-Speen (circ)      | b    | 12           | 420           | 31.02 | 21.2   | 89            |
| 334C1      | HW-Speen (circ)      | b    | 12           | 420           | 31.1  | 21.25  | 88            |
| 339F1      | Lane End-HW          | b    | 12           | 60            | 21.49 | 10.03  | 42            |
| 339R5      | HW-Lane End          | b    | 12           | 60            | 27.16 | 9.96   | 39            |
| 339R7      | HW-Lane End          | b    | 12           | 60            | 27.16 | 9.96   | 39            |
| 340F1      | HW-Radnage           | b    | 12           | 140           | 38.89 | 20.74  | 46            |
| 340R2      | Radnage-HW           | b    | 12           | 105           | 42.26 | 17.61  | 45            |
| 342F1      | HW-Ibstone           | b    | 12           | 210           | 45.64 | 20.54  | 45            |
| 342R2      | Ibstone-HW           | b    | 12           | 140           | 45.31 | 20.39  | 47            |
| 345F1      | GR8 Missenden-HW     | b    | 12           | 70            | 26.83 | 13.86  | 60            |
| 345R2      | HW-GR8 Missenden     | b    | 12           | 70            | 38.7  | 15.48  | 54            |
| 362F2      | HW-Chesham           | b    | 12           | 70            | 26.76 | 24.08  | 104           |
| 362R4      | Chesham-HW           | b    | 12           | 70            | 23.66 | 22.08  | 100           |
| 372F1      | HW-Chesham           | b    | 12           | 60            | 26.34 | 23.71  | 104           |
| 372R7      | Chesham-HW           | b    | 12           | 60            | 27.81 | 25.96  | 115           |
| 393F1      | Newland Park-HW      | b    | 12           | 210           | 31.53 | 23.65  | 82            |
| 393F2      | Newland Pk-Stanley H | b    | 12           | 420           | 35.8  | 8.95   | 17            |
| 393R3      | HW-Newland Park      | b    | 12           | 140           | 31.99 | 23.99  | 85            |
| 400F7      | HW-Bourne End        | b    | 12           | 52.5          | 31.15 | 12.98  | 66            |
| 400R10     | Bourne End-HW        | b    | 12           | 60            | 23.9  | 9.56   | 46            |
| 400R11     | Wye Sch-Mrlw Rd Sch  | b    | 12           | 420           | 24.22 | 12.11  | 60            |
| 643F1      | HW-Ibstone School    | b    | 12           | 420           | 18.9  | 17.01  | 38            |
| 651F1      | HW-Stokenchurch sch  | b    | 12           | 420           | 29.98 | 12.99  | 33            |
| 757F1      | Stansted-HW-Oxford   | b    | 12           | 210           | 57.21 | 85.81  | 129           |
| 757R2      | Oxford-HW-Stansted   | b    | 12           | 140           | 48.99 | 85.73  | 125           |
| A40F1      | HW-Heathrow          | b    | 12           | 60            | 32.25 | 32.25  | 91            |
| A40R2      | Heathrow-HW          | b    | 12           | 60            | 32.57 | 32.57  | 103           |
| CRSXE<br>P | Cressex-HW Rail      | b    | 12           | 30            | 13.27 | 3.76   | 25            |
| CRSXR<br>2 | HW Rail-Cressex      | b    | 12           | 30            | 16    | 3.2    | 21            |

Table 3: Evening Peak Transit Line Summary

| line   | description          | mode | veh.<br>Type | hdwy<br>(min) | speed | length | no.of<br>segs |
|--------|----------------------|------|--------------|---------------|-------|--------|---------------|
| 001F1  | HW-Bourne End        | b    | 12           | 40            | 26.26 | 10.94  | 60            |
| 001R10 | Bourne End-HW        | b    | 12           | 120           | 26.73 | 10.69  | 56            |
| 001R9  | Bourne End-HW        | b    | 12           | 60            | 25.92 | 11.23  | 68            |
| 004F1  | HW-Chesham           | b    | 12           | 24            | 28.75 | 23.48  | 102           |
| 004R2  | Chesham-HW           | b    | 12           | 30            | 29.35 | 23.97  | 108           |
| 031F1  | Penn-HW-Downley      | b    | 12           | 13.33         | 17.15 | 15.15  | 78            |
| 031R3  | Downley-HW-Penn      | b    | 12           | 15            | 17.35 | 14.46  | 76            |
| 033F1  | Totteridge-Castlefie | b    | 12           | 9.23          | 14.96 | 7.73   | 50            |
| 033R1  | Castlefield-Tttridge | b    | 12           | 12            | 13.03 | 6.95   | 43            |
| 074F4  | HW-Slough            | b    | 12           | 20            | 28.63 | 26.72  | 85            |
| 074R9  | Slough-HW            | b    | 12           | 40            | 29.94 | 26.95  | 94            |
| 100F1  | Cressex Island-HW PR | b    | 12           | 15            | 11.43 | 3.43   | 27            |
| 100R3  | HW-Cressex PR        | b    | 12           | 15            | 13.45 | 4.26   | 31            |
| 275F1  | HW-Oxford            | b    | 12           | 120           | 43.02 | 41.59  | 58            |
| 275F2  | Stokenchurch-Oxford  | b    | 12           | 120           | 39.91 | 28.6   | 25            |
| 275F3  | Milton-Oxford        | b    | 12           | 120           | 33.28 | 15.53  | 13            |
| 301F1  | HW-Flackwell         | b    | 12           | 60            | 13.12 | 6.34   | 48            |
| 301R2  | Flackwell-HW         | b    | 12           | 60            | 15.41 | 6.42   | 51            |
| 305R4  | Uxbridge-HW          | b    | 12           | 120           | 17.23 | 31.66  | 99            |
| 308/9B | HW-Plomer-HW-Micklef | b    | 12           | 60            | 32.71 | 12.54  | 63            |
| 309F1  | St Hughs-HW          | b    | 12           | 60            | 25.28 | 6.32   | 41            |
| 309R2  | HW-St Hughs          | b    | 12           | 120           | 19.93 | 6.31   | 36            |
| 317F1  | HW-Maidenhead        | b    | 12           | 40            | 22.42 | 18.68  | 84            |
| 317F2  | HW-Bourne End        | b    | 12           | 60            | 27.35 | 10.94  | 60            |
| 317R3  | coach                | b    | 12           | 40            | 21.85 | 10.56  | 63            |
| 317R4  | Maidenhead-HW        | b    | 12           | 60            | 21.73 | 18.83  | 90            |
| 323F1  | Aylesbury-HW         | b    | 12           | 120           | 30.56 | 27.5   | 81            |
| 323R3  | HW-Aylesbury         | b    | 12           | 60            | 29.87 | 27.38  | 74            |
| 324F1  | Aylesbury-HW         | b    | 12           | 120           | 30.12 | 27.11  | 80            |
| 324R4  | HW-Aylesbury         | b    | 12           | 60            | 29.44 | 26.99  | 73            |
| 326F1  | Booker-HW-Micklefiel | b    | 12           | 15            | 15.74 | 12.07  | 81            |
| 326R3  | Micklefield-Booker   | b    | 12           | 20            | 15.23 | 11.42  | 81            |
| 328F1  | HW-Reading           | b    | 12           | 60            | 31.96 | 44.75  | 113           |
| 328R6  | Reading-HW           | b    | 12           | 60            | 27.06 | 36.08  | 97            |
| 329F1  | HW-Reading           | b    | 12           | 60            | 27.17 | 35.32  | 94            |
| 329R5  | Reading-HW           | b    | 12           | 60            | 26.4  | 36.08  | 97            |
| 331F3  | Chinnor-HW           | b    | 12           | 120           | 26.98 | 13.49  | 37            |
| 331R5  | Marlow Hill-Chinnor  | b    | 12           | 120           | 25.9  | 15.97  | 50            |
| 331R6  | HW-Chinnor           | b    | 12           | 120           | 23.91 | 13.55  | 35            |
| 334C1  | HW-Speen (circ)      | b    | 12           | 120           | 31.1  | 21.25  | 88            |
| 334C2  | HW-Speen (circ)      | b    | 12           | 120           | 27.65 | 23.5   | 102           |
| 339F1  | Lane End-HW          | b    | 12           | 60            | 20.06 | 10.03  | 42            |
| 339F4  | Lane End-HW          | b    | 12           | 60            | 24    | 10     | 39            |
| 339R5  | HW-Lane End          | b    | 12           | 60            | 22.98 | 9.96   | 39            |
| 339R7  | HW-Lane End          | b    | 12           | 60            | 22.98 | 9.96   | 39            |
| 339R8  | HW-Lane End via MH   | b    | 12           | 120           | 30.03 | 9.51   | 43            |

| line       | description          | mode | veh.<br>Type | hdwy<br>(min) | speed | length | no.of<br>segs |
|------------|----------------------|------|--------------|---------------|-------|--------|---------------|
| 340F1      | HW-Radnage           | b    | 12           | 60            | 32.75 | 20.74  | 46            |
| 342R2      | Ibstone-HW           | b    | 12           | 120           | 50.98 | 20.39  | 47            |
| 345F1      | GR8 Missenden-HW     | b    | 12           | 60            | 25.2  | 13.86  | 60            |
| 345R2      | HW-GR8 Missenden     | b    | 12           | 120           | 26.54 | 15.48  | 54            |
| 348R2      | no description       | b    | 12           | 40            | 24.14 | 14.08  | 52            |
| 362F2      | HW-Chesham           | b    | 12           | 120           | 23.3  | 24.08  | 104           |
| 362F3      | HW-Chesham           | b    | 12           | 120           | 23.22 | 22.06  | 97            |
| 362R5      | Holmer Green-HW      | b    | 12           | 120           | 20.11 | 7.04   | 42            |
| 372F1      | HW-Chesham           | b    | 12           | 120           | 24.96 | 23.71  | 104           |
| 372F3      | HW-Chesham           | b    | 12           | 60            | 23.04 | 25.73  | 111           |
| 372R7      | Chesham-HW           | b    | 12           | 40            | 21.63 | 25.96  | 115           |
| 393F1      | Newland Park-HW      | b    | 12           | 120           | 31.53 | 23.65  | 82            |
| 393F2      | Newland Pk-Stanley H | b    | 12           | 120           | 10.74 | 8.95   | 17            |
| 400F1      | HW-Stokenchurch      | b    | 12           | 120           | 43.3  | 12.99  | 33            |
| 400F12     | Spring Lane-HW       | b    | 12           | 120           | 30    | 5.17   | 30            |
| 400R10     | Bourne End-HW        | b    | 12           | 120           | 23.9  | 9.56   | 46            |
| 400R12     | Flackwell-HW         | b    | 12           | 120           | 30.92 | 7.73   | 42            |
| 400R13     | Bourne End-HW        | b    | 12           | 120           | 28.86 | 24.53  | 92            |
| 757F1      | Stansted-HW-Oxford   | b    | 12           | 60            | 49.03 | 85.81  | 129           |
| 757R2      | Oxford-HW-Stansted   | b    | 12           | 60            | 57.15 | 85.73  | 125           |
| A40F1      | HW-Heathrow          | b    | 12           | 30            | 32.25 | 32.25  | 91            |
| A40R2      | Heathrow-HW          | b    | 12           | 120           | 32.57 | 32.57  | 103           |
| CRSXE<br>P | Cressex-HW Rail      | b    | 12           | 17.14         | 13.27 | 3.76   | 25            |
| CRSXR<br>2 | HW Rail-Cressex      | b    | 12           | 15            | 11.29 | 3.2    | 21            |